ISSN Print: 2664-844X
ISSN Online: 2664-8458
NAAS Rating (2026): 4.97
IJAFS 2026; 8(5): 300-305
www.agriculturaljournals.com
Received: 06-02-2026
Accepted: 08-03-2026

Madhuri Sathyanarayana
Department of Food Technology, Kuvempu University, Shankaraghatta, Karnataka, India

Meghana M
Assistant Professor and Head, Department of Biochemistry, MMK and SDM Mahila Mahavidyalaya, Mysore, Karnataka, India

Ramya GT
Department of Biochemistry, Kuvempu University, Shankaraghatta, Karnataka, India

Manoj S
Department of Biochemistry, Kuvempu University, Shankaraghatta, Karnataka, India

SE Neelagund
Department of Biochemistry, Kuvempu University, Shankaraghatta, Karnataka, India

Corresponding Author:
SE Neelagund
Department of Biochemistry, Kuvempu University, Shankaraghatta, Karnataka, India

Decoding the phytochemical complexity of butterfly pea (*Clitoria ternatea*): A comprehensive review

Madhuri Sathyanarayana, Meghana M, Ramya GT, Manoj S and SE Neelagund

DOI: https://www.doi.org/10.33545/2664844X.2026.v8.i5d.1522

Abstract
Clitoria ternatea (butterfly pea) is a medicinally important perennial climber widely distributed in tropical and subtropical regions, with a long history of use in traditional systems such as Ayurveda. The plant has gained increasing scientific and industrial attention due to its rich phytochemical composition and broad spectrum of biological activities. This review highlights the diverse bioactive constituents of *C. ternatea*, including flavonoids, anthocyanins (notably ternatins), alkaloids, phenolic compounds, saponins, tannins, and unique cyclic peptides known as cyclotides. These compounds are responsible for its potent antioxidant, anti-inflammatory, antimicrobial, neuroprotective, and antidiabetic properties. The presence of anthocyanins not only contributes to its intense blue coloration but also supports its application as a natural food colorant with added health benefits. Cyclotides, due to their exceptional stability and bioactivity, further enhance the pharmaceutical potential of the plant. Experimental and clinical studies validate its traditional use as a cognitive enhancer and therapeutic agent for managing oxidative stress-related and metabolic disorders. In addition to medicinal applications, *C. ternatea* is increasingly utilized in functional foods and nutraceutical formulations. Overall, the integration of traditional knowledge with modern research underscores the plant's significance as a promising natural resource for future drug development and health-promoting applications.

Keywords: *Clitoria ternatea*, anthocyanins, cyclotides, antioxidant activity, nutraceuticals

Introduction

Clitoria ternatea, commonly referred to as butterfly pea, is a perennial herbaceous climber belonging to the Fabaceae family and is widely distributed throughout tropical and subtropical regions, particularly in South and Southeast Asia. The plant has been deeply rooted in traditional systems of medicine such as Ayurveda, where it is commonly known as "Aparajita" and is valued for its rejuvenating, memory-enhancing, and anxiolytic properties. Historically, different parts of the plant, including roots, leaves, seeds, and especially flowers, have been utilized for the treatment of various ailments ranging from neurological disorders and inflammation to infections and metabolic diseases. In addition to its medicinal uses, *C. ternatea* has gained increasing prominence in the food and beverage industry as a natural colorant due to the striking blue pigmentation of its flowers, which can change color depending on pH, making it highly attractive for functional and aesthetic applications in foods and drinks (Mukherjee et al., 2008; Kazuma et al., 2003) [11, 16].

The growing interest in *Clitoria ternatea* is largely attributed to its rich and diverse phytochemical composition, which serves as the foundation for its wide range of pharmacological activities. Among the most significant bioactive compounds present in the plant are flavonoids and anthocyanins, particularly a unique group of polyacylated anthocyanins known as ternatins. These compounds are responsible not only for the vibrant blue coloration of the flowers but also for their potent antioxidant properties. Ternatins have been shown to effectively scavenge free radicals, inhibit lipid peroxidation, and protect cellular components from oxidative damage, thereby playing a crucial role in preventing oxidative stress-related diseases such as cardiovascular disorders, neurodegenerative conditions, and certain types of cancer (Kazuma et al., 2003; Jeyaraj et al., 2022) [8, 11]. In addition to anthocyanins, other flavonoids such as quercetin, kaempferol, and myricetin derivatives further enhance the antioxidant and anti-inflammatory potential of the plant by modulating key cellular signaling pathways and reducing the production of pro-inflammatory mediators (Sahu et al., 2023) [26].

Beyond flavonoids, *C. ternatea* contains a variety of other phytoconstituents, including alkaloids, glycosides, saponins, tannins, and phenolic acids, each contributing to its multifaceted biological activities. Alkaloids such as clitorin and aparajitin have been associated with neuropharmacological effects, supporting the traditional use of the plant as a cognitive enhancer and nervine tonic. Experimental studies have demonstrated that extracts of *C. ternatea* can improve memory, learning, and cognitive performance, potentially through modulation of cholinergic activity and enhancement of acetylcholine levels in the brain (Mukherjee et al., 2008; Rai et al., 2002) [16, 25]. Phenolic compounds, including gallic acid and p-coumaric acid, further contribute to the plant's antioxidant capacity and play a role in reducing inflammation and protecting against chronic diseases (Sahu et al., 2023) [26]. Saponins and tannins present in the plant exhibit antimicrobial and antidiabetic properties, with saponins known to improve glucose metabolism and lipid profiles, while tannins exert astringent and antimicrobial effects (Jeyaraj et al., 2022) [8].

One of the most distinctive and scientifically intriguing aspects of *Clitoria ternatea* is the presence of cyclotides, a class of cyclic peptides characterized by a unique cystine knot structure that imparts exceptional stability against thermal, chemical, and enzymatic degradation. Cyclotides such as cliotides have attracted considerable attention due to their diverse biological activities, including antimicrobial, antiviral, insecticidal, and cytotoxic effects. Their remarkable stability and bioactivity make them promising candidates for pharmaceutical development, particularly in the design of novel peptide-based therapeutics (Poth et al., 2011; Craik et al., 1999) [3, 23]. The discovery of cyclotides in *C. ternatea* has opened new avenues for research into plant-derived bioactive peptides and their potential applications in medicine and agriculture. The pharmacological properties of *C. ternatea* are extensive and have been validated through numerous in vitro and in vivo studies. Its antioxidant activity is one of the most well-documented effects, with various extracts demonstrating strong radical scavenging capacity and protective effects against oxidative stress-induced cellular damage (Jeyaraj et al., 2022; Sahu et al., 2023) [8, 26]. The anti-inflammatory activity of the plant is mediated through the inhibition of inflammatory mediators such as prostaglandins, cytokines, and nitric oxide, thereby reducing inflammation and associated tissue damage. Additionally, the plant exhibits significant antimicrobial activity against a broad spectrum of bacterial and fungal pathogens, supporting its traditional use in treating infections (Kamkaen & Wilkinson, 2009) [9].

The neuroprotective and nootropic effects of *Clitoria ternatea* are particularly noteworthy, as they align closely with its traditional use as a brain tonic. Studies have shown that the plant can enhance memory and learning, reduce anxiety, and protect against neurodegenerative changes, possibly through antioxidant mechanisms and modulation of neurotransmitter systems (Rai et al., 2002; Mukherjee et al., 2008) [16, 25]. Furthermore, emerging evidence suggests that *C. ternatea* may possess antidiabetic properties, with extracts demonstrating the ability to lower blood glucose levels, improve insulin sensitivity, and inhibit carbohydrate-digesting enzymes such as α-amylase and α-glucosidase (Chusak et al., 2018) [2]. These findings highlight the potential of the plant as a natural therapeutic agent for the management of diabetes and related metabolic disorders. In addition to its medicinal applications, *Clitoria ternatea* has gained considerable attention in the food and nutraceutical industries. The anthocyanin-rich extracts of the flowers are increasingly being used as natural food colorants, offering a safer and more sustainable alternative to synthetic dyes. The pH-sensitive color-changing property of ternatins further enhances their appeal in innovative food products and beverages. Moreover, the incorporation of *C. ternatea* into functional foods and dietary supplements is being explored due to its health-promoting properties, including antioxidant and anti-inflammatory effects (Chayaratanasin et al., 2015) [1].

Overall, the integration of traditional knowledge with modern scientific research has established *Clitoria ternatea* as a plant of significant pharmacological and industrial importance. Its rich phytochemical profile, encompassing flavonoids, anthocyanins, alkaloids, phenolics, and cyclotides, underlies its diverse biological activities and therapeutic potential. As research continues to uncover new insights into its mechanisms of action and potential applications, *C. ternatea* stands out as a promising candidate for the development of novel nutraceuticals, functional foods, and pharmaceutical agents. The growing body of evidence not only validates its traditional uses but also highlights its relevance in addressing contemporary health challenges, making it an important subject of ongoing and future scientific investigation.

Chemical Composition of *Clitoria ternatea*

The chemical constituents of *C. ternatea* can be broadly classified into polyphenols, flavonoids, anthocyanins, alkaloids, terpenoids, peptides, and other secondary metabolites.

Table 1: Table showing the major phytochemical compounds identified in *Clitoria ternatea*, their plant sources, biological functions, and reported pharmacological significance.

Class of Compounds	Specific Compounds Identified	Plant Part	Key Features / Notes	References
Flavonoids (Flavonols)	Kaempferol, kaempferol-3-glucoside, kaempferol-3-rutinoside, quercetin, quercetin-3-glucoside, myricetin derivatives	Flowers, leaves, seeds	Major antioxidants; contribute to anti-inflammatory and free radical scavenging activity	Saito et al., 1985; Kazuma et al., 2003; Morita et al., 1976 [11, 15, 28]
Anthocyanins (Ternatins)	Ternatin A1-A3, B1-B4, C1-C5, D1-D3; delphinidin derivatives	Flowers	Responsible for blue coloration; strong antioxidant and pH-sensitive pigments	Terahara et al., 1989; Kazuma et al., 2003 [11, 31]
Phenolic Compounds	Gallic acid, p-coumaric acid, cinnamic acid, phenolic aglycones	Leaves, seeds, flowers	Contribute to antioxidant and anti-inflammatory effects	Kulshreshtha & Khare, 1967; Sahu et al., 2023 [12, 26]

Alkaloids	Clitorin, aparajitin (reported), other indole-type alkaloids	Roots, seeds	Associated with neuroprotective and nootropic effects	Mukherjee et al., 2008 [16]
Glycosides	Flavonol glycosides, anthocyanin glycosides	Leaves, flowers	Enhance solubility and biological activity of flavonoids	Kazuma et al., 2003 [11]
Terpenoids (Triterpenoids)	Taraxerol, taraxerone	Roots, aerial parts	Exhibit anti-inflammatory and antimicrobial activity	Reported phytochemical screenings
Cyclotides (Peptides)	Cliotides, Cter A-R, cT1-cT21 (~85+ identified)	Seeds, leaves, flowers	Highly stable cyclic peptides with antimicrobial, cytotoxic, and insecticidal properties	Poth et al., 2011; Nguyen et al., 2011 [20, 23]
Proteins & Amino Acids	Albumin-like proteins, enzyme butelase-1	Seeds, pods	Involved in peptide cyclization; important in biotechnology	Nguyen et al., 2011 [20]
Saponins	Triterpenoid saponins (various)	Roots, leaves	Contribute to antidiabetic and cholesterol-lowering effects	Jeyaraj et al., 2022 [8]
Tannins	Condensed tannins	Whole plant	Astringent, antimicrobial activity	General phytochemical studies
Sterols	β-sitosterol, stigmasterol	Roots, leaves	Anti-inflammatory and lipid-lowering effects	Phytochemical reports
Fatty Acids & Lipids	Palmitic acid, oleic acid, linoleic acid	Seeds	Nutritional and metabolic significance	Nutritional analyses
Carbohydrates & Sugars	Glucose, rhamnose, xylose (anthocyanin sugars)	Flowers	Structural components of anthocyanins	
Minerals	Calcium, magnesium, potassium	Flowers	Nutritional contribution	Nutritional studies

1. Anthocyanins (Major Pigments)

Anthocyanins represent the most distinctive and extensively studied class of phytochemicals in *Clitoria ternatea* flowers, primarily responsible for their intense and deep blue coloration. These pigments are predominantly present as polyacylated anthocyanins known as ternatins, which are structurally derived from delphinidin and further modified by glycosylation and acylation with aromatic acids. Major ternatins such as ternatin A1, A2, B1, and D1 contribute significantly to the stability and vivid hue of the flower extract. The polyacylation of these anthocyanins enhances their molecular stability against environmental factors such as light, heat, and pH changes, distinguishing them from less stable anthocyanins found in other plants. In addition to their coloring properties, these compounds exhibit potent antioxidant activity by effectively scavenging reactive oxygen species and inhibiting oxidative damage at the cellular level. A unique and commercially valuable feature of ternatins is their pH-sensitive color variation, where the pigment shifts from deep blue in neutral conditions to purple and pink under acidic environments, making them highly suitable as natural food colorants and pH indicators in functional foods and beverages. This property has led to their increasing application in the food industry as safer alternatives to synthetic dyes, while also offering additional health benefits associated with their bioactive nature (Kazuma et al., 2003; Terahara et al., 1989; Gamage et al., 2021) [4, 11, 31].

2. Flavonoids and Flavonol Glycosides

Flavonoids constitute a major class of phenolic compounds in *Clitoria ternatea* and play a crucial role in its biological and pharmacological activities. The plant contains several well-characterized flavonoids, including kaempferol, quercetin, myricetin, and their glycosidic derivatives such as kaempferol-3-glucoside and quercetin-3-glucoside. These compounds are predominantly present in glycosylated forms, which enhance their solubility, stability, and bioavailability within plant tissues and biological systems. Flavonoids in *C. ternatea* are recognized for their strong antioxidant properties, primarily through their ability to donate hydrogen atoms or electrons to neutralize reactive oxygen species and thereby prevent oxidative stress-induced cellular damage. In addition to antioxidant activity, these compounds exhibit significant anti-inflammatory effects by modulating key signaling pathways such as NF-κB and inhibiting the production of pro-inflammatory mediators, including cytokines and enzymes like cyclooxygenase. The synergistic interaction of these flavonoids further enhances the overall therapeutic potential of the plant, supporting its traditional use in managing inflammatory and oxidative stress-related disorders (Saito et al., 1985; Kazuma et al., 2003; Jeyaraj et al., 2020) [5, 8, 11, 28].

3. Phenolic Compounds (Polyphenols)

Polyphenols are widely distributed throughout *Clitoria ternatea* and represent an important group of bioactive constituents contributing to its therapeutic potential. This class primarily includes phenolic acids, phenolic alcohols, and various cinnamic acid derivatives, which are known for their strong antioxidant properties. Common phenolic acids such as gallic acid, caffeic acid, and p-coumaric acid have been identified in different parts of the plant and are recognized for their ability to donate hydrogen atoms or electrons, thereby neutralizing reactive oxygen species and preventing oxidative damage to cellular components. Phenolic alcohols further enhance this protective effect by stabilizing free radicals and interrupting chain reactions involved in lipid peroxidation. Cinnamic acid derivatives, on the other hand, contribute not only to antioxidant activity but also to anti-inflammatory and antimicrobial effects through modulation of enzymatic and signaling pathways. The collective action of these polyphenolic compounds plays a crucial role in reducing oxidative stress, which is a key factor in the pathogenesis of chronic diseases such as cardiovascular disorders, diabetes, and neurodegenerative conditions. Thus, the rich polyphenolic profile of *C. ternatea* supports its growing application in nutraceuticals and functional foods aimed at promoting health and preventing disease (Multisona et al., 2023; Sahu et al., 2023) [17, 26].

4. Alkaloids

Alkaloids are an important group of nitrogen-containing secondary metabolites present in *Clitoria ternatea*, contributing significantly to its pharmacological profile. Although the alkaloid content of the plant is less extensively characterized compared to its flavonoid and anthocyanin fractions, compounds such as clitorin have been reported, along with other partially identified or unidentified alkaloidal constituents. These compounds are believed to play a key role in the plant's neuropharmacological effects, particularly in relation to its traditional use as a brain tonic in Ayurvedic medicine. Experimental studies suggest that alkaloids in *C. ternatea* may exert neuroprotective and cognitive-enhancing effects by modulating neurotransmitter systems, especially the cholinergic pathway, which is crucial for memory and learning processes. Additionally, these compounds may help reduce oxidative stress in neural tissues and protect against neurodegenerative changes by enhancing antioxidant defenses and inhibiting neuronal damage. The presence of such alkaloidal fractions supports the plant's reported benefits in improving memory, reducing anxiety, and enhancing overall cognitive function, thereby reinforcing its potential application in the management of neurological disorders (Mohan, 2013; Sahu et al., 2023) [13, 26].

5. Terpenoids and Phytosterols

Lipophilic constituents of *Clitoria ternatea* include phytosterols such as β-sitosterol, stigmasterol, and campesterol, along with triterpenoids like taraxerol, which collectively contribute to the plant's pharmacological activities. These compounds are typically localized in lipid-rich fractions of the plant and play important roles in maintaining cellular integrity and modulating biological functions. Phytosterols structurally resemble cholesterol and are known to competitively inhibit its intestinal absorption, thereby contributing to cholesterol-lowering effects and improved lipid profiles. In addition, β-sitosterol and stigmasterol exhibit notable anti-inflammatory activity by suppressing pro-inflammatory mediators such as cytokines and prostaglandins. Taraxerol, a pentacyclic triterpenoid, further enhances these effects through its ability to stabilize cellular membranes, reduce oxidative stress, and inhibit inflammatory pathways. The lipophilic nature of these compounds also facilitates their interaction with biological membranes, improving membrane fluidity and protecting cells from damage. Altogether, these bioactive lipophilic molecules support the therapeutic potential of *C. ternatea* in managing inflammation, hyperlipidemia, and related metabolic disorders (Multisona et al., 2023; Sahu et al., 2023) [17, 26].

6. Cyclotides (Bioactive Peptides)

One of the most distinctive chemical features of *Clitoria ternatea* is the presence of cyclotides, a unique class of cyclic peptides characterized by a head-to-tail cyclized backbone and a cystine knot motif that confers extraordinary structural stability. Among these, kalata-type cyclotides are particularly prominent and share structural similarities with the well-studied kalata B1, while *C. ternatea* also contains butelase-associated peptides linked to the enzyme butelase-1, which plays a crucial role in peptide cyclization. These cyclotides exhibit a wide range of biological activities, including potent antimicrobial effects against bacteria, fungi, and viruses, as well as insecticidal properties that contribute to the plant's natural defense mechanisms. Their remarkable resistance to thermal, chemical, and enzymatic degradation makes them highly stable even under harsh physiological conditions, distinguishing them from most linear peptides. Due to these properties, cyclotides are increasingly recognized as promising molecular scaffolds for drug development, particularly in the design of peptide-based therapeutics with improved stability, bioavailability, and target specificity. The exploration of cyclotides from *C. ternatea* continues to provide valuable insights into their potential applications in pharmaceutical and agricultural fields (Poth et al., 2011; Poth et al., 2019; Nguyen et al., 2014) [21, 22, 23].

7. Saponins and Glycosides

Clitoria ternatea contains a range of triterpenoid saponins and glycosidic compounds that significantly contribute to its biological activities. Triterpenoid saponins are amphiphilic molecules composed of a triterpene aglycone linked to sugar moieties, which enhance their solubility and bioavailability. These compounds are known for their strong antioxidant potential, primarily through their ability to scavenge free radicals, inhibit lipid peroxidation, and protect cellular components from oxidative damage. In addition, saponins exhibit notable immunomodulatory effects by stimulating or regulating immune responses, including the activation of macrophages, modulation of cytokine production, and enhancement of antibody responses. Glycosidic compounds present in *C. ternatea*, including flavonoid and other secondary metabolite glycosides, further contribute to these effects by improving compound stability and facilitating interaction with biological targets. Together, these constituents support the plant's traditional use in boosting immunity and protecting against oxidative stress-related disorders, highlighting its potential application in nutraceutical and therapeutic formulations (Mohan, 2013; Sahu et al., 2023) [13, 26].

8. Tannins and Resins

Clitoria ternatea contains both hydrolyzable and condensed tannins, along with resinous compounds, which contribute significantly to its antimicrobial and astringent properties. Hydrolyzable tannins, composed of gallic or ellagic acid esters, and condensed tannins (proanthocyanidins) are known for their ability to bind proteins and precipitate microbial enzymes, thereby inhibiting the growth of bacteria and fungi. These tannins also exert astringent effects by forming complexes with proteins in tissues, leading to contraction and tightening of mucosal surfaces, which is beneficial in wound healing and in controlling diarrhea and minor infections. Resinous compounds present in the plant further enhance antimicrobial activity by disrupting microbial cell membranes and interfering with metabolic processes. The combined action of tannins and resins not only protects the plant against pathogens but also supports its traditional use in treating infections and inflammatory conditions. These properties highlight the therapeutic relevance of *C. ternatea* in herbal medicine and its potential application in developing natural antimicrobial agents (Mohan, 2013; Sahu et al., 2023) [13, 26].

9. Nutritional and Mineral Components

Apart from its rich phytochemical profile, *Clitoria ternatea* flowers also possess notable nutritional constituents that enhance their value as a functional food ingredient. The flowers contain essential macronutrients such as proteins, carbohydrates, and dietary fiber, which contribute to basic nutritional requirements and support overall metabolic health. Proteins present in the flowers may provide amino acids necessary for tissue repair and physiological functions, while carbohydrates serve as an immediate energy source. Dietary fiber plays a crucial role in promoting digestive health, regulating bowel movements, and aiding in glycemic control by slowing glucose absorption. In addition to these macronutrients, the flowers are a source of important minerals, including calcium, magnesium, and potassium. Calcium is essential for bone health and cellular signaling, magnesium acts as a cofactor in numerous enzymatic reactions and supports neuromuscular function, and potassium is vital for maintaining electrolyte balance and cardiovascular health. The presence of these nutrients, combined with bioactive compounds, makes *C. ternatea* an excellent candidate for incorporation into functional foods and nutraceutical products aimed at improving health and preventing disease (Sahu et al., 2023; Chayaratanasin et al., 2015) [1, 26].

Conclusion

In conclusion, *Clitoria ternatea* stands out as a chemically diverse and pharmacologically significant medicinal plant, owing to its rich repertoire of bioactive compounds such as anthocyanins (particularly ternatins), flavonoids, and cyclotides. These constituents collectively underpin a wide spectrum of biological activities, including antioxidant, anti-inflammatory, antimicrobial, neuroprotective, and metabolic regulatory effects, thereby validating its long-standing use in traditional medicine. The presence of highly stable, polyacylated anthocyanins not only contributes to its distinctive coloration but also supports its growing application as a natural food colorant with added health benefits. Moreover, the discovery of cyclotides structurally robust cyclic peptides with remarkable resistance to degradation opens new avenues for the development of novel peptide-based therapeutics. Beyond medicinal applications, the integration of *C. ternatea* into functional foods, nutraceuticals, and cosmetic formulations highlights its multidisciplinary relevance. Overall, the convergence of traditional knowledge and modern scientific validation positions *Clitoria ternatea* as a promising natural resource with substantial potential in advanced drug development and innovative functional product industries.

References

1. Chayaratanasin P, Barbieri MA, Suanpairintr N, Adisakwattana S. Inhibitory effect of *Clitoria ternatea* flower extract on advanced glycation end products. Food Chemistry. 2015;173:1009-1016.
2. Chusak C, Thilavech T, Adisakwattana S. Consumption of *Clitoria ternatea* flower extract modulates postprandial glycemia. Journal of Functional Foods. 2018;42:257-264.
3. Craik DJ, Daly NL, Bond T, Waine C. Plant cyclotides: A unique family of cyclic peptides. Journal of Molecular Biology. 1999;294(5):1327-1336.
4. Gamage GC, Lim YY, Choo WS. Anthocyanins from *Clitoria ternatea* flower: Biosynthesis, extraction, stability, and applications. Frontiers in Plant Science. 2021;12:792303.
5. Jeyaraj EJ, et al. Extraction and biological activities of phytochemicals from *Clitoria ternatea*. Journal of Food Science and Technology. 2020.
6. Jeyaraj EJ, Lim YY, Choo WS. Antioxidant and antibacterial activities of *Clitoria ternatea* flower extracts and their phytochemical analysis. Journal of Food Science and Technology. 2020;57(6):2054-2062.
7. Jeyaraj EJ, Lim YY, Choo WS. Antioxidant, antibacterial, and phytochemical analysis of *Clitoria ternatea* flower extracts. Journal of Food Science and Technology. 2022;59(3):1200-1210.
8. Jeyaraj EJ, Lim YY, Choo WS. Antioxidant, cytotoxic, and antibacterial activities of *Clitoria ternatea* flower extracts. Scientific Reports. 2022;12:14890.
9. Kamkaen N, Wilkinson JM. The antioxidant activity of *Clitoria ternatea* flower extracts. Journal of Food Composition and Analysis. 2009;22(7-8):555-559.
10. Kazuma K, et al. Identification of flavonoids in *Clitoria ternatea*.
11. Kazuma K, Noda N, Suzuki M. Flavonoid composition related to petal color in different lines of *Clitoria ternatea*. Phytochemistry. 2003;64(6):1133-1139.
12. Kulshreshtha DK, Khare A. Chemical constituents of *Clitoria ternatea*. Journal of Indian Chemical Society. 1967.
13. Mohan C. Phytochemical analysis of *Clitoria ternatea* Linn. Journal of Indian Botanical Society. 2013.
14. Mohan VR. Pharmacognostic and phytochemical evaluation of *Clitoria ternatea*. International Journal of Pharma and Bio Sciences. 2013;4(3):123-130.
15. Morita N, et al. Flavonoid constituents of *Clitoria ternatea* leaves. Chemical & Pharmaceutical Bulletin. 1976.
16. Mukherjee PK, Kumar V, Kumar NS, Heinrich M. The Ayurvedic medicine *Clitoria ternatea* From traditional use to scientific assessment. Journal of Ethnopharmacology. 2008;120(3):291-301.
17. Multisona RR, Shirodkar S, Arnold M, Gramza-Michalowska A. *Clitoria ternatea* flower and its bioactive compounds: Potential use as microencapsulated ingredient for functional foods. Applied Sciences. 2023;13(4):2134.
18. Multisona R, et al. Polyphenolic and lipophilic composition of *Clitoria ternatea* and its biological activities. Journal of Food Biochemistry. 2023;47(2):e14235.
19. Multisona R, et al. Polyphenolic composition and antioxidant activity of *Clitoria ternatea*: A comprehensive analysis. Journal of Food Biochemistry. 2023;47(2):e14235.
20. Nguyen GKT, et al. Butelase-mediated cyclization and cyclotide diversity in *Clitoria ternatea*. Journal of Biological Chemistry. 2011.
21. Nguyen GKT, Wang S, Qiu Y, Hemu X, Lian Y, Tam JP. Butelase 1 is an Asx-specific ligase enabling peptide macrocyclization and synthesis. Nature Chemical Biology. 2014;10(9):732-738.
22. Poth AG, Chan LY, Craik DJ. Cyclotides as versatile molecular scaffolds for drug design. Toxins. 2019;11(9):498.
23. Poth AG, Colgrave ML, Lyons RE, Craik DJ. Butterfly pea (*Clitoria ternatea*), a cyclotide-bearing plant with applications in agriculture and medicine. Frontiers in Plant Science. 2019;10:645.
24. Poth AG, Colgrave ML, Philip R, Kerenga B, Daly NL, Craik DJ. Discovery of cyclotides in *Clitoria ternatea*: Isolation, characterization, and bioactivity. Journal of Biological Chemistry. 2011;286(30):24528-24538.

25. Rai KS, Murthy KD, Karanth KS, Nalini K. *Clitoria ternatea* root extract enhances memory in rats. Pharmacology Biochemistry and Behavior. 2002;71(3):529-534.
26. Sahu AN, Mishra S, Jena S. Phytochemical and pharmacological overview of *Clitoria ternatea*: A comprehensive review. Journal of Herbal Medicine. 2023;38:100632.
27. Sahu D, Sahu JK, Kumar V, Tamrakar SK. Phytochemicals and medicinal uses of *Clitoria ternatea*. International Journal of Plant & Soil Science. 2023;35(18):942-951.
28. Saito N, et al. Flavonol glycosides from *Clitoria ternatea*. Phytochemistry. 1985.
29. Saito N, Tatsuzawa F, Honda T. Flavonoid glycosides in *Clitoria ternatea*. Phytochemistry. 1985;24(5):1007-1011.
30. Taranalli AD, Cheeramkuzhy TC. Influence of *Clitoria ternatea* extracts on memory and central cholinergic activity. Pharmacology Biochemistry and Behavior. 2000;67(2):293-297.
31. Terahara N, et al. Structure of ternatin A1 from *Clitoria ternatea*. Tetrahedron Letters. 1989.
32. Terahara N, Saito N, Honda T, Toki K, Osajima Y. Structure of ternatin A1 from *Clitoria ternatea*. Tetrahedron Letters. 1989;30(47):6271-6274.
33. Vidana Gamage GC, Lim YY, Choo WS. Anthocyanins from *Clitoria ternatea* flower. Frontiers in Plant Science. 2021;12:792303.