The Pharmacological and Ethnobotanical significance of *Clitoria ternatea*

Praveen Kumar Maddheshiya[1], Shubhra Gupta[1], Kiran Gupta[2] and Kapil Gupta[1]*

[1]Department of Biotechnology, Siddharth University, Kapilvastu, Siddharth Nagar, Uttar Pradesh, India

[2]Department of Botany, Siddharth University, Kapilvastu, Siddharth Nagar, Uttar Pradesh, India

Abstract

Clitoria ternatea, which is a tropical plant cherished for its many uses and eye-catching blue blooms. It is widely distributed throughout Asia, Africa, and Central and South America, belonging to the Fabaceae family. For centuries, people in many cultures have utilized *C. ternatea* in medical treatments. The plant's pharmacological actions are due to its abundance of phytochemicals, including flavonoids, tannins, anthocyanins, terpenoids and alkaloids. Because of its antibacterial, antioxidant, and anti-inflammatory qualities, it is used for the treatments of different health problems. It has been used for centuries to enhance mental and memory function, and studies have suggested that it may have antidepressant, anxiolytic, and nootropic effects. Ayurveda as well as Chinese traditional medicine widely utilize *C. ternatea* for some kind of therapeutic conditions, including fever and dermatological as well as urethral/urinary disorders besides respiratory pathologies. Flowers commonly have been considered in the development of herbal infusion tea, popularly believed for anxiolysis and providing sedative properties. As an adjunct with medicine, Clitoria leaves are also used for cosmetic besides being naturally utilized as pigmentation.

Keywords: *Clitoria ternatea*, Medicinal plant, Phytochemistry, Pharmacological properties, Cancer

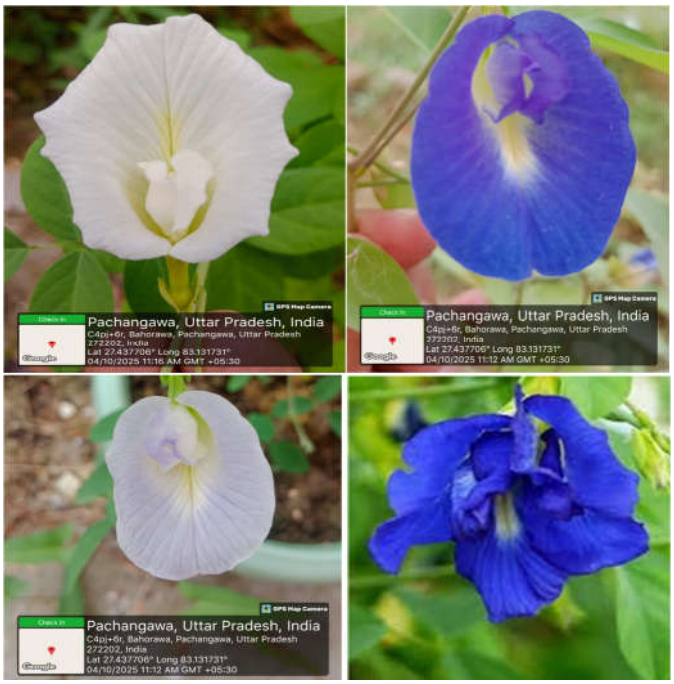
Abbreviations:

Ach: Acetylcholine; b.w.: Body weight; *C. ternatea*: *Clitoria ternatea*; CT: *Clitoria ternatea*; FTIR: Fourier Transform Infrared Spectroscopy; i.p.: Intraperitoneal; IGC: Intragastric catheter tube; KET: Ketoconazole; MES: Maximum electroshock; mg/kg: Milligram/Kilogram; mm: Millimeter; P.O: Oral route "per os"

INTRODUCTION

For fighting the adverse effects of modern medication and to promote health, medicinal herbs are used quite often as an alternative (Kiranmai et al., 2023). The number of papers on the advantages of various medicinal compounds found in aparajita and their molecular and biochemical effects has increased. Therefore, in order to make educated decisions regarding their use, scientific examination of their biological characteristics, therapeutic potential, and safety will be helpful (Taylor and Berridge 2006). Traditional medicinal herbs have yielded a number of important medicines and physiologically active chemicals. The medicinal properties of plants are diverse and include antibacterial, antioxidant, cancer prevention, hypolipidemic, respiratory, cardiovascular, immune-mediated, analgesics, anti-inflammatory, and antipyretic qualities (Jenifer Tamizharasi et al., 2022). The countries of India, China, Central and South America, and the East and the West Indies are home to the recognized species known as the Asiatic tropical butterfly pea, or *C. ternatea* (Barik et al., 2007). The proteins, alkaloid compounds, lipoprotein glycosides, anthocyans, stigmast-4-ene-3,6-dione, volatile oils, steroids, sugars, saponins, triterpenoids, phenols, tannins, phlobatannin, and flavanoids were all identified in *C. ternatea* (Kazuma, 2003). Insecticidal, antimicrobial in nature cancer-fighting, anti-inflammatory in nature antipyretic, analgesic, anti-diabetic, neurological system, and hypolipidemic properties are among the plant's known pharmacological qualities (Chakraborthy et al., 2018).

Plant profile:



Taxonomic classification:
Kingdom: Plantae,
Subkingdom: Viridaeplanta,
Infrakingdom: Streptophyta,
Division: Tracheophyta,
Subdivision: Spermatophytina,
Infrodivision: Angiospermae,
Class: Magnoliopsida,
Order: Fabales,
Family: Fabaceae,
Genus: Clitoria L.
Species: *ternatea*
(Shinde and Khemnar, 2024)

Common names: *Clitoria ternatea* have different Local names in different languages like In Hindi: It is called Aparajita; In Punjabi: It is called Koyal; In Sanskrit: It is called Girikarnika, Vishnukanta; In Tamil: It is called Kakkanam; In Telugu: It is called Dintena; In Arabic: It is called Mazerion Hidi,

Baslat el-Zuhoor; In Bengali: It is called Aparajita; In English: It is called blue-pea, bluebell vine, butterfly-pea, Darwin-pea and cordofan pea, (Jenifer Tamizharasi et al., 2022).

History:

From ancient time "Shankhpushpi" has been considered as an authentic Ayurvedic drug and it is employed as a purgative, nervine tonic and brain tonic. Shankhapushpi is referred to as a MEDHYA-RASAYANA in the Ayurvedic classics. It is composed of the following: *Convolvulus pluricaulis, Evolvulus alsinoides, Conscora decusata,* and *C. ternatea*. It is an Ayurvedic medication that acts on the central nervous system, particularly as a memory and cognitive enhancers (Sethiya et al., 2009). The *C. ternatea* flowers are called "SHANKPUSHPI"

because they resemble conch-shell in Sanskrit. This plant is considered to be a great MEDHYA-RASAYANA, and its extracts have been utilized to treat neurological illnesses and Masasika Roga's mental disorders (Daisy and Rajathi, 2009; Kumar et al.,2008). *C. ternatea* is a tall, lean, climbing legume with deep roots, a deep blue bloom, and five to seven leaflets.

Chemical Constituents:

The screening of preliminary phytochemistry reveals the presence of triterpenoids, tannins, cardiac glycosides, proteins, phlobatannin, anthocyanins, carbohydrates, alkaloids, steroids, saponins, phenols, flavanoids, flavonol glycosides, antharaquinone, Stigmast-4-ene-3, 6-dione, and volatile oils (Rai et al., 2015).

Phytochemistry

Flower: According to Chayaratanasin in the flowers of Aparajita flavonol, glycosides, quercetin, and phenolic substances were found (Chayaratanasin et al., 2015). It contains anthocyanins, flavones, flavonols, cyclotides, phenolic acids, and flavonol glycosides. The flower contains the following compounds: kaempferol 3-2G-rhamnosylrutinoside, kaempferol 3-neohesperidoside, quercetin 3-neohesperidoside, myricetin 3-neohesperidoside, kaempferol 3-rutinoside, quercetin 3-rutinoside, myricetin 3-rutinoside, kaempferol 3-glucoside, quercetin 3glucoside, and myricetin 3-glucoside (Mukherjee et al., 2008)

Leaf

Clitorin and kaempferol have been isolated from ethanolic leaf extracts (Gomez and Kalamani, 2003). The leaves also contain 3-rutinoside, 3-monoglucoside, 3-o-rhamnosyl-glucoside, 3-o-rhamnosylgalactoside of kaemferol and 3-neohesperidoside in addition to 3-o rhamnosyl o-rhamnosyl glucoside. Besides, it contains β-sitosterol and aparajitin (Mukherjee et al., 2008).

Root:

Plant roots contain both taxaxerone and taxaxerol. Root bark contains flavonol glycosides, starch, tannin, and resin. α-aminobutyric acid, alanine, valine, Glycine, leucine, glutamic acid, arginine, aspartic acid, ornithine, γ-aminobutyric acid and histadine are the constituents of the root nodules, according to (Sarma et al., 2023).

Seed:

C. ternatea Seeds contain bitter acid resin constitutes the majority of seed and these seeds also contain tannic acid and glucose, besides possessing greenish yellow oil. The two substances which are extracted from the seeds are anthoxanthin and sitosterol (Raut et al., 2025). Along this, seed oil also yields palmitic, linolenic acids, oleic, linoleic and stearic. It has been known that oils from the blue and white flower types are almost identical. Hexacosanol, a nucleoprotein and cinnamic acid, with a sequence that is similar to human insulin, also occur in the seed (Jiji and Muralidharan, 2020).

Medicinal uses:

Root is used in the therapy of skin diseases, sore throat, visceral abdominal enlargement, and ascetics. They were not suggested to be taken as purgatives, even though they caused irritation and grinding. In addition to honey and ghee, roots were administered to children in general tonics that helped them in improving their intellectual and physical strength besides enhancing their colour (setiawati et al*.,* 2025). Roots were also applied for the cure of insanity and epilepsy. Using seeds and leaves are used as a brain tonic to improve memory and intellect was a widespread practice. Extract of flowers and its Juicy liquid were used to treat snake bites. Seeds are also used to treat painful joints, and crushed seeds are consumed with either hot or cold water to treat urinary problems and this is according to (Meilawati et al*.,* 2025).

Parts of Ct plant:

The leaves, sprouts, seeds, fruits, bark, stems and roots of plants have been utilized to extract different important metabolites and medicinal compounds.

Pigments extracted from flowers:

Extraction of pigments from *C. ternatea* petals is done by a simple process. The petals were chopped up into small pieces and kept in a glass beaker along with a defined volume of deionized waters. A filter paper of 50 mm pore size was used to collect the blue-coloured solutions from the mixture after a 24-hour period and it was then transferred to another test tube. Fourier Transform InfraRed (FTIR) analysis revealed presence of Flavonoids, anthocyanins, polyphenolic compounds, mono glycosides, di glycosides, and other substances are found in the collected blue solution (Al-Khayri et al., 2019; Ragupathy and Newmaster, 2009).

Preparation of extract from the roots of *C. ternatea*

The *C. ternatea* roots were air dried at room temperature in the shade to eliminate any remaining moisture, and then finely powdered in an electric grinder. Ethanol and a Soxhlet apparatus were used to treat the powdered materials for hot continuous extraction. After moderate heating, the extract was collected and condensed using a Rotar at vacuum evaporator. The percentage yield of the concentrated extract was estimated and then stored. The extract was analysed using the HR LCMS along with several preliminary phytochemical tests performed by Ragupathy and Newmaster in (2009).

Preparation of methanolic extract

Methanol was used to completely dissolve the leaf powder by stirring it periodically. Filter paper of (Whatman No. 1) and cheesecloth were used for removing the material from the solvent. The filtrate which was obtained after filtration was run through a membrane measuring 0.22 mm. After that, a quarter of the filtrate's volume was extracted by vacuum evaporation. Using a rotating evaporator, this was accomplished at 60 °C. At 40 °C, this viscous paste was dried in an oven. For future research, the resulting extract was stored at 4 °C. Methanol was utilized as a solvent in this experiment to simulate how these traditional healers might prepare plant extract as a decoction with water. Among all the polar protic solvents, methanol and water have the highest polarity. Moreover, evaporation is done more easily by methanol compared to water (Nawaz et al., 2009).

Preparation of ethanolic extract:

After being cleaned with distilled water, the leaves of *Trichosanthes dioica* and *C. ternatea* were left to dry for a few days in the shade. A mechanical grinder was used to crush the leaves into a coarse powder after they had been shade-dried. A Soxhlet extractor was used to extract the dried powdered ingredients in 70% ethanol. Until the last drop of extract was completely colorless, the extraction process was resumed. The extracts were concentrated with rotary evaporations under vacuum at 60°C. The extracts were kept in an oven between 40 and 50°C for eight hours so that residual solvent could evaporate. The dried residues were given by an intragastric catheter tube (IGC) of dosages following their previous studies on antidiabetic, done by Nawaz et al, 2009.

Pharmacological Activities

According to pharmacological research, *C. ternatea* exhibits a wide spectrum of biological activities, some of which are quite suggestive for future developmental objectives.

Nootropic Activity:

The leaves and seeds of *C. ternatea* are used for brain tonic and were thought to enhance memory and intellect. The effectiveness of *C. ternatea* for treating the Alzheimer's disease was investigated, as well as the main bioactive ingredient that causes the activity (Maan et al.,2025). The result showed the

various ways in which *C. ternatea* aqueous extract assisted people with Alzheimer's disease. The extracted compounds can be used as a source for the development of new derivatives that could be used for improving memory (Shahnas and Akhila,2014). When rats in the neonatal and young adult age groups were given 100 mg/kg of *C. ternatea* aqueous root extract (CTR) for 30 days, their hippocampi's acetylcholine (ACh) content significantly increased in comparison to age-matched controls. Because their hippocampal ACh content has increased, their memory and enhance their learning ability which may have a neurochemical foundation (Rai et al., 2005).

Studies on the anti-epileptic effect

The methanolic extract which was extracted from the upper aerial portions of *C. ternatea* by the process of distillation has been studied on mice using pentylenetetrazol (PTZ) and maximum electroshock (MES) at a dose of 100 mg/kg by p.o. route. It is widely known that the start of seizures and the period of tonic extensor hind-limb extension are both markedly delayed in MES-induced spasm (Sethiya et al., 2009).

Research on the Antipyretic activity, Anti-inflammatory and Analgesic: Rat models were used in the study to determine the methanolic extract from *C. ternatea* Linn. roots' anti-inflammatory properties (Devi et al*.,* 2003; Bhat et al*.,* 2025). Using the tail clip method, the ethanolic extract's analgesic properties were assessed in the same study in mice that were writhing in reaction to acetic acid and mechanical stimuli (Parimaladevi et al., 2004).The antipyretic efficacy of methanol extract in albino rats was assessed in another experiment, and it was shown to be equivalent to that of paracetamol (PCM), a common antipyretic medication (150 mg/kg b.w. p.o.) (Parimaladevi et al., 2004).

Anti-Cancer

Chemotherapy is one of the present cancer treatments that kills cancer cells by causing irreversible metabolic damage, but it still has major side effects. As a result, developing novel cancer treatment approaches is essential. Current research has demonstrated that natural plant pigments have anti-cancer properties by causing cancer cells to undergo apoptosis via signaling pathways such ERK1/2MAPK and P13K/AKT (Manochkumar et al., 2022). Cui created a rat oesophageal cancer model generated by N-nitroso-benzylamine and examined the anti-cancer potential of astaxanthin (Cui et al., 2019). Investigation shows that by increasing superoxide dismutase and glutathione peroxidase activities and decreasing NF-B and COX2 protein expressions, astaxanthin cereal significantly reduced the risk of oesophageal cancer. Through a p53-regulated signal pathway, Yeh and his collaborators verified how naphthoquinone shikonin, which is derived from shikonin, may induce apoptosis and inhibit the development of human alveoli basal epithelial cells A549 in a dose- dependent manner (Yeh et al., 2014). Lim et al., have investigated the potential of delphinidin found in anthocyanins to prevent cancer of the epithelial ovary (Lim et al., 2017). The study found that vermicellin inhibits the growth of SKOV3

cells through the ERK1/2MAPK and P13K/AKT signaling pathways. Additionally, a DNA break at the SKOV3 site triggers ovary cancerous cells to undergo apoptosis (Abdullaev, F.I., 2002).

Studies about inhibition of aggregation in blood platelets

In vitro platelet aggregation inhibitory action was investigated in rabbits using anthocyanin ternatins D1, which was extracted from the petals of *C. ternatea* and showed a strong inhibition of collagen-induced platelet aggregation and adenosine diphosphate (ADP) (Mukherjee et al.,2008 and Kazuma, 2003).

Diabetes prevention studies

Blood glucose, glycosylated haemoglobin, urea, triglycerides, creatinine and total cholesterol level all significantly decreased after taking 400 mg/kg body weight of *C. ternatea* leaf aqueous extract orally for 84 days. The gluconeogenic enzymes glucose-6-phosphatase additionally revealed a reduction in activity. On the other hand, blood insulin, protein, HDL cholesterol, liver function and skeletal muscle levels of glycogen all are increased, along with the rate of activity associated with the glycolytic enzyme glucokinase. Rats which are feeded with *C. ternatea* leaves demonstrates slightly higher levels of activity for all of the metabolic tests covered above than these rats with diabetes are fed flowers (Daisy et al., 2009).

Study on local anaesthetic action

An alcohol-based extract made from the aerial section of *C. ternatea* was investigated for its local anaesthetic properties in rabbits with corneal anaesthesia and frogs with plexus anaesthesia by Jain et al., (2003). In comparison to a local anaesthetic effect, the level of success was almost that of xylocaine (Mukherjee et al., 2008 and Jain et al., 2003).

Diuretic activity

Only one intravenous injection of the ethanol extract produced a considerable increase in the excretions of Na and K in the urine and a decrease in Cl, but there is no any change in urine volume and colours, indicating that the dried whole root powder and extract had a diuretic effect. Additionally, oral dose had a noteworthy effect (Ashraf et al., 2024).

Anticonvulsant activity:

Seizures were brought on by imbalance between excitatory and inhibitory neurotransmitters. In experimental models of seizures, medications that raise the brain's GABA level may have anticonvulsant properties. The maximal electroshock (MES) is the authorized technique for assessing antiepileptic drugs in situations of generalized tonic-conic seizure (Oguis et al.,2019). A methanol

extract of apical *C. ternatea* segments shown anticonvulsant efficacy in mice with MES-induced and PTZ seizures: At an oral dose of 100 mg/kg, p.o., the methanol extracts of aerial portions of *C. ternatea* has demonstrated anticonvulsant efficacy by delaying the start of convulsions and shortening the length of tonic posterior leg extension caused by PTZ and MES, respectively. In a second trial, an ethanol extract taken from the aerial section of *C. ternatea*, even at doses of 230 and 460 mg/kg, did not stop rats from having seizures caused by PTZ and MES. Jain (2003) and others.

Antidepressive activity:

At doses of 100 and 400 mg/kg, p.o, the methanolic extract of *C. ternatea* showed the antidepressive effect using a mouse tail suspension tested by Rai (2010). At dose levels of 100 and 400 mg/kg the *C. ternatea* extract has significantly reduced immobility period of the animal. The dose of 400 mg/kg *C. ternatea* has decreased time of immobility more prominently than that the dose of fluoxetine at level of 10 mg/kg used intraperitoneally. Another study showed that the ethanolic extract of *C. ternatea* root had antidepressant effects at doses of 150 mg/kg and 300 mg/kg. As discovered in one other earlier published article, it seems that separated fractions, Z)-9, 17-octadecadienal, and n-hexadecenoic acid of root *C. ternatea* extracts are useful in a new select MAO-A inhibitor drug compound creation which, theoretically, should prove as the first herbal therapeutic aid in mentally diseases, namely depression and anxiety treatments (Margret et al., 2015).

Digestive:

C. ternatea aqueous and ethanolic extracts were investigated for their antiulcer activities in rats with a variety of experimentally produced ulcer forms. The whole plant was given to rats with indomethacin-induced stomach ulcers and pylorus ligation at 200 and 400 mg/kg as an ethanolic extract and 200 and 400 mg/kg as an aqueous extract. Following the development of ulcers, a wide range of metrics were assessed and compared between extracts, standard, and vehicle control groups. These metrics included stomach acid released, pH, total acidity, ulcer index, and antioxidant characteristics. Additionally, in the pylorus ligation and indomethacin-induced ulceration, high concentrations of alcoholic extract demonstrated a significant antiulcer activity at other dosages (Kelemu et al., 2004).

Anti-histamics and anti-asthmatic:

C. ternatea root ethanol extract's anti-asthmatic properties were examined in mice with milk-induced leucocytosis and eosinophilia, rats with mast cell degranulation’s caused by egg albumin, and rats with passive cutaneous anaphylaxis at doses of 100–150 mg/kg i.p. Rats exposed to histamine-induced bronchoconstriction demonstrated protection from *C. ternatea* extracts. Inhibiting inflammatory cells to penetrate the bronchioles and the stabilizing the mast cell resulted in the shutdown of histamine-like

mediators, the effects revealed that, apart from possessing a bronchodilation activity, the aqueous extract of *C. ternatea* even decreases bronchial hyperactivity (Ripperger, 1978).

Protective Effects:

The roots of *C. ternatea* with blue and white flowers have been shown to be hepatoprotective against carbon tetrachloride (CCl4)-induced liver damage in rats. To determine the hepatoprotective impact, a number of biochemical tests were used, including liver tissue histopathology investigations, total bilirubin, and blood levels of alkaline phosphatase, glutamate pyruvate transaminase, and glutamate oxaloacetate transaminase phosphatase. With *C. ternatea* treatment, the significantly raised blood levels of total bilirubin, alkaline phosphatase, and transaminases were also significantly brought back to almost normal. Biochemical improvement was further confirmed through histopathological examination of liver slices (Terahara et al.,1998). A study was carried out on ethanol extract of aerial parts of C. ternate's, exploring its nephroprotective and antioxidant properties in rats given acetaminophen-induced toxicity. Biochemical studies revealed that blood urea and creatinine levels increased in acetaminophen-induced groups, while body weight increased and uric acid levels decreased. Treatment with two different dosages of *C. ternatea* extracts significantly increased all of these values. Antioxidant tests showed that the animals treated with APAP had significantly higher levels of renal Septo optic dysplasia (SOD), glutathione peroxidase (GPx), Growth Stimulating Hormone (GSH), and Computerised Axial Tomography (CAT), while the groups treated with *C. ternatea* ethanol extract had lower levels of MDA. Histopathological alterations also reflect the potential of the *C. ternatea* extract to neutralize the necrotic damage to the renal tissues induced by acetaminophen (Kazuma et al., 2003). The preventive effects of *C. ternatea* (CT) flower extracts with antioxidant activity against testicular injury in rats caused by ketoconazole (KET) were investigated. Sperm concentration, serum testosterone level, testicular histopathology, and testicular tyrosine phosphorylation levels were among the male reproductive markers. The ferric reducing antioxidant power (FRAP) and 2,2-diphenyl 1 picrylhydrazyl (DPPH) tests were used to assess the antioxidant activity of *C. ternatea* flower extracts. Testicular damage-causing KET (100 mg/kg b.w) was injected intraperitoneally for 7 days (induction period: Days 22–28) and male rats were given *C. ternatea* flower extracts (10, 50, or 100 mg/kg BW) or distilled water via a stomach tube for 28 days (preventive period: Days 1–21) (Iamsaard et al., 2014). Testicular weight, epididymis, vas deferens, and seminal vesicles were measured following the experiment, as were sperm concentration, testicular histological makeup and diameter, and testicular tyrosine phosphorylation levels for each animal. The *C. ternatea* flower extracts scavenged DPPH and exhibited a high reduction power. There was no apparent adverse effect at 100 mg/kg b.w to the male reproductive system. In the CT+KET groups, *C. ternatea* flower extracts at 50 and 100 mg/kg b.w significantly reduced loss of sperm concentration, testosterone levels, and weight parameters of reproductive organs. Additionally, *C. ternatea* flower extracts protected testes in rats from KET administration. Moreover, the expression of a testicular 50-kDa tyrosine phosphorylated protein in the CT100+KET group was highly induced by the *C. ternatea* flower extracts compared to

other groups (Iamsaard et al., 2014).

CONCLUSION

The plant *C. ternatea* was studied as a medicinal herb with various pharmacological activity and extraction methods. The pharmaceutical industry is concentrating on creating new drugs from plants by investigating possible leads from traditional medicine. *C. ternatea* has been linked to a variety of pharmacological actions, including antileprosy, anti-inflammatory, antihelmintic, immunomodulatory, antiasthamatic, antidepressant, anticonvulsant, analgesic, antipyretic, antifungal, proteolytic, and antihyperlipidemic effects. The action was attributed to a number of important phytoconstituents. *C. ternatea* possesses a wide range of biological potential, according to scientific studies on the plant. The quality of information about CT's bioactive secondary metabolites, bioavailability, pharmacokinetics, and therapeutic value, including clinical studies, is poor, despite the evidence supporting CT's safety and effectiveness. It is quite probable that the thorough data in this assessment will offer thorough evidence of this plant's use in a variety of drugs. Concurrently, *C. ternatea*'s organic and aqueous extracts might be utilised in the future as a source of advantageous phytochemical components for the pharmaceutical industry.

Acknowledgements

The authors acknowledge support extended by Prof. Kavita Shah, Vice chancellor of Siddharth University for this study. PKM thanks CSTUP for project fellowship. KG thanks CSTUP, UPHED and Seed Money Grant of Siddharth University, Kapilvastu.

Declarations

Funding Declaration

This study was funded by the Council of Science and Technology (CSTUP Grant Id-4127), UP Higher Education Department Research Grant (No. 41/2024/336/70-4-2024-001-4(59)/2022) for financial support and the Seed Money Grant Seed Money Grant SMGFOC/2023-24/FS-015 of Siddharth University, Kapilvastu.

Availability of Data and Material

This manuscript does not have any specific data

Authors contribution

Praveen Kumar Maddheshiya (PKM) and Kapil Gupta (KG) contributed to initial draft preparation; Kiran Gupta (KiG), KG and Shubhra Gupta (SG) contributed to reviewing original draft and writing; PKM, KG, KiG and SG contributed to final reviewing and extensive editing.

Ethics declaration

Not Applicable

Conflict of Interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

Ethical Approval

Not applicable

Consent to participate

Not applicable

Consent for publication

Not applicable

References:

1. Abdullaev, F.I., 2002. Cancer chemopreventive and tumoricidal properties of saffron (Crocus sativus L.). Experimental biology and medicine, 227(1), pp.20-25. https://doi.org/10.1177/153537020222700104
2. Al-Khayri, J.M., Jain, S.M. and Johnson, D.V. eds., 2019. *Advances in plant breeding strategies: Legumes* (Vol. 4). Berlin: Springer, https://doi.org/10.1007/978-3-030-23400-3
3. Ashraf K, Adlin NF, Basri AN, Ahmad W, Sultan S. The Traditional Uses, Phytochemistry, and Pharmacological Effects of Clitoria ternatea.: A Review. Indian J

of Pharmaceutical Education and Research. 2024;58(1):1-14, https://doi.org/10.5530/ijper.58.1.1.

4. Barik, DP, Naik, SK, Mudgal, A & Chand, PK 2007, 'Rapid plant regeneration through in vitro axillary shoot proliferation of butterfly pea (Clitoria ternatea L.)—a twinning legume', In Vitro Cellular & Developmental Biology - Plant, vol. 43, no. 2, Springer Science and Business Media LLC, pp. 144–148, http://dx.doi.org/10.1007/s11627-007-9040-y.
5. Bhat, K.M., Upadhya, R., Adiga, S., Kumar, S.P., Manjula, S.D., Acharya, N., Subramanian, H.H. and Upadhya, D., 2025. Regulation of chronic neuroinflammation through dietary herbal products. *Frontiers in Nutrition*, *12*, p.1487786. https://doi.org/10.3389/fnut.2025.1487786
6. Chakraborthy, G.S., Kumar, V., Gupta, S., Kumar, A., Gautam, N. and Kumari, L., 2018. Phytochemical and pharmacological aspects of *Clitoria ternatea*-A review. *Journal of Applied Pharmaceutical Sciences and Research*, pp.3-9. https://doi.org/10.31069/japsr.v1i2.13061
7. Chayaratanasin, P., Barbieri, M.A., Suanpairintr, N. and Adisakwattana, S., 2015. Inhibitory effect of Clitoria ternatea flower petal extract on fructose-induced protein glycation and oxidation-dependent damages to albumin in vitro. *BMC complementary and alternative medicine*, *15*, pp.1-9, https://doi.org/10.1186/s12906-015-0546-2
8. Cui, L., Xu, F., Wang, M., Li, L., Qiao, T., Cui, H., … Sun, C. (2019). Dietary natural astaxanthin at an early stage inhibits *N*-nitrosomethylbenzylamine–induced esophageal cancer oxidative stress and inflammation via downregulation of NFκB and COX2 in F344 rats. *OncoTargets and Therapy*, *12*, 5087–5096. https://doi.org/10.2147/OTT.S197044
9. Daisy, P & Rajathi, M 2009, 'Hypoglycemic Effects of Clitoria ternatea Linn. (Fabaceae) in Alloxan-induced Diabetes in Rats', Tropical Journal of Pharmaceutical Research, vol. 8, no. 5, African Journals Online (AJOL), http://dx.doi.org/10.4314/tjpr.v8i5.48082.
10. Devi, BP, Boominathan, R & Mandal, SC 2003, 'Anti-inflammatory, analgesic and antipyretic properties of Clitoria ternatea root', Fitoterapia, vol. 74, no. 4, Elsevier BV, pp. 345–349, http://dx.doi.org/10.1016/s0367-326x(03)00057-1.
11. Gomez, S.M. and Kalamani, A., 2003. Butterfly pea (Clitoria ternatea): A nutritive multipurpose forage legume for the tropics–an overview. *Pakistan Journal of Nutrition*, *2*(6), pp.374-379, 10.3923/pjn.2003.374.379.

12. Iamsaard, S., Burawat, J., Kanla, P. *et al.* Antioxidant activity and protective effect of *Clitoria ternatea* flower extract on testicular damage induced by ketoconazole in rats*. *J. Zhejiang Univ. Sci. B* **15**, 548–555 (2014). https://doi.org/10.1631/jzus.B1300299
13. Jain, N. N., Ohal, C., Shroff, S., Bhutada, R., Somani, R., Kasture, V., & Kasture, S. (2003). Clitoria ternatea and the CNS. *Pharmacology Biochemistry and Behavior*, *75*(3), 529-536. https://doi.org/10.1016/S0091-3057(03)00130-8.
14. Jiji, K. and Muralidharan, P., 2020. Neuropharmacological potential of Clitoria ternatea Linn.-A review. *Research Journal of Pharmacy and Technology*, *13*(11), pp.5497-5502. https://doi.org/10.5958/0974-360X.2020.00960.9
15. Kazuma, K 2003, 'Malonylated flavonol glycosides from the petals of Clitoria ternatea', Phytochemistry, vol. 62, no. 2, Elsevier BV, pp. 229–237, http://dx.doi.org/10.1016/s0031-9422(02)00486-7
16. Kazuma, K., Noda, N., & Suzuki, M. (2003). Flavonoid composition related to petal color in different lines of Clitoria ternatea. *Phytochemistry*, *64*(6), 1133-1139. https://doi.org/10.1016/S0031-9422(03)00504-1.
17. Kelemu, S., Cardona, C., & Segura, G. (2004). Antimicrobial and insecticidal protein isolated from seeds of Clitoria ternatea, a tropical forage legume. *Plant Physiology and Biochemistry*, *42*(11), 867-873. https://doi.org/10.1016/j.plaphy.2004.10.013
18. Kiranmai, VS, Kumar, PK, Rajesham, VV & Rao, TR 2023, 'Extraction Methods and Pharmacological Importance of Clitoria ternatea Plant', International Journal of Pharmaceutical Sciences Review and Research, vol. 83, no. 2, Global Research Online, http://dx.doi.org/10.47583/ijpsrr.2023.v83i02.015.
19. Kumar, V., Mukherjee, K., Kumar, S., Mal, M., & Mukherjee, P. K. (2008). Validation of HPTLC method for the analysis of taraxerol in Clitoria ternatea. *Phytochemical Analysis*, *19*(3), 244-250. https://doi.org/10.1002/pca.1042
20. Lim, W. and Song, G., 2017. Inhibitory effects of delphinidin on the proliferation of ovarian cancer cells via PI3K/AKT and ERK 1/2 MAPK signal transduction. *Oncology Letters*, *14*(1), pp.810-818, https://doi.org/10.3892/ol.2017.6232
21. M., Jenifer Tamizharasi, Rajila R., Beula Shiny D., Vijila Jasmin J., and Kumaran T., 2022, 'Bioactive Natural Medicinal Plants in South Indian Western Ghats and Their Pharmacological Importance', Journal of Basic and Applied Research in Biomedicine, vol. 6, no. 2, Journal of Basic and Applied Research in Biomedicine, pp. 62–69, http://dx.doi.org/10.51152/jbarbiomed.v6i2.11.

22. Maan, P, Gupta, N & Chauhan, S 2025, 'Nootropics: Traditional Medicinal Prospective', Neuro-Nutraceuticals and Drug Discovery and Delivery in Alzheimer's Disease, Apple Academic Press, pp. 235–268, http://dx.doi.org/10.1201/9781003570356-11.
23. Manochkumar, J., Doss, C. G. P., Efferth, T., & Ramamoorthy, S. (2021). Tumor preventive properties of selected marine pigments against colon and breast cancer. *Algal Research*, *61*, 102594. https://doi.org/10.1016/j.algal.2021.102594
24. Margret, A.A., Begum, T.N., Parthasarathy, S. *et al.* A Strategy to Employ *Clitoria ternatea* as a Prospective Brain Drug Confronting Monoamine Oxidase (MAO) Against Neurodegenerative Diseases and Depression. *Nat. Prod. Bioprospect.* **5**, 293–306 (2015). https://doi.org/10.1007/s13659-015-0079-x
25. Meilawati, NLW, Arlianti, T, Heryanto, R & Purwiyanti, S 2025, 'Morphological Diversity and Relationships among Butterfly Pea (Clitoria ternatea) Accessions in Bogor', IOP Conference Series: Earth and Environmental Science, vol. 1482, no. 1, IOP Publishing, p. 012010, http://dx.doi.org/10.1088/1755-1315/1482/1/012010.
26. Mukherjee, PK, Kumar, V, Kumar, NS & Heinrich, M 2008, 'The Ayurvedic medicine Clitoria ternatea—From traditional use to scientific assessment', Journal of Ethnopharmacology, vol. 120, no. 3, Elsevier BV, pp. 291–301, http://dx.doi.org/10.1016/j.jep.2008.09.009.
27. Nawaz, A.H.M.M., Hossain, M., Karim, M., Khan, M., Jahan, R. and Rahmatullah, M., 2009. An ethnobotanical survey of Rajshahi district in Rajshahi division, Bangladesh. *American Eurasian Journal of Sustainable Agriculture*, *3*(2), pp.143-150.
28. Oguis, G. K., Gilding, E. K., Jackson, M. A., & Craik, D. J. (2019). Butterfly Pea (Clitoria ternatea), a Cyclotide-Bearing Plant With Applications in Agriculture and Medicine. *Frontiers in Plant Science*, *10*, 448370. https://doi.org/10.3389/fpls.2019.00645.
29. Parimaladevi, B., Boominathan, R. and Mandal, S.C., 2004. Evaluation of antipyretic potential of Clitoria ternatea L. extract in rats. *Phytomedicine*, *11*(4), pp.323-326. https://doi.org/10.1078/0944711041495191
30. Ragupathy, S & Newmaster, SG 2009, 'Valorizing the "Irulas" traditional knowledge of medicinal plants in the Kodiakkarai Reserve Forest, India', Journal of Ethnobiology and Ethnomedicine, vol. 5, no. 1, Springer Science and Business Media LLC, http://dx.doi.org/10.1186/1746-4269-5-10.

31. Rai, K.S., 2010. Neurogenic potential of Clitoria ternatea aqueous root extract-a basis for enhancing learning and memory. *World academy of science, Engineering and technology*, *70*, pp.237-240.
32. Rai, SS, Banik, A, Singh, A & Singh, M 2015, 'EVALUATION OF ANTI-ULCER ACTIVITY OF AQUEOUS AND ETHANOLIC EXTRACT OF WHOLE PLANT OF CLITORIA TERNATEA IN ALBINO WISTAR RATS', International Journal of Pharmaceutical Sciences and Drug Research, International Journal of Pharmaceutical Sciences and Drug Research, pp. 33–39, viewed http://dx.doi.org/10.25004/ijpsdr.2015.070106.
33. Raut, S., Belekar, M., Maroti Jeurkar, D.N.C., Ingole, S., Kakde, V., Warhate, V. and Gajbhiye, S., Pharmacognostical and Pharmacolological Account on *Clitoria ternatea*: A Review.Int. J. of Pharm. Sci., 2025, Vol 3, Issue 3, 2788-2796. https://doi.org/10.5281/zenodo.15099492
34. Ripperger, H., 1978. Isolation of stigmast-4-ene-3, 6-dione from Hamelia patens and Clitoria ternatea. *Die Pharmazie*, *33*(1), pp.82-83.
35. Sarma, DSK, Kumar, D, Yamini, C, Santhalahari, C, Lahari, C & Kumar, GC 2023, 'REVIEW ON CLITORIA TERNATA', International Journal of Pharmaceutical Sciences and Medicine, vol. 8, no. 9, Zain Publications, pp. 43–58, http://dx.doi.org/10.47760/ijpsm.2023.v08i09.004.
36. Sethiya NK, Nahata A, Mishra SH, Dixit VK. An update on Shankhpushpi, a cognition-boosting Ayurvedic medicine. Zhong xi yi jie he xue bao = Journal of Chinese Integrative Medicine. 2009 Nov;7(11):1001-1022. DOI: 10.3736/jcim20091101. PMID: 19912732.
37. Setiawati, MCN & Munisih, S 2025, 'Medicinal usage of Clitoria ternatea flower petal: A narrative review', BIS Health and Environmental Science, vol. 2, Universitas Muhammadiyah Magelang, p. V225002, http://dx.doi.org/10.31603/bishes.241.
38. Shahnas, N. and Akhila, S., 2014. Phytochemical, in vitro and in silico evaluation on Clitoria ternatea for alzheimer's disease. *PharmaTutor*, *2*(9), pp.135-149.
39. Shinde, Y.N. and Khemnar, C., 2024. A review on Clitoria ternatea (Linn); traditional uses/pharmacological activity. *International Research Journal of Modernization in Engineering Technology and Science*, *6*(2), pp.277-282.
40. Taylor, S & Berridge, V 2006, 'Medicinal plants and malaria: an historical case study of research at the London School of Hygiene and Tropical Medicine in the twentieth century', Transactions of the Royal Society of Tropical Medicine and Hygiene, vol.

100, no. 8, Oxford University Press (OUP), pp. 707–714, http://dx.doi.org/10.1016/j.trstmh.2005.11.017.

41. Terahara, N., Toki, K., Saito, N., Honda, T., Matsui, T. and Osajima, Y., 1998. Eight new anthocyanins, ternatins C1− C5 and D3 and preternatins A3 and C4 from young clitoria t ernatea flowers. *Journal of Natural Products*, *61*(11), pp.1361-1367. https://doi.org/10.1021/np980160c
42. Yeh, C., Liu, J., & Lai, C. (2014). Shikonin Induces Apoptosis, Necrosis, and Premature Senescence of Human A549 Lung Cancer Cells through Upregulation of p53 Expression. *Evidence-Based Complementary and Alternative Medicine*, *2015*(1), 620383. https://doi.org/10.1155/2015/620383