American Journal of
Biomedical Science & Research

www.biomedgrid.com
ISSN: 2642-1747

Research Article

Copyright© Anil Kumar

Unveiling the Phytochemical Profile and Therapeutic Potential of Clitoria Ternatea (C.T.) Flower Extract: Insights from Experimental Analysis

Anil Kumar[1*] and Rishav Raj[2]

[1]*Head & Assistant Professor, P.G. Department of Chemistry, Sahibganj College, India*

[2]*UG Scholar, P.G. Department of Chemistry, Sahibganj College, India*

***Corresponding author:** Anil Kumar, Sahibganj College, Sahibganj, Jharkhand, India.

To Cite This Article: *Anil Kumar* and Rishav Raj, Unveiling the Phytochemical Profile and Therapeutic Potential of Clitoria Ternatea (C.T.) Flower Extract: Insights from Experimental Analysis. Am J Biomed Sci & Res. 2024 21(4) AJBSR.MS.ID.002861,* DOI: 10.34297/AJBSR.2024.21.002861

Received: : February 07, 2024; **Published:** February 19, 2024

Abstract

The objective of this study was to assess the flower extract of C. Ternatea and explore its diverse phytochemical constituents. The analysis uncovered a broad spectrum of secondary metabolites, notably terpenoids, alkaloids, flavonoids, and tannins. These active components are renowned for their pharmacological significance and have been linked to numerous therapeutic benefits.

However, it is imperative to conduct further investigations to pinpoint the specific bioactive compounds responsible for addressing complex ailments such as cancer, neurological disorders, nephrological disorders, hyperglycemia, urinary disorders, goiter, and respiratory disorders. Additionally, a comprehensive exploration of the detailed pharmacological activities and the precise mode of action of these bioactive compounds is warranted. Ongoing research endeavors will delve deeper into unraveling the intricate therapeutic potential of C.T flower extract and its constituents. The spot found in the TLCPTM was used to calculate the retention factor by the distance travelled by the solute to distance travelled by the solvent. The ORFV for anthocyanin and glycosides are 0.3968 and 0.7301 respectively.

Keywords: C. Ternatea, Phytochemical constituents, Secondary metabolites, Terpenoids, Glycosides, Anthocyanin, Alkaloids, Flavonoids, Tannins, Pharmacological significance, Therapeutic benefits, Bioactive compounds, Cancer, Neurological disorders, Nephrological disorders, Hyperglycemia, Urinary disorders, Goiter, Respiratory disorders, Mode of action, Retention factor, TLCPTM

Abbreviations: TLCPTM: Thin Layer Chromatography Plate Test Method; C.T: Clitoria Ternatea; R.F: Retention Factor; ORFV: Observed Retention Factor Value; CRFV: Calculated Retention Factor Value; CVDs: Cardiovascular diseases.

Introduction

C. Ternatea, widely recognized as Asian Pigeon Wings (APW), Butterfly Pea (B.P), Blue Bellvine (B.B), Cordofan Pea (C.P), and Darwin Pea (D.P), belongs to the Fabaceae family and papilionoideae subfamily [1-3]. This perennial leguminous plant boasts a diverse array of common names and is celebrated for its ornamental appeal, making it a noteworthy member of the plant kingdom [4]. This plant thrives both as an ornamental specimen and in reclamation projects, displaying resilience and requiring minimal maintenance when cultivated While it requires a patient 90 days before the plant initiates its flowering stage, the seemingly gradual pace is swiftly surpassed once the blossoms emerge [5]. Once the flowering process commences, the plant reveals its prolific nature, consistently producing vibrant blooms that grace the landscape from early summer well into the late autumn months. C. Ternatea Originated in tropical Asia, this plant later dispersed to various regions, including South and Central America, the East and West Indies, as well as China and India C.T, scientifically known as C. Ternatea, is recognized by an array of names across different regions worldwide [6]. Commonly referred to as Clitoria, Blue Pea (B.P), Korrdofan Pea (Sudan), Cunha (Brazil), or Pokindong (Philippines), it goes by diverse names reflecting its global presence. In various languages, it is known as Aprajita (Bengali), Kaakkanam (Tamil), Shankapushpi, Gokarna, Aparajita, Gokarnika, Aasphota, Girikarni-

This work is licensed under Creative Commons Attribution 4.0 License

ka, Ashwakhura, Aardrakarni, Kotabhi, Dadhipushpika, Gardabhi, Sitapushpi, Shwetaspanda, Shwetabhadra, Supuspi, Vishahantri, Naagparyaykarni, Shwetapushppi, Shweta Gajkarnika, Shwetaanama, Shjwetaswanna, Abheda, Sheeta, Mohanashini, Vishmukranta, Vaajikhura (Sanskrit name), Kalligaranii, Kaalikoyal (Gujarati), Dinten (Telugu), Shankhapushpa (Kannada), and Shankpuushpam (Malayalam) (Figure 1). This rich tapestry of names underscores the plant's cultural significance and widespread usage in diverse linguistic communities [7-9] (Figures 1&2).

Figure 1: C. Ternatea in Multilingual.

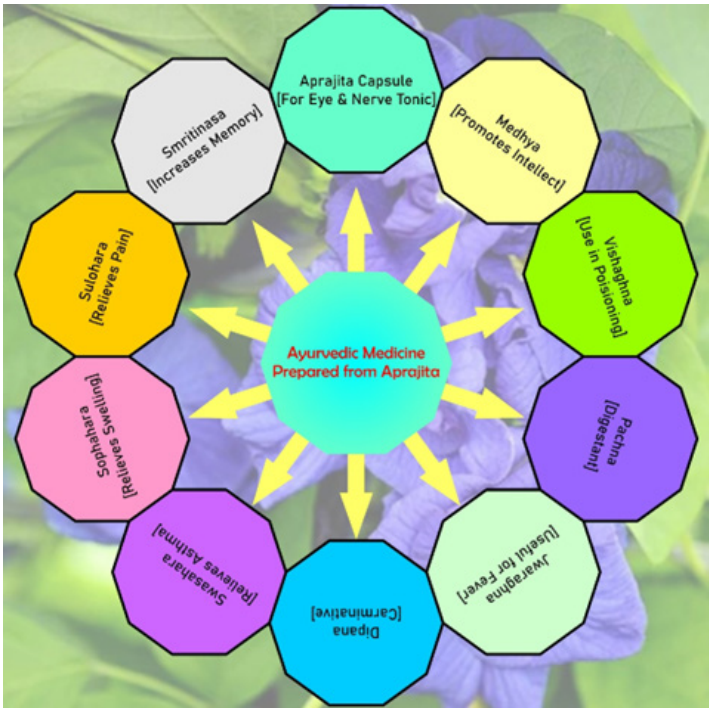

Figure 2: Role of C. Ternatea in Prepratation of Ayurvedic Medicine.

Twinning Herb, Leaves, Flowers, Fruits and Pods: Petals, Size, Shape & Colour

C.T, a perennial twining herb, features seven elliptic and obtuse leaflets, exhibiting a distinctive growth pattern as a vine or creeper in moist and neutral soil [10]. Its pinnate leaves, 5-9 foliolate and ranging from 6-13 cm in length, contribute to its lush and vibrant appearance. The flowers, characterized by their showy nature, are solitary and boast a deep blue hue with light-colored markings or, in an alternate presentation, can be white. The fruit pods of C.T are linear and compressed, presenting as flat structures measuring 5-7 cm in length. Each pod contains 6-10 seeds and is characterized by its edibility when tender. The seeds, numbering between 6-10, display a distinctive black color [11-13]. The leaflets of C.T are characterized by their ovate to oblong shape, measuring 2-5 cm in length. Notably, stomata with wavy cell walls are present on both the upper and lower epidermis of the leaflets, adding to the distinctive features of this plant. Multicellular trichomes on C.T. exhibit a distinctive structure, featuring two basal cells smaller than the terminal cells. The roots of C.T. establish a profound root system, enhancing the plant's resilience to endure up to 7-8 months of drought. Notably, these roots play a vital role in nitrogen fixation by producing large nodules. In a symbiotic relationship, the legumes of C.T. collaborate with soil-dwelling bacteria, where the bacteria extract gaseous nitrogen from the air in the soil and, in return, supply this nitrogen to the legumes. As part of this mutually beneficial exchange, the plants contribute carbohydrates to the bacteria. When utilized as green manure or in ley pastures, C.T. significantly enhances soil fertility, thereby improving yields for subsequent crops such as maize, sorghum, and wheat. Additionally, its role as a revegetation species further underscores its versatility and ecological significance. C.T. thrives in various regions of South India, including Karnataka, Kerala, and Andhra Pradesh, along with other parts of the country. Beyond India, C. Ternatea has a global presence, contributing to the world's botanical diversity and cultural landscapes.

Phytochemical Constituents of C.T: [14-25] (Table 1)

Table 1: Phytochemical Constituents and Functions of Different Parts of C. Ternetea [31-37].

Sl. No.	Plant Parts	Phytochemicals	Functions
1	Flower	Carbohydrates, Glycosides, Saponin, Tannins, Alkaloids, Phytosteriods,	Analgesic, Anti-inflammatory, Anti-diabetic, Improve Eye- Sight, Treats Neurological Disorder, Heal Wound, Effective on Hair loss treatment, C.T tea possess mild laxative properties, Increases Digestion, helps to alleviate Constipation & promote a healthy digestive system.
2	Leaves	Steroids, Alkoids, Flavonoids, Reducing agents, Glycosides	Preservation of Neurodegenerative diseases and diabetes melitus and effectively controls excessive Sweating
3	Root	1,1-diphenyl-2-picrylhydrazyl (DPPH)	It is used as antioxidant and the root bark is diuretic and laxative. Decoction is given as a demulcent in the irritation of the bladder and urethra. It is used in traditional medicine to treat a variety of ailoments including, respiratory problems, skin condition, fever.
			Nootropic, antiasthamatic, anti-inflammatory, analgesic, antipyretic, antidiabetic, antilipidemic, antiarthritic, anti-oxidant, wound healing properties.
			It is used in Ayurvedic medicine as memory enhancing, nootropic, antistress, anxiolytix, antidepressant, anticonvulsant, tranquilizing

4	Seed	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 a phenol glycoside, 3,5,7.4-tetrahydroxy-flavone-3-rhamoglycoside, an alkoid, ethyl D-galactopyranoside, p hydroxycinnamic acid polypeptide, a highly basic protein-finotin, a better acid resin, tannic acid, 6 % ash and a toxic alkaloid	Seeds are cathartic, purgative and apcrients. They are used in swollen joints, dropsy and enlargement of abdominal viscera.
5	Flower and Roots	As above	As a colouring agent used in dietary products.
6	Whole Plant	As above	In the treatment of Nootropic, Anxiolytic, Antidepressant, Anticonvulsant and antistress activity. Also used in treating sexual ailments and as fertility and gonorrhoca, Given in heart stable function

Chemical Composition of C.T: C.T roots boast taraxerol and taraxerone, while its seeds contain cinnamic acid and anthoxanthin glucoside. A highly basic small protein named finotin, water-soluble mucilage, delphinidin 3, 3', 5'-triglucoside, and beta-sitosterol, adding depth to the plant's nutritional and pharmacological potential. The seeds further encompass valuable sources of essential fatty acids like palmitic, stearic, oleic, linoleic, and linolenic acids. C.T leaves house glycosides of kaemferol and stigmast-4-ene-3,6-dione, and its flowers contain delphinidin-3,5-diglucoside.

Isolated Chemical Compounds: Various chemical compounds can be isolated from C.T, including triterpenoids, glycosides, flavonoids, anthocyanins, steroids, cliotides, and peptides.

Nutrient Content in C.T Flowers: [26] C.T flowers exhibit a rich nutrient profile, with notably high levels of calcium (3.09mg/g), magnesium (2.23mg/g), potassium (1.25mg/g), zinc (0.59mg/g), sodium (0.14mg/g), copper (0.013mg/g), selenium (0.001mg/g), and iron (0.14mg/g).

Phytoconstituents in C.T Plant: The C.T plant contains essential phytoconstituents such as taraxerol, taraxerone, aparajitin, beta-sitosterol, and kaempferol [27-30]. These compounds contribute to the anti-allergic, antibacterial, and anti-inflammatory properties of Aprajita. This intricate chemical composition underscores the diverse array of beneficial compounds present in different parts of the C.T plant, highlighting its potential therapeutic and nutritional value. The preliminary phytochemical screening of the plant revealed a diverse array of bioactive compounds. Notably, the presence of tannins, phlobatannin, carbohydrates, saponins, triterpenoids, phenols, flavonoids, flavonol glycosides, proteins, alkaloids, anthraquinone, anthocyanins, cardiac glycosides, Stigmast-4-ene-3,6-dione, volatile oils, and steroids underscores the rich chemical profile of the plant [31-37] (Table 1).

Materials & Methods

Plant Material Collection & Extract Preparation: [38-44]

Flower petals of C. Ternatea were meticulously collected from diverse locations, including Sahibganj, home gardens, and nearby area. Subsequently, these petals were carefully dried for a period of 1-3 weeks before being transformed into a coarse powder using a mortar and pestle. To extract the plant's components, 100 grams of the resulting powder underwent a systematic, successive hot continuous soxhlet extraction with eleven solvents, each selected based on its polarity.

Prior to the extraction with each subsequent solvent, the powdered material was subjected to air-drying in a hot air oven maintained below 50°C. Following the effective extraction process, the solvents were distilled off, and the resulting extract was concentrated on a water bath. The weight of the extract obtained with each solvent was measured, and the percentage was calculated concerning the air-dried weight of the plant material.

To further analyze the different constituents, a TLC Plate Test Method (TLCPTM) [45-51] was employed, and the Retention Factor (R.F) was calculated to discern the various components present in the extracts. This comprehensive methodology provides a detailed insight into the chemical composition of C. Ternatea flower petals collected from distinct geographical locations.

Result and Discussion

Phytochemical Screening of Extracts: [52-54]

Phytochemical screening involves the systematic process of extracting, screening, and identifying bioactive substances present in plants. This intricate procedure aims to unveil a spectrum of compounds with potential therapeutic benefits. Among the notable bioactive substances derived from plants are carbohydrates, flavonoids, alkaloids, glycosides, steroids, fats, tannins, and phenolic compounds (Figure 3). Each of these compounds plays a distinctive role in the plant's chemistry and can contribute to various health-promoting properties when utilized for medicinal or nutritional purposes.

Figure 3: C. Ternatea Chemical Constituent.

The aqueous extract of C. ternatea flowers underwent a comprehensive investigation to identify key chemical constituents. Various chemical tests were employed to assess the presence of specific compounds. The results indicated the presence of phenolic compounds (confirmed by the FeCl3 Test), alkaloids (detected using Wagner's Test), flavonoids, glycosides, saponins, steroids (identified through Liberman-Burchard's Test), and tannins.

Further analysis of the flower's composition revealed the presence of flavonol glycosides, specifically 3-O-(2"-O-alpharhamnosyl-6"-O-malonyl)-beta-glucoside of kaempferol, quercetin, and myricetin. Delphinidin glycosides, including 3-O-beta-glucoside, 3-O-(2"-O-alpha-rhamnosyl)-beta-glucoside, and 3-O-(2"-O-alpha-rhamnosyl-6"-O-malonyl)-beta-glucoside of delphinidin, were also identified. Furthermore, eight anthocyanins were isolated from the flowers, including ternatins C1, C2, C3, C4, C5, and D3, as well as preternatins A3 and C4 [55-58] (Figure 3).

Flavonoids: To test for the presence of flavonoids, 0.5 ml of alcohol extracts of the C. Ternatea extract were introduced into a test tube. Subsequently, 5-10 drops of diluted hydrochloric acid (HCl) were added, along with a small piece of magnesium. The solution was then boiled for a few minutes. The presence of flavonoids, the solution exhibited a distinctive pink, reddish-pink, or brown coloration. This color change served as an indicator of the presence of flavonoid compounds in the tested sample.

Alkaloids: The Wagner's Test for alkaloids was conducted by acidifying 1 ml of the alcoholic extract of the C. Ternatea extract with 1.5% hydrochloric acid (HCl) and introducing a few drops of Wagner's reagent. The formation of a brown precipitate indicated a positive test for alkaloids. This distinctive color change served as confirmation for the presence of alkaloid compounds in the tested sample.

Glycosides: The detection of glycosides involved dissolving a small amount of alcohol extracts from the C. Ternatea extract in a mixture of 1 ml water and 1N sodium hydroxide (NaOH) solution. The emergence of a yellow color during this process was indicative of the presence of glycosides in the tested sample. This distinct color change served as a positive indication for the presence of glycoside compounds in the tested sample.

Steroids: The Liberman-Burchard's Test for steroids was conducted by combining the ethanolic extract of the C. Ternatea extract with chloroform (CHCl3) and acetic anhydride. Following this, 1 ml of concentrated sulfuric acid was introduced. The presence of steroids was affirmed by the development of a reddish-brown ring at the interface of the two layers. This distinctive color change acted as a positive indication for the presence of steroid compounds in the tested sample.

Phenols: For the detection of phenols, a small quantity of alcohol extracted from the C. Ternatea extract was dissolved in 2 ml of distilled water, and a few drops of 10% ferric chloride solution were added. The presence of phenols was indicated by the production of a blue or green color. This color change served as confirmation for the presence of phenolic compounds in the tested sample.

Saponins: For the detection of saponins, a small quantity of alcohol extract from the C. Ternatea extract was dissolved in 5 ml of distilled water. The mixture was shaken vigorously and left undisturbed for 3 minutes. The presence of saponins was indicated by the formation of a honeycomb-like froth. This distinctive froth served as confirmation for the presence of saponin compounds in the tested sample.

Tannins: To detect the presence of tannins, a few drops of 5% aqueous ferric chloride solution were added to the ethanolic ex-

tract of the C. Ternatea extract. The development of a bluish-black color indicated the presence of tannins in the tested sample.

Retention Factor

R.F. was calculated by using the TLCPTM. The spots found in the TLC Plate were used to calculate the Retention Factor by the distance travelled by solute to Distance travelled by solvent (Table 2).

Table 2: Retention Factor Parameter (RFP) and Comparison of Calculated RF Value (CRFV) and Observed RF Value (ORFV) for the Determination of Relative Quantities of Separated Compounds.

Sl. No	Colour of Spot Found	Compound Name	Distance Travelled by Solute	Distance Travelled by Solvent	Calculated RF Value	Solvent Used	Rf Reference (RFRR)	Observed RF Value (ORFV)	Inference
1	Blue	Anthocyanin	2. 5 cm	6.3 cm	2.5/6.3= 0.3968	Ethanol: Water 01:01:00	0.32-0.62	0.3968	Observed RF Value confirm Anthocyanin
2	Brown	Glycosides	4.6 cm	6.3 cm	4.6/6.3= 0.7301	Ethanol: Water 01:01:00	0.02-0.96	0.7301	Glycosides on the basis of the colored of spot and its reference range in the Ethanol System

Note: 1. Phenol Reference Range : 0.2-0.6

2. Flavonoids Reference Range : 0.4-0.9

3. Alkaloids Reference Range : 0.14-0.65

4. Saponins Reference Range : 0.08-0.93

5. Tannins Reference Range : 0.07-0.93

C.T was found to possess various organic compounds, including phenols, flavonoids, alkaloids, saponins, tannins, anthocyanin, glycosides, etc. Anthocyanin and glycosides were quantified using the TLCPTM, with observed values for Anthocyanin (0.3968) and Glycosides (0.7301) falling within the range of 0.32-0.62 for Anthocyanin and 0.02-0.96 for Glycosides, respectively (as shown in Table 2). Further Some assessment is going for various applications, including its potential as a food colorant and its efficacy in inflammation protection, diabetes, cancer, heart disease, obesity, paw edema, and heel crack and more research is required for better results.

Multivariate Therapeutic Uses of C. Ternatea [59-68]

[Figures 4,5&6] clearly depicts the Spiritual Approach of C. Ternatea, Diverse Application of C. Ternatea, & C. Ternatea Health Concerns.

Figure 4: Spiritual Approach of C. Ternatea.

Figure 5: Diverse Application of C. Ternatea.

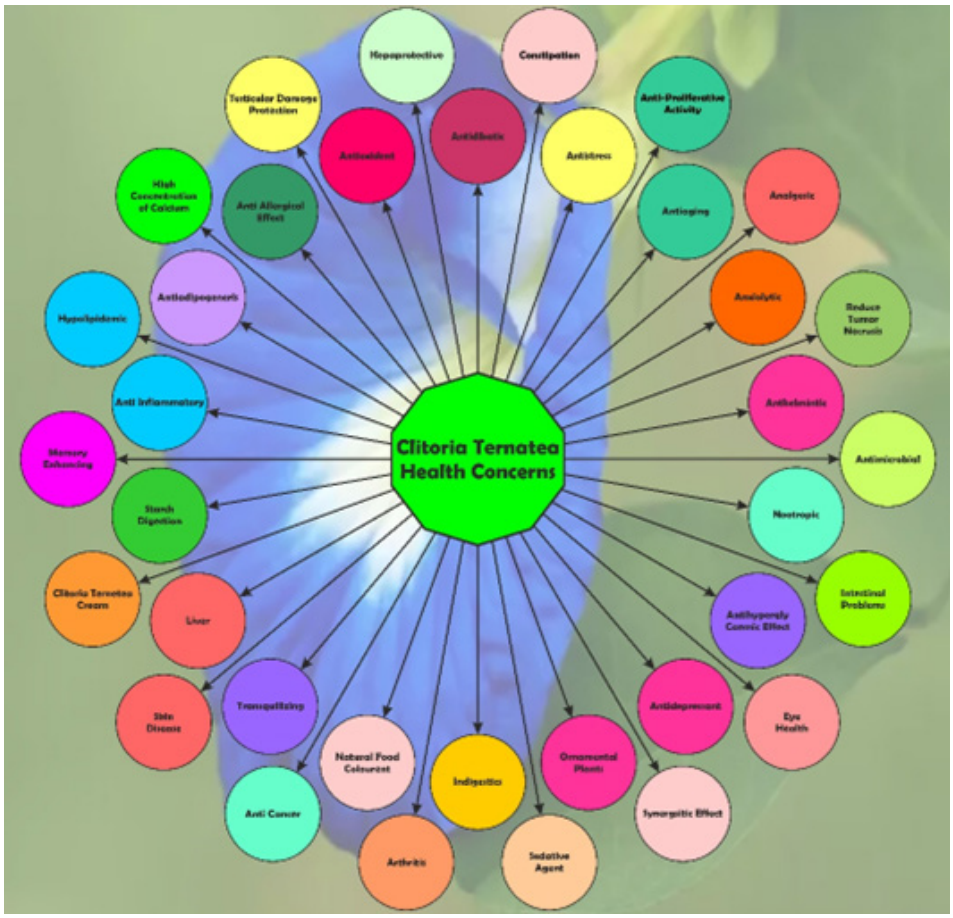

Figure 6: C. Ternatea Health Concerns.

C.T Flavonoids & Anti-Inflammatory Agent: C. Ternatea, known for its flavonoids, serves as a potent anti-inflammatory agent, promoting smooth and calm skin. It supports moisture retention and lipid balance, strengthening the dermal barrier.

Regulator of Blood Sugar Levels: C. Ternatea plays a role in regulating blood sugar levels, contributing to overall health and well-being.

Mood Enhancement and Cognitive Benefits: C. Ternatea, commonly referred to as Blue-tea, has mood-enhancing properties, reducing stress, anxiety, and depression. It positively impacts the brain, improving memory and cognitive function.

Spiritual Significance: C. Ternatea is utilized in daily puja rituals and worshipping, particularly for Lord Shiva, embodying a sacred and traditional connection.

Antioxidant and Anti-Inflammatory Properties: C. Ternatea blue tea is rich in antioxidants and anti-inflammatory properties, facilitating body detoxification and aiding in the reduction of unwanted fats in the stomach.

Hair Care and Premature Greying: C. Ternatea flower, with its anthocyanin content, is employed to treat premature hair greying, enhancing blood flow to the scalp and addressing hair damage and loss.

Astrological Significance: By growing C. Ternatea on specific days (Thursday for Lord Vishnu and Friday for Goddess Lakshmi), it is believed to alleviate money-related issues and attract wealth.

Digestive Health and Skin Radiance: Consuming C. Ternatea tea regularly is beneficial for digestive health, eliminating indigestive food particles and clearing the stomach, liver, and kidneys. It brightens dull skin, removes dark spots, and evens out skin tone.

Medicinal Uses: C. Ternatea roots are utilized in treating conditions such as edema, skin disorders, and digestive disorders, showcasing its medicinal versatility.

Positive Energy and Protection: C. Ternatea is considered an auspicious plant, bringing good luck and happiness to homes, while also providing protection against negative energy.

Neurological Treatment and Vastu Dosh Remover: C. Ternatea extract, used in medhya-rasayana, is a rejuvenating recipe for neurological disorders. Planting C. Ternatea at home is believed to purify energies, protect against daily life defects, and act as a remedy for Vastu dosh, removing negative energy from the home and its surroundings [69-79] (Figures 4-6).

Conclusion

In this comprehensive study, the flower extract of C. Ternatea was thoroughly examined, revealing a spectrum of therapeutic phytochemical constituents such as terpenoids, alkaloids, flavonoids, and tannins. While these components exhibit promising health benefits, further research is vital to pinpoint specific bioactive compounds for targeting complex ailments like cancer and neurological disorders. The study underscored the cultural significance and ecological adaptability of C. Ternatea, emphasizing its ornamental value.

The phytochemical analysis highlighted compounds contributing to anti-allergic, antibacterial, and anti-inflammatory properties. Rigorous methodologies, including precise plant material collection and the TLCPTM, provided valuable insights into the chemical composition. The study revealed that C. Ternatea is a promising medicinal plant with a wide range of pharmacological activities which could be utilized in several medicinal applications because of its effectiveness and safety.

Phytochemical screening confirmed the presence of various compounds in the flower extract including anthocyanin & glycoside that help in anti-inflammatory, cardiotonic, anti-bacterial, antiviral, antidiabetic, anti-obesity, CVDs, etc. The study explored the multivariate therapeutic uses of C. Ternatea, emphasizing its blood sugar regulation, mood-enhancing, antioxidant, and treatment properties.

In conclusion, this study offers valuable insights into the phytochemical composition and potential therapeutic applications of C. Ternatea flower extract, with ongoing research at Sahibganj College, Sahibganj aiming to unlock its full potential across various health aspects.

Acknowledgements

The authors express deep gratitude to Vice-Chancellor Prof. (Dr.) B.P. Singh of Sido-Kanhu Murmu University, Dumka and the Principal Dr. Rahul Kumar Santosh of Sahibganj College for their indispensable moral & ethical support. The authors express their gratitude to Dr. R.C. Pandit and Dr. Rajesh Kumar Sah of Sadar Hospital, Sahibganj for their invaluable insights and guidance, which proved immensely beneficial throughout the course of this study. Special appreciation is extended to U.G./P.G./Ph.D. Scholars for their dedicated contributions in literature review, resourcing, experiment setup, typing, printing, and diagram sketching. The authors also acknowledge the invaluable support from individuals, not explicitly mentioned, whose diverse skills played a crucial role in this research. The collaborative efforts of the research community are sincerely appreciated in this expression of thanks.

Conflict of Interest

Authors declare no conflict of interest.

References

1. Shahid M, Shahid A, Anis M (2009) Antibacterial potential of the extracts derived from leaves of medicinal plants Pterocarpus marsupium Roxb., Clitoria ternatea, Korean Medical Database. Oriental Pharmacy and Experimental Medicine 174-181.

2. Shahnas N, Akhila S (2014) Phytochemical, in vitro and in silico evaluation on Clitoria ternatea for alzheimer's disease. PharmaTuto 2(9): 135-149.

3. The Plants Database, database (version 4.0.4). National Plant Data Center (pp. 70874–74490). (n.d.). NRCS, USDA. Baton Rouge, LA.

4. Jain NN, Ohal CC, Shroff SK, Bhutada RH, Somani RS, et al. (2003) Clitoria ternatea and the CNS. Pharmacology, Biochemistry, and Behavior 75(3): 529-536.

5. Gomez S, Kalamani M (2003) Butter-fly Pea (Clitoria ternatea): A Nutritive Multipurpose Forage Legume for the Tropics- An Overview. Pakistan Journal of Nutrition 2(6): 374-379.
6. Barik D, Naik P, Mudgal K, Chand A (2007) Rapid plant regeneration through in vitro axillary shoot proliferation of butter-fly pea (Clitoria ternatea L.) - a twinning legume. In Vitro Cell.Dev.Biol.-Plant 43: 144-148.
7. USDA, ARS, National Genetic Resources Program. Germplasm Resources Information Network-(GRIN), National Germplasm Resources Laboratory, Beltsville, Maryland.
8. Chauhan N, Singh N, Gupta J, Shah K, Mishra P, et al. (2017) A Review on Clitoria ternatea(Linn.): Chemistry and Pharmacology.
9. Parimaladevi B, Boominathan R, Mandal S (2003) Antiinflammatory, analgesic and anti-pyretic properties of Clitoria ternatea root. Fitoterapia 74(4): 345-349.
10. Taur DJ, Patil RY (2010) Antihistaminic activity of Clitoria ternatea L. roots. Journal of Basic and Clinical Pharmacy 2(1): 41-44.
11. Asian pigeonwings - encyclopedia of life. (n.d.).
12. Alok S, Gupta N, Kumar A, Malik A (2015) An update on Ayurvedic herb vishnukanta (Clitoria ternatea Linn.): A review. International Journal of Life Sciences and Review (IJLSR) 1(1): 1-9.
13. Hall T (1985) Adaptation and Agronomy of Clitoria ternatea L. Tropical Grasslands 19(4): 156-163.
14. Banerjee SK, Chakravarti RN (1963) Taraxerol from Clitoria ternatea Linn. Bulletin of the Calcutta School of Tropical Medicine11: 106-107.
15. Banerjee SK, Chakravarti RN (1964) Taraxerone from Clitoria ternatea Linn. Bulletin of the Calcutta School of Tropical Medicine 12: 23.
16. Uma B, Prabhaka K, Rajendran S (2009) Phytochemical Analysis and AntiMicrobial Activity of Clitoria ternatea Linn against Extended Spectrum Beta Lactamase Producing Enteric and Urinary Pathogens. Asian Journal of Pharmaceutical and Clinical Research 2(4): 94-96.
17. Mukherjee P, Kumar K, Kumar V, Heinrich S (2008) The Ayurvedic medicine Clitoria ternatea- From traditional use to scientific assessment. Journal of Ethnopharmacology 120(3): 291-301.
18. Joshi S, Shrivastava S, Shrivastava K (1981) Chemical examination of Clitoria ternatea Seeds. Journal of American Oil Chemical Society 58(6): 714-715.
19. Potsangbam L, Ningombam S, Laitonjam W (2008) Natural dye yielding plants and indigenous knowledge of dyeing in Manipur, Northeast India. Northeast India, Indian Journal of Traditional Knowledge 7(1): 141-147.
20. Sinha A (1960) Studies on the unsaponifiable matter of the seeds of Clitoria ternatea Linn. And isolation of - sitosterol. Proceedings of the National Academy of Sciences 29: 23-26.
21. Banerjee SK. Chakravarti RN (1964) Taraxerone from Clitoria ternatea Linn. Bulletin of the Calcutta School of Tropical Medicine 12: 23.
22. Braca A, Sortino C, Politi M, Morelli I, Mendez J (2002) Antioxidant activity of flavonoids from Licania linaniaeflora. Journal of Ethnopharmacology 79(3): 379- 381.
23. Kumar Dhakad P, Singh R, Singh SKYP (2021) Anxiolytic Activity of Extract of Flowers of Clitoria Ternatea Linn. International Journal of Toxicological and Pharmacological Research 11(5): 107-112.
24. Terahara N, Toki K, Saito N, Honda T, Matsui T, et al. (1998) Eight new anthocyanins, ternatins C1-C5 and D3 and preternatins A3 and C4 from young clitoria ternatea flowers. Journal of Natural Products 61(11): 1361-1367.
25. Waltner Law ME, Wang XL, Law BK (2002) Epigallocatechin gallate, a constituent of green tea, represses hepatic glucose production. Journal of Biological Chemistry 277(45): 34933-34940.
26. Neda GD, Rabeta MS, Ong MT (2013) Chemical composition and anti-proliferative properties of flowers of Clitoria ternatea. Int Food Res J 20: 1229-1234.
27. Morita N, Arisawa M, Nagase M, Hsu H, Chen Y (1977) Studies on the Constituents of Foramosan Leguminosae. L.The Constituents in the Leaves of Clitoria ternatea L 97(6): 649-653.
28. Joshi S, Shrivastava S, Shrivastava K (1981) Chemical examination of Clitoria ternatea Seeds. Journal of American Oil Chemical Society 58(6): 714-715.
29. Potsangbam L, Ningombam S, Laitonjam W (2008) Natural dye yielding plants and indigenous knowledge of dyeing in Manipur, Northeast India. Northeast India, Indian Journal of Traditional Knowledge 7(1): 141-147.
30. Sinha A (1960) Studies on the unsaponifiable matter of the seeds of Clitoria ternatea Linn. And isolation of - sitosterol. Proceedings of the National Academy of Sciences 29: 23-26.
31. Jain NN, Ohal CC, Shroff SK, Bhutada RH, Somani RS, et al. (2003) Clitoria ternatea and the CNS. Pharmacology, Biochemistry, and Behavior 75(3): 529-536.
32. Patil AP, Patil VR (2011) Comparative Evaluation of in vitro Antioxidant Activity of Root of Blue and White Flowered Varieties of Clitoria ternatea Linn. International Journal of Pharmacology 7(4): 485-491.
33. Waltner Law ME, Wang XL, Law BK (2002) Epigallocatechin gallate, a constituent of green tea, represses hepatic glucose production. Journal of Biological Chemistry 277(45): 34933-34940.
34. Arise R, Malomo O, Adebayo O, Igunnu O (2009) Effects of aqueous extract of Eucalyptus globules on lipid peroxidation and selected enzymes of rat liver. J. Med. Plant Res 77-81.
35. Pratt D (1992) Phenolic compounds in food and their effects on health. New York: American Chemical Society 54–72.
36. Kaur G, Alam MS, Jabbar Z, Javed K, Athar M (2006) Evaluation of antioxidant activity of Cassia siamea flowers. Journal of Ethnopharmacology 108(3): 340-348.
37. Youwei Z, Jinlian Z, Yonghong P (2008) A comparative study on the free radical scavenging activities of some fresh flowers in southern China. Lebensmittel-Wissenschaft Und Technologie [Food Science and Technology] 41(9): 1586-1591.
38. Lakshan SAT, Jayanath NY, Abeysekera WPKM, et al (2019) A commercial potential blue pea (Clitoria ternatea L.) flower extract incorporated beverage having functional properties. Evid Based Complement Altern Med 2019:1-13.
39. Lopez Prado AS, Shen Y, Ardoin R, et al (2019) Effects of different solvents on total phenolic and total anthocyanin contents of Clitoria ternatea L. petal and their anti-cholesterol oxidation capabilities. Int J Food Sci Technol 54: 424-431.
40. Mehmood A, Ishaq M, Zhao L, Sanabil Yaqoob, Bushra Safdar, et al (2019) Impact of ultrasound and conventional extraction techniques on bioactive compounds and biological activities of blue butterfly pea flower (Clitoria ternatea L.). Ultrason Sonochem 51: 12-19.
41. Srichaikul B (2018) Ultrasonication extraction, bioactivity, antioxidant activity, total flavonoid, total phenolic and antioxidant of Clitoria ternatea linn flower extract for anti-aging drinks. Pharmacogn Mag 14: 322.
42. Phrueksanan W, Yibchokanun S, Adisakwattana S (2014) Protection of Clitoria ternatea flower petal extract against free radicalinduced hemolysis and oxidative damage in canine erythrocytes. Res Vet Sci 97: 357-363.
43. Kamkaen N, Wilkinson JM (2009) The antioxidant activity of Clitoria ternatea flower petal extracts and eye gel. Phytother Res 23(11): 1624-1625.
44. Jeyaraj EJ, Lim YY, Choo WS (2021) Extraction methods of butterfly pea (Clitoria ternatea) flower and biological activities of its phytochemicals. Journal of food science and technology 58(6): 2054-2067.

45. Kumar V, Mukherjee K, Kumar S, Mal M, Mukherjee PK (2008) Validation of HPTLC method for the analysis of taraxerol in Clitoria ternatea. Phytochemical Analysis: PCA 19(3): 244-250.

46. Ravi R, Mohd Amin, MF Said A, Ishak I, Srikumar S, et al. (2020) Chemical composition and larvicidal activity against Aedes mosquitoes of flower extracts from Clitoria Ternatea.

47. Pal A, Chakraborty S, Bala NN (2022) Comparative Study of Thin-Layer Chromatography Bioautography and Antioxidant Activities of Different Parts of Clitoria Ternatea (Fabaceae). Asian Journal of Pharmaceutical and Clinical Research 15(3): 134-138.

48. Nikolaichuk H, Choma IM, Morlock GE (2023) Effect-Directed Profiling of Akebia quinata and Clitoria ternatea via High-Performance Thin-Layer Chromatography, Planar Assays and High-Resolution Mass Spectrometry. Molecules 28(7): 2893.

49. Sethiya NK, Raja MK, Mishra SH (2013) Antioxidant markers-based TLC-DPPH differentiation on four commercialized botanical sources of Shankhpushpi (A Medhya Rasayana): A preliminary assessment. Journal of advanced pharmaceutical technology & research 4(1): 25-30.

50. Ravindran DR, Bharathithasan M, Ramaiah P, Rasat MSM, Rajendran D, et al. (2020) Chemical Composition and Larvicidal Activity of Flower Extracts from Clitoria ternatea against Aedes (Diptera: Culicidae). Journal of Chemistry 2020: 3837207.

51. Chauhan, N, Rajvaidhya S, Dubey BK (2012) Pharmacognostic, phytochemical and pharmacological review on Clitoria ternatea for antiasthmatic. IJPSR 3(2): 398-404.

52. Dhakad PK, Singh R, Yadav SK, Singh P (2021) Anxiolytic Activity of Extract of Flowers of Clitoria Ternatea Linn. International Journal of Toxicological and Pharmacological Research 11(5): 107-112.

53. Shyamkumar IB (2012) Anti-inflammatory, analgesic and phytochemical studies of Clitoria ternatea Linn flower extract. International Research Journal of Pharmacy 3(3): 208-210.

54. Terahara N, Toki K, Saito N, Honda T, Matsui T, et al. (1998) Eight new anthocyanins, ternatins C1-C5 and D3 and preternatins A3 and C4 from young clitoria ternatea flowers. Journal of Natural Products 61(11): 1361-1367.

55. Kazuma K, Noda N, Suzuki M (2003) Malonylated flavonol glycosides from the petals of Clitoria ternatea. Phytochemistry 62: 229-237.

56. Yapar K, Kart A, Karapehlivan M, Atakisi O, Tunca R, et al. (2007) Hepatoprotective effect of l-carnitine against acute acetaminophen toxicity in mice. Experimental and Toxicologic Pathology 59: 121-128.

57. Youwei Z, Jinlian Z, Yonghong P (2008) A comparative study on the free radical scavenging activities of some fresh flowers in southern China. Lebensmittel-Wissenschaft Und Technologie [Food Science and Technology] 41(9): 1586-1591.

58. Jeyaraj EJ, Lim YY, Choo WS (2021) Extraction methods of butterfly pea (Clitoria ternatea) flower and biological activities of its phytochemicals. Journal of food science and technology 58(6): 2054-2067.

59. Oguis GK, Gilding EK, Jackson MA, Craik DJ (2019) Butterfly Pea (Clitoria ternatea), a Cyclotide-Bearing Plant With Applications in Agriculture and Medicine. Frontiers in Plant Science 10: 645.

60. Multisona RR, Shirodkar S, Arnold M, Gramza Michalowska A (2023) Clitoria ternatea Flower and Its Bioactive Compounds: Potential Use as Microencapsulated Ingredient for Functional Foods. Applied Sciences 13(4): 2134.

61. Jeyaraj EJ, Lim YY, Choo WS (2022) Antioxidant, cytotoxic, and antibacterial activities of Clitoria ternatea flower extracts and anthocyanin-rich fraction. Scientific Reports 12(1): 14890.

62. Goh SE, Kwong PJ, Ng CL, Ng WJ, Ee KY (2022) Antioxidant-rich Clitoria ternatea L. flower and its benefits in improving murine reproductive performance. Food Science and Technology 42.

63. Sahu D, Sahu JK, Kumar V, Tamrakar SK (2023) Phytochemicals and Medicinal Uses of Clitoria ternatea. International Journal of Plant & Soil Science 35(18): 942-951.

64. Islam MA, Mondal SK, Islam S, Akther Shorna MN, Biswas S, et al. (2023) Antioxidant, Cytotoxicity, Antimicrobial Activity, and In Silico Analysis of the Methanolic Leaf and Flower Extracts of Clitoria ternatea. Biochemistry Research International, 2023: 8847876.

65. Dhakad PK, Singh R, Yadav SK, Singh P (2021) Anxiolytic Activity of Extract of Flowers of Clitoria Ternatea Linn. International Journal of Toxicological and Pharmacological Research 11(5): 107-112.

66. Sethiya NK, Nahata A, Mishra H, Dixit VK (2009) An update on Shankhpushpi, a cognition boosting Ayurvedic medicine. Journal of Chinese Integrative Medicine 7(11): 1001-1022.

67. Nadkarni KM (1976) Indian Materia Medica. Bombay: Popular Publications 14: 354-355.

68. https://pubmed.ncbi.nlm.nih.gov.

69. https://journalipss.com.

70. https://www.sciencedirect.com.

71. https://www.wikipedia.org.

72. https://www.mdpi.com.

73. https://www.frontiersin.org.

74. https://www.medicinenet.com.

75. https://www.google.com.

76. https://www.researchgate.net.

77. https://scholar.google.com.

78. https://orcid.org.

79. https://www.webofscience.com.