WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

The Versatile Butterfly Pea: Trends in Food and Cosmetic Applications.

Ms. Harshata R Borse[1], Ms. Komal Y Godambe[2], Ms. Sakshi S Vishe[3], Ms. Manasi M Lute[4], Ms. Anamika J Khapare[5]

[1,2,3,4,5]Research Scholar, Siddhi's Institute Of Pharmacy,DBATU University, Nandgaon, Murbad, Thane (421601).

ABSTRACT:-

Clitoria ternatea, commonly known as butterfly pea, is a plant that has several traditional therapeutic uses. These are attributed to the amount of physiologically active compounds in the plant. Its aboveground and underground components are used to treat a variety of conditions, such as digestive disorders, diabetes, high blood pressure, retinal damage, and edema. The medicinal potential of this plant has generated a lot of curiosity, which has led to research on its many health benefits and applications in functional meals that highlight its safety and efficacy.

The pharmacological properties of Clitoria ternatea flower extract are notable. Studies have indicated that it possesses health-promoting cytotoxic, antibacterial, antioxidant, anti-inflammatory, and antidiabetic qualities. Important metabolites of the plant include apagitin, clitorin, triterpenoids, anthocyanins, steroidal glycosides, and flavonols. Its diverse therapeutic benefits are believed to be caused by these substances, which support its use in conventional treatments. They serve as a foundation for modern pharmaceutical applications as well.

Additional research reveals that Clitoria ternatea may be used to treat mental diseases and enhance cognitive function. Its anticonvulsant, antidepressant, and antianxiety properties suggest that it could be useful for mental health management, and its nootropic properties could improve cognitive and memory function. It has additional medical uses due to its analgesic and anti-stress properties. This plant has been connected to a wide spectrum of functions, making it a flexible choice for developing new medications and dietary supplements.

Significant ramifications result from these findings, indicating that Clitoria ternatea may be used as a natural substitute in therapeutic and preventative health tactics. The use of Clitoria ternatea into health regimens may support holistic approaches to health and wellness, given the growing interest in herbal remedies and functional foods. Furthermore, continued studies into its bioactive components could result in novel therapies for long-term illnesses, expanding the use of natural medicine.

Clitoria ternatea's numerous pharmacological advantages make it a noteworthy asset in both conventional and alternative medicine. In addition to treating a variety of medical conditions, its varied active ingredients open the door for possible new medication advancements. The plant's potential to improve health and treat illnesses is expected to grow as more study is conducted, highlighting the significance of identifying and utilizing natural sources in modern healthcare.

KEYWORDS:-Clitoria ternatea, High blood pressure, Antioxidants properties, Pharmacological activities, Traditional medicines, Diabetes treatment, Antibacterial activities, Therapeutic properties, Functional food applications.

1.INTRODUCTION:-

One notable thermo-mechanical technique that is frequently employed in the food sector to produce a variety of goods, such as meat substitutes, morning cereals, and puffed snacks, is extrusion processing. Starch-rich ingredients, which expand well during processing and improve the end goods' texture and appearance, are a major component of this approach. However, because certain starch sources—like wheat and corn—are often used, questions have been raised about the extrudates' nutritional value because they are often abundant in calories but lacking in vital elements. In order to solve this problem, scientists have looked into using pulse flours—yellow pea in particular—to increase the protein level of extruded snacks because of their advantageous nutritional profile, which includes a high protein content and healthy dietary fiber.

Yellow pea flour's remarkable nutritional qualities—it contains 18–28 grams of protein and 14–17 grams of dietary fiber per 100 grams of dry matter—have drawn notice. Yellow peas are known for their high protein content, low glycemic index, and a variety of bioactive substances that enhance their health advantages. Notably, bioactive substances such the phenolics in butterfly pea and yellow pea blossoms have been linked to a number of health benefits, such as lowered risks for cardiovascular illnesses and anti-diabetic properties. These substances, especially phenolics, are useful for adding to food products because they have anti-inflammatory and antioxidant qualities that improve health when ingested.

Butterfly pea blossoms are especially notable for having a high concentration of anthocyanins and phenolic chemicals, which have health advantages and can be used as natural food coloring. Butterfly pea blooms have few culinary uses, despite their potential.

Their incorporation into extruded products has been the subject of recent investigations, with some success noted at modest quantities. Optimizing the amounts of butterfly pea flower in extrusion formulations to optimize health benefits while preserving the quality of the extruded foods is a difficulty, though. Examining the effects of changing the butterfly pea flower concentration on the nutritional value and physical characteristics of extruded products, like breakfast cereals, is essential.

Butterfly pea blossoms offer nutritional benefits, but because of their special qualities, they may also contribute to improving the texture and structural consistency of extruded goods. However, there might be difficulties integrating them into conventional cereal formulations, such as compatibility problems that could interfere with the extrusion process. Therefore, to guarantee desired results in texture and nutritional content, a careful assessment of the butterfly pea flower concentration and its interaction with other ingredients is required. This research may lead to the development of novel, healthful breakfast cereals that combine the advantages of butterfly pea and yellow pea flour.

One intriguing approach to creating wholesome and health-promoting food options is the incorporation of butterfly pea flower into extruded products. Through the optimization of both yellow pea and butterfly pea flour in extrusion procedures, scientists may produce breakfast cereals that are enhanced with bioactive substances and high in dietary fiber and protein. Research into these ingredients is essential because it may result in new food products that address the nutritional inadequacies frequently present in conventional extruded snacks and appeal to consumers who are health-conscious.

2.PLANT PROFILE:-

BUTTERFLY PEAFLOWER:

2.1.SYNONYMS:

Clitoria albiflora Mattei, Clitoria bracteata Poir. Clitoria mearnsii De Wild., Clitoria tanganicensis Micheli,

Clitoria zanzibarensis Vatke.

2.2.BIOLOGICAL SOURCE :-

It is made up of dried seeds from perennial herbaceous plants that are members of the fabaceae family.

2.3. FAMILY: Fabaceae. **GENUS:** Clitoria L. **SPECIES:** Clitoria ternatea.

3.SOIL AND CLIMATE PARAMETER:

The tropical plant Clitoria ternatea, also called the butterfly pea blossom, is distinguished by its fibrous root system and inclination for fertile, well-drained loamy soil. It thrives in temperatures between 19° and 28° C and needs water that is moderately available, between 700 and 1500 mm. This hardy plant is a useful addition to many ecosystems despite its brief lifespan because it can withstand drought conditions for up to 7-8 months.

The plant is known by a number of names, such as blue pea, bluebell, and Asian pigeon wing, and it is used in a variety of culinary and cultural contexts. Clitoria ternatea is used in traditional medicine, the food industry, and religious rituals since all of its parts—flowers, seeds, roots, and leaves—are edible. The vivid hues of the flowers—mostly blue, dark blue, or purple, though certain areas also have white and light-yellow varieties—make them especially remarkable.

Clitoria ternatea is a cultural and gastronomic staple in many Asian nations, in addition to being a multipurpose tropical plant with particular growth requirements. Its importance in both agriculture and traditional traditions is highlighted by its adaptability to harsh environments and wide range of uses.

4.MORPHOLOGICAL CHARCTERISTICS:-

Clitoria ternatea, popularly called the blue pea bloom, is a climbing legume that is valued for its vibrant blue petals and nutritious content. With five distinct petals and a unique configuration of two wings, two keels, and a central flag with light yellow patterns, the flower is roughly 4 cm long and 3 cm wide. This evergreen shrub has slender leaves that are 1.5 to 3.5 cm wide and 2.5 to 5 cm long. Clitoria ternatea has fibrous roots.

Rhizobium bacteria make it possible for the system to fix nitrogen, making it an environmentally friendly crop. This perennial plant is both visually pleasing and economically significant. It grows from black seeds into pods that are 7 to 11 cm long.

The blue pea blossom has several culinary and medicinal use. Its vibrant hue is extracted for use as a natural food coloring, while the roots and leaves are utilized in traditional herbal medicine. Notably, the plant is widely recognized for its health benefits, which include promoting healthy skin, lowering blood pressure, aiding with digestion, and enhancing vision. Additionally, the young leaves are commonly consumed as side dishes. Blue pea powder, sometimes referred to as butterfly pea powder, has grown in popularity in the market due to these health benefits.

Research indicates that Clitoria ternatea has a multitude of bioactive compounds that support its therapeutic properties, including as glycosides, flavonoids, and anthocyanins.

Clitoria ternatea contains anthocyanins, which are naturally occurring pigments that give the flower its distinctive blue color and offer a number of health benefits. Anthocyanins protect the body from oxidative stress and inflammation due to their antioxidant properties, which may reduce the risk of chronic diseases like diabetes, cancer, and heart disease. Furthermore, the stability of these substances is crucial to their efficacy as food coloring; they exist in a stable form known as ternatins, which are polyacylated anthocyanins that endure well under a range of conditions.

Knowledge of Clitoria ternatea's bioactive components highlights the plant's potential health and wellness benefits. The plant's many culinary and medicinal applications demonstrate its importance in both traditional and modern processes. The study of its antibacterial and antioxidant properties also reveals its broader significance for promoting health and preventing illness. Additional investigation into this plant could provide fresh insights into its benefits and applications across a range of fields promoting health and preventing disease. Additional investigation into this plant could provide fresh insights into its benefits and applications across a range of fields.

- Clitoria ternatea is a versatile plant with significant applications in cookery, manufacturing, and medicine. Its extensive bioactive profile, particularly the health-promoting anthocyanins, makes it a valuable resource for natural colorants and health supplements. As interest in natural remedies and sustainable practices grows, the blue pea blossom's nutritional and overall health benefits might gain more recognition. With more research into the benefits of this remarkable plant, we can increase our understanding and use of it.
- A variety of plant elements, such as leaves, seeds, bark, fruits, sprouts, and stems, have therapeutic uses.
- Every component of the plant may have special medicinal qualities and health advantages.
- These plant components' significance in natural healing procedures is highlighted by their use in traditional medicine.
- Herbal remedies can be more effective and holistic health approaches can be promoted by knowing the therapeutic functions of various plant sections.

5.CHEMICAL CONSTITUENTS:-

A rich composition of bioactive chemicals, including pentacyclic triterpenoids like taraxerol and taraxerone as well as complex flavonol glycosides, is shown by the investigation of Clitoria Ternatea (presumably referring to a particular plant or species). These substances, which are mostly present in the plant's roots, may have therapeutic benefits. Furthermore, Clitoria Ternatea seeds are prized for their nutritional content, which includes fatty acids, proteins, and other phytochemicals including p-hydroxycinnamic acid and β-sitosterol, which could be beneficial to health.

The presence of antimicrobial proteins, particularly the finotin protein, which has been found to have insecticidal qualities, is another important finding in Clitoria ternatea seeds. Clitoria Ternatea's flowers are also abundant in a range of flavonoids, such as ternatins and other types of kaempferol, which improve the plant's overall biochemical profile. This wide range of chemicals raises the possibility that Clitoria ternatea has important traditional medicinal uses and may also be investigated for possible uses in agriculture and healthcare.

Clitoria Ternatea's potential as a source of advantageous compounds is highlighted by the thorough profile of the plant, which includes information on its roots, seeds, and flowers. More investigation into its uses in agriculture and health is necessary due to the presence of both nutritious and bioactive components.

The significance of protecting such plant species for future advantages is highlighted by the potential for creative applications of these substances in natural treatments and pest control techniques.

Clitoria ternatea, or butterfly pea, contains water-soluble pigments called anthocyanins, which are the main functional components. They are members of the flavonoid subclass of polyphenols. These pigments give many fruits and plants their vivid hues, which is why Butterfly pea blooms are so appealing. More than 700 different kinds of anthocyanins have been discovered by scientists; six common anthocyanidins, such as cyanidin and pelargonidin, are well-known for their ability to shield plant cells from UV rays and facilitate pollination. The pH of the surrounding environment affects how anthocyanins change color, changing from red at low pH levels to green at higher pH levels.

The primary bioactivity of anthocyanins is their antioxidant capacity, which allows them to shield cells from harm brought on by free radicals. They lessen oxidative stress by giving free radicals electrons or hydrogen atoms. By reducing oxidative damage, studies show that the anthocyanins in butterfly peas can prevent a number of illnesses, such as diabetes and neurological conditions. These anthocyanins are promising possibilities for natural food coloring and health supplements since in vitro research has shown that they have significant antioxidant action without exhibiting toxicity at specific dosages.

Butterfly pea anthocyanins have several uses beyond only being visually pleasing; they may also be used as natural antioxidants and health-promoting substances. Their importance in nutrition and health is highlighted by their capacity to prevent oxidative stress and lower the likelihood of conditions like hyperglycemia. Their function in supporting human health, especially in preventing chronic diseases linked to oxidative damage and metabolic disorders, may be further clarified by ongoing research into their mechanisms and applications.

6.EXTRACTION METHOD:-

Butterfly pea plant components must be extracted for use in both industrial and agricultural settings. Traditional (conventional) and modern (non-conventional) extraction techniques are the two primary categories. Depending on the particular substances being extracted and variables like temperature, pH, solvent type, and extraction time, these techniques' efficacy vary. While non-traditional techniques like ultrasound-assisted and microwave extraction are becoming more and more popular due to their effectiveness, standard techniques like maceration, Soxhlet, and cold/hot water extraction have been used since the 1970s.

Among the traditional techniques, maceration extraction stands out for its ability to extract colors from blue pea flowers, with a yield of 45.52% under specified circumstances. Another common method that successfully extracts anthocyanins using solvents like ethanol and distilled water is hydroalcoholic extraction, which can produce yields of up to 56.1%. High yields can be obtained in shorter amounts of time using unconventional techniques like ultrasonic-assisted extraction; nevertheless, research indicates that maceration may be a more efficient approach for extracting flavonoids than ultrasound. Phenolic and flavonoid chemicals are also produced in considerable quantities by both hot and cold water extractions.

Traditional extraction techniques are still often employed, although unconventional techniques are becoming more and more popular as phytochemical extraction substitutes. Investigating these "green techniques" can improve extraction efficiency, which could result in more effective use of resources in industrial and agricultural settings. Using contemporary techniques could offer a more sustainable way to harvest important components from butterfly pea plants as research advances.

- Anthocyanins, especially ternatins, which are also found in other superfoods like berries and red wine, are abundant in butterfly pea blossoms.
- Kaempferol, which has been shown in numerous test-tube experiments to have potential anti-cancer effects, is present in the blooms.
- p-Coumaric acid, contained in the plant has been associated to anti- inflammatory, antibacterial, and antiviral properties, suggesting its function in disease prevention.
- Delphinidin-3,5-glucoside, another antioxidant in butterfly pea, may enhance immune function and induce cell death in colorectal cancer cells, according to research.

7.FOOD AND COSMETICS:-

The plant Clitoria ternatea, also referred to as butterfly pea, has important therapeutic qualities and is valued in Ayurveda for its wide range of pharmacological benefits. It is a useful tool in the treatment of many illnesses because of its antidiabetic, antibacterial, anti-inflammatory, and anticancer properties. Studies have shown that it has cytotoxic effects on cancer cell lines and can reduce blood glucose levels in diabetic rat models. Its therapeutic versatility is demonstrated by the fact that extracts from its leaves, flowers, and seeds have demonstrated promise in the treatment of diseases like diabetes and several forms of cancer.

Clitoria ternatea has been shown in numerous studies to be effective in controlling diabetes due to its hypoglycemic qualities, as evidenced by the fact that different extracts dramatically lowered blood glucose levels in test mice. Additionally, cytotoxic activity against a variety of cancer

cell lines, especially in leaf extracts, supports its anticancer potential. Additionally, the plant has antibacterial properties against a variety of diseases, demonstrating its promise as a natural remedy for illnesses. Its repute as a versatile medicinal herb is further supported by its hepatoprotective and antioxidant properties.

In addition to its medical applications, Clitoria ternatea is used in cooking, especially as a natural food and beverage colorant because of its vivid blue anthocyanin pigment. The flowers are frequently used to improve the nutritional value and visual attractiveness of traditional foods. The demand for Clitoria ternatea is increasing as people become more interested in natural food coloring. Its anti-inflammatory and anti-carcinogenic qualities, among other health advantages, add to its appeal as a useful supplement to herbal therapy and dietary regimens.

The butterfly pea plant's roots and leaves are used in the food industry for their therapeutic qualities and to make herbal beverages. Butterfly pea powder is the most well-known product made from this plant and has become more popular all over the world. Its use in a variety of beverages and culinary applications has increased due to its vivid blue hue and health advantages.

All things considered, the butterfly pea flower's flexibility and attractiveness have made it a sought-after ingredient in the market.

Botanical extracts are becoming more widely acknowledged for their essential roles in sun protection, which improves the efficacy of sunscreen formulas.
These organic materials have built-in photoprotective qualities, such as the capacity to absorb UV rays and lessen the damaging effects they have on the skin. Incorporating these components into sunscreen enhances its protective properties and accommodates consumers' increasing inclination towards natural ingredients.

Flavonoids and carotenoids, two UV-absorbing chemicals found in botanical extracts, are important processes via which they protect against sun damage by preventing damaging rays from penetrating the skin. Furthermore, these extracts' antioxidant qualities, which are enhanced by their high vitamin and polyphenol content, reduce oxidative damage and skin aging by scavenging free radicals generated by UV radiation. Additionally, certain extracts have anti-inflammatory properties that promote healing and soothe skin after exposure to the sun. They also strengthen the skin's natural defenses against UV rays by encouraging the formation of melanin, which helps the skin barrier stay hydrated and resilient to environmental stressors.

UV absorption, antioxidant activity, anti-inflammatory actions, and skin barrier maintenance are just a few of the many diverse functions of botanical extracts in sun protection. Their complementary qualities improve the effectiveness of sunscreens and support the general well-being of the skin. Botanical extracts in sunscreen formulas provide an enticing solution that blends efficacy with a dedication to natural ingredients, as customers increasingly look for safer and more natural sun protection solutions.

7.1.USES:-

- Traditionally, the root was used to treat a number of ailments, such as skin disorders, sore throats, and gastrointestinal problems, however its purgative properties were frequently dismissed as undesirable.
- It was frequently combined with honey and ghee as a child's tonic to improve their vigor, mental clarity, and complexion.
- The seeds and leaves improved memory and cognitive performance by acting as brain tonics.
- Crushed seeds were used to treat inflamed joints and urinary problems, while the juice and flowers served as antidotes for snake bites.
- The health of skin and hair is enhanced by butterfly bean flowers. Because it contains antioxidants that improve moisture and protect against sun damage, its topical application can help fight early symptoms of aging including fine lines and uneven texture. Butterfly peas help hair growth by lowering inflammation and increasing blood flow to hair follicles.
- Benefits for Skin Health: Butterfly pea blossoms are known for their antioxidant qualities, which, when brewed as tea, can promote healthy aging and enhance skin conditions.
- Collagen Production: Green tea's flavonoids encourage the production of collagen, which improves skin suppleness, brightens drab skin, and evens out uneven skin tone.
- Support for Hair development: The anthocyanins in butterfly peas strengthen hair follicles and increase blood flow to the scalp, which may improve hair development.
- Anti-Aging Properties: Butterfly pea tea's antioxidants help protect skin by scavenging free radicals, which can hasten aging and other health problems.

- Enhancement of Eye Health: The proanthocyanidin complex in green tea has anti-inflammatory properties that help to support vision and reduce discomfort from eye infections.
- Metabolic Function Aid: Butterfly pea has demonstrated the ability to stabilize blood sugar levels, reduce blood pressure, and cholesterol, all of which support cardiovascular and metabolic health.
- Cognitive Support: Acetylcholine levels are raised by compounds in butterfly peas, which may improve memory and brain function while supporting mental health and cognitive functions.
- Digestion and Detox Benefits: By eliminating toxins and enhancing gut health, regular green tea consumption promotes digestion and detoxification.

8.CONCLUSION:-

Clitoria ternatea, also referred to as butterfly pea, is a versatile plant that has been used for a number of medicinal purposes due to its abundance of bioactive chemicals. This plant has generated a lot of interest due to its possible health advantages. It has been used traditionally in many cultures to treat conditions like diabetes, hypertension, and digestive problems. Scientific studies have been conducted in response to the investigation of butterfly pea's therapeutic qualities with the goal of confirming its applications and integrating it into functional foods while highlighting its efficacy and safety.

Butterfly pea's pharmacological characteristics are especially noteworthy: studies have shown that its flower extract has a variety of health-promoting effects, such as cytotoxic, antibacterial, antioxidant, anti-inflammatory, and antidiabetic activities; these effects are thought to be supported by the plant's bioactive constituents, such as anthocyanins, flavonols, and triterpenoids, which not only support the traditional medicinal uses of Clitoria ternatea but also offer opportunities for development in contemporary pharmaceuticals.

Additional benefits of Clitoria ternatea are revealed by further research, especially in the area of mental health management. The plant's analgesic and anti-stress effects add to its diverse therapeutic profile, and its anticonvulsant and antidepressant qualities suggest that it could be a useful adjunct in treating a variety of mental disorders. Because of its adaptability, Clitoria ternatea is a promising candidate for the development of new drugs and dietary supplements that target both physical and mental health issues.

The discoveries made on Clitoria ternatea have important ramifications for wellness and health initiatives. Including butterfly pea in health regimens could encourage holistic approaches to well-being as interest in natural supplements and herbal therapies grows. Furthermore, continued investigation into its bioactive components may result in novel therapies for long-term illnesses, highlighting the significance of natural medicine in modern healthcare. The plant's potential as a sustainable health resource is further enhanced by its accessibility and environmental tolerance.

In both conventional and contemporary medical procedures, Clitoria ternatea is a noteworthy resource. Its potential to cure a wide range of medical disorders is highlighted by its extensive pharmacological profile, which is marked by multiple health benefits. Butterfly pea's potential for use in illness prevention and health promotion is expected to grow as research advances, underscoring the importance of using natural sources in medical innovation. By utilizing Clitoria ternatea's therapeutic qualities, we can open the door to fresh, sustainable, and efficient health solutions that complement the expanding movement toward natural and holistic wellness practices.

9. REFERENCES:-

1. Oguis GK, Gilding EK, Jackson MA, Craik DJ. Butterfly pea (Clitoria ternatea), a cyclotide-bearing plant with applications in agriculture and medicine. Frontiers in plant science. 2019;10:645
2. 2.Vidana Gamage GC, Lim YY, Choo WS. Sources and relativestabilities of acylated and nonacylated anthocyanins in beverage systems. Journal of Food Science and Technology, 2021, 1-15.
3. Lakshan SAT, Jayanath NY, Abeysekera WPKM, Abeysekera WKSM. A commercial potential blue pea (Clitoria ternatea L.) flower extract incorporated beverage having functional properties. Evidence-Based Complementary and Alternative Medicine, 2019.
4. Suarna IW, Wijaya IMS. Butterfly Pea (Clitoria ternatea L.: Fabaceae) and Its Morphological Variations in Bali. Journal of Tropical Biodiversity and Biotechnology. 2021;6(2):63013.
5. Singh NK, Garabadu D, Sharma P, Shrivastava SK, Mishra P. Anti- allergy and anti-tussive activity of Clitoria ternatea L. in experimental animals. Journal of ethnopharmacology. 2018;224:15-26.

6. Chusak C, Ying JAY, Zhien JL, Pasukamonset P, Henry CJ, Ngamukote S, et al. Impact of Clitoria ternatea (butterfly pea) flower on in vitro starch digestibility, texture and sensory attributes of cooked rice using domestic cooking methods. Food chemistry. 2019;295:646-652.

7. Barik DP, Naik SK, Mudgal A, Chand PK. Rapid plant regeneration through in vitro axillary shoot proliferation of butterfly pea (Clitoria ternatea L.): A twinning legume. In vitro Cellular & Developmental Biology-Plant. 2007;43(2):144-148.

8. Gupta, Girish Kumar, Jagbir Chahal, Manisha Bhatia. Clitoria ternatea (L.): Old and new aspects. J Pharm Res. 2010;3(11):2610-2614.

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

10. Thuy NM, Minh VQ, Ben TC, Thi Nguyen MT, Ha HTN, Tai NV. Identification of anthocyanin compounds in butterfly pea flowers (Clitoria ternatea L.) by ultra-performance liquid chromatography/ultraviolet coupled to mass spectrometry. Molecules. 2021;26(15):4539.

11. Baskaran, A., Mudalib, S. K. A., & Izirwan, I. Optimization of aqueous extraction of blue dye from butterfly pea flower. In Journal of Physics: Conference Series IOP Publishing. 2019 November;1358(1):012001.

12. 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.

13. Pasukamonset P, Kwon O, Adisakwattana S. Oxidative stability of cooked pork patties incorporated with Clitoria ternatea extract (blue pea flower petal) during refrigerated storage. Journal of Food Processing and Preservation. 2017;41(1):e12751.

14. Singh J, Tiwari KN. In vitro plant regeneration from decapitated embryonic axes of Clitoria ternatea L.: An important medicinal plant. Industrial Crops and Products. 2012;35(1):224-229.

15. Satria D, Sofyanti E, Wulandari P, Pakpahan SD, Limbong SA. Antibacterial activity of Medan Butterfly pea (Clitoria ternatea L.) corolla extract against Streptococcus mutans ATCC® 25175™ and Staphylococcus aureus ATCC® 6538™. Pharmacia, 2022;69(1):195-202.

16. Saptarini NM, Suryasaputra D, Nurmalia H. Application of Butterfly Pea (Clitoria ternatea Linn) extract as an indicator of acid-base titration. J Chem. Pharm. Res. 2015;7:275-280.

17. Heuzé V, Tran G, Boval M, Bastianelli D, Lebas F. Butterfly pea (Clitoria ternatea), 2016.

18. Murugalakshmi M, Valli G, Mareeswari P, Thangapandian V. Antipyretic and purgative activities of Clitoria ternatea leaves extracts. World Journal of Pharmacy and Pharmaceutical Sciences (WJPPS). 2014;3(1):632-637.

19. Daisy P, Santosh K, Rajathi M. Antihyperglycemic and antihyperlipidemic effects of Clitoria ternatea Linn. in alloxan-induced diabetic rats. African Journal of Microbiology Research. 2009;3(5):287-291.

20. Mishra P, Saxena V, Kesheri M, Saxena A. Synthesis, characterization and pharmacological evaluation of some cinnoline derivatives. J Pharm Biol Sci. 2015;10(2):72-77.

21. Gunjan M, Ravindran M, Sengamalam R, Jana GK, Jha AK. Pharmacognostic and antidiabetic study of Clitoria ternatea. International journal of Phytomedicine, 2010, 2(4).

22. Kalyan BV, Kothandam H, Palaniyappan V, Praveen AR. Hypoglycaemic Activity of Seed Extract of Clitoria ternatea Linn in Streptozotocin-Induced Diabetic Rats. Pharmacognosy Journal. 2011;3(19):45-47.

23. Sharma AK, Majumder M. Some observations on the effect of Clitoria ternatea Linn on changes in serum sugar level and small intestinal mucosal carbohydrases activities in alloxan diabetes. Calcutta medical journal. 1990;87(11-12):168-171.

24. Latha MS. Anticancer Activity of Clitoria ternatea Linn. Against Dalton's lymphoma. IJPPR. 2013;4:207-212.

25. Uma B, Prabhakar K, Rajendran S. Phytochemical analysis and antimicrobial activity of Clitorea ternatea Linn. against extended spectrum beta lactamase producing enteric and urinary pathogens. Asian J Pharm Clin Res. 2009;2:94-96.

26. Kamilla L, Ramanathan S, Sasidharan S, Mansor SM. Evaluation of antinociceptive effect of methanolic leaf and root extracts of Clitoria ternatea Linn. in rats. Indian journal of pharmacology. 2014;46(5):515.

27. Anand SP, Doss A, Nandagopalan V. Antibacterial studies on leaves of Clitoria ternatea Linn: A high potential medicinal plant. IJABPT. 2011;2:453-456.

28. Leong CR, Azizi MAK, Taher MA, Wahidin S, Lee KC, Tan WN, et al. Anthocyanins from Clitoria ternatea attenuate food-borne Penicillium expansum and its potential application as food bio preservative, Natural Product Sciences. 2017;23(2):125-131.

29. Kelemu S, Cardona C, Segura G. Antimicrobial and insecticidal protein isolated from seeds of Clitoria ternatea, a tropical forage legume. Plant Physiol Biochem. 2004;42:867-873.

30. Ponnusamy S, Gnanaraj WE, Antonisamy MJ, Selvakumar V, Nelson J. The effect of leaves extracts of Clitoria ternatea Linn. against the fish pathogens. Asian Pac J Trop Med, 2010, 412-420.

31. Shahid M, Shahzad A, Anis M. Antibacterial potential of the extracts derived from leaves and in vitro raised calli of medicinal plants Pterocarpus marsupium Roxb., Clitoria ternatea L., and Sansevieria cylindrica Bojer ex Hook. Orient. Pharm. Exp. Med. 2009;9:174-181. doi: 10.3742/OPEM.2009.9.2.174.

32. Nithianantham K, Shyamala M, Chen Y, Latha LY, Jothy SL, Sasidharan, S.Hepatoprotective potential of Clitoria ternatea leaf extract against paracetamol induced damage in mice. Molecules. 2011;16(12):10134- 10145.

33. Jayachitra A, Sreelatha S, Padma PR. Antioxidant and hepatoprotective effect of Clitoria ternatea leaf extracts by using in vivo model. Int J Med Arom Plants. 2012;2:323-332.

34. Kamkaem N, Wilkinson JM. The antioxidant activity of Clitoria ternatea flower petal and eye gel. Phytother Res. 2009;23:1624-1625.

35. Jain RA, Shukla SH, Saluja AK. In vitro evaluation of Clitoria ternatea stems extract for antioxidant property. IJPSR. 2010;1:88-94.

36. Parimala BD, Boominanthan R, Subhash CM. Anti-inflammatory, analgesic and antipyretic properties of Clitoria ternatea root. Fitoterapia. 2003;74:345-349.

37. Suganya G, Kumar PS, Dheeba B, Sivakumar R. In vitro antidiabetic, antioxidant and anti- inflammatory activity of Clitoria ternatea L. Int J Pharm Sci. 2014;6:342-347.

38. Gollen B, Mehla J, Gupta P. Clitoria ternatea Linn: A herb with potential pharmacological activities: future prospects as therapeutic herbal medicine. Journal of Pharmacological Reports. 2018;3(1):1-8.

39. Chayaratanasin P, Barbieri MA, Suanpairintr N, Adisakwattana S. 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, 2015;15(1), 1-9.

40. Sen Z, Zhan XK, Jing J, Yi Z, Wanqi Z. Chemosensitizing activities of cyclotides from Clitoria ternatea in paclitaxel-resistant lung cancer cells. Oncology letters. 2013;5(2):641-644.

41. Bhat KI, Sufeera K, Kumar PCS. Synthesis, characterization and biological activity studies of 1, 3, 4-Oxadiazole analogs. Journal of Young Pharmacists. 2011;3(4):310-314.

42. Rahman AS, Saha R, Talukder N, Khaleque SMA, Ali HA. Bioactivity guided cytotoxic activity of Clitoria ternatea utilizing brine shrimp lethality bioassay. Bangladesh Journal of Physiology and Pharmacology, 2006, 18- 21.

43. Sutakwa A, Nadia LS, Suharman S. Addition of blue pea flower (Clitoria ternatea L.) extract increase antioxidant activity in yogurt from various types of milk. Journal Agercolere. 2021;3(1):31-37.

44. Akter R, Uddin SJ, Grice ID, Tiralongo E. Cytotoxic activity screening of Bangladeshi medicinal plant extracts. Journal of natural medicines. 2014;68(1):246-252.

45. Neda GD, Rabeta MS, Ong MT. Chemical composition and anti- proliferative properties of flowers of Clitoria ternatea. International Food Research Journal. 2013, 20(3).

46. Iamsaard S, Burawat J, Kanla P, Arun S, Sukhorum W, Sripanidkulchai B, et al. Antioxidant activity and protective effect of Clitoria ternatea flower extract on testicular damage induced by ketoconazole in rats. Journal of Zhejiang University-Science B. 2014;15(6):548-555.

47. Phrueksanan W, Yibchok-anun S, Adisakwattana S. Protection of Clitoria ternatea flower petal extract against free radical- induced hemolysis and oxidative damage in canine erythrocytes. Research in veterinary science. 2014;97(2):357-363.

48. Kumar BS, Bhat KI. In vitro cytotoxic activity studies of Clitoria ternatea Linn flower extracts. Int J Pharma Sci Rev Res. 2011;6:120-121.

49. Jaafar NF, Ramli ME, Salleh RM. Optimum extraction condition of Clitorea ternatea flower on antioxidant activities, total phenolic, total flavonoid and total anthocyanin contents. Tropical life sciences research. 2020;31(2):1.

50. Anthika B, Kusumocahyo SP, Sutanto H. Ultrasonic approach in Clitoria ternatea (butterfly pea) extraction in water and extract sterilization by ultrafiltration for eye drop active ingredient. Procedia Chemistry. 2015;16:237-244.

51. Chong FC, Gwee XF. Ultrasonic extraction of anthocyanin from Clitoria ternatea flowers using response surface methodology. Natural product research. 2015;29(15):1485-1487.

52. Minh NP. Efficacy of steaming, vacuum drying and stir-frying to total phenolic, flavonoid and organoleptic properties in butterfly pea flower (Clitoria ternatea) tea. Journal of Entomological Research. 2020;44(4):621-624.

53. Pham TN, Lam TD, Nguyen MT, Le XT, Vo DVN, Toan TQ, et al. Effect of various factors on extraction efficiency of total anthocyanins from Butterfly pea (Clitoria ternatea L. Flowers) in Southern Vietnam. In IOP Conference Series: Materials Science and Engineering. IOP Publishing. 2019 July;544(1):012013.

54. Marsin AM, Jusoh YMM, Abang DN, Zaidel ZH, Yusof AHM, Muhamad II. Microwave-assisted encapsulation of blue pea flower (Clitoria ternatea) colourant: Maltodextrin concentration, power, and time. Chemical engineering, 2020.

55. Marpaung AM, Lee M, Kartawiria IS. The development of butterfly pea (Clitoria ternatea) flower powder drink by co-crystallization. Indonesian Food Science & Technology Journal. 2020;3(2):34-37.

56. Salacheep S, Kasemsiri P, Pongsa U, Okhawilai M, Chindaprasirt P, Hiziroglu S. Optimization of ultrasound-assisted extraction of anthocyanins and bioactive compounds from butterfly pea petals using Taguchi method and Grey relational analysis. Journal of Food Science and Technology. 2020;57(10):3720-3730.

57. Escher GB, Wen M, Zhang L, Rosso ND, Granato D. Phenolic composition by UHPLC-Q-TOF-MS/MS and stability of anthocyanins from Clitoria ternatea L. (butterfly pea) blue petals. Food Chemistry. 2020;331:127341.

58. Tan JBL, Lim YY. Critical analysis of current methods for assessing the in vitro antioxidant and antibacterial activity of plant extracts. Food Chemistry. 2015;172:814-822.

59. Cazarolli LH, Folador P, Pizzolatti MG, Silva FRMB. Signaling pathways of kaempferol-3-neohesperidoside in glycogen synthesis in rat soleus muscle. Biochimie. 2009;91(7):843-849.

60. López Prado AS, Shen Y, Ardoin R, Osorio LF, Cardona J, Xu Z, Prinyawiwatkul W. Effects of different solvents on total phenolic and total anthocyanin contents of Clitoria ternatea L. petal and their anti- cholesterol oxidation capabilities. International Journal of Food Science & Technology. 2019;54(2):424-431.

61. Mehmood A, Ishaq M, Zhao L, Yaqoob S, Safdar B, Nadeem M, et al. Impact of ultrasound and conventional extraction techniques on bioactive compounds and biological activities of blue butterfly pea flower (Clitoria ternatea L.). Ultrasonics sonochemistry. 2019;51:12-19.

62. Xu Z, Zhang T, Prinyawiwatkul W, Samuel Godber J. Capabilities of different cooking oils in prevention of cholesterol oxidation during heating. Journal of the American Oil Chemists' Society. 2005;82(4):243- 248.

63. McDougall GJ, Shpiro F, Dobson P, Smith P, Blake A, Stewart D. Different polyphenolic components of soft fruits inhibit α-amylase and α-glucosidase. Journal of agricultural and food chemistry. 2005;53(7):2760-2766.

64. Gurunathan S, Lee KJ, Kalishwaralal K, Sheikpranbabu S, Vaidyanathan R, Eom SH. Antiangiogenic properties of silver nanoparticles. Biomaterials. 2009;30(31):6341-6350.

65. Sahayaraj K, Rajesh S. Bionanoparticles: synthesis and antimicrobial applications. Science against microbial pathogens: communicating current research and technological advances. 2011;23:228-244.

66. Anitha P, Gayathramma K, Tejavathi DH. Antimicrobial potential of leaf extract of normal and tissue cultured plants of Andrographis paniculata Nees. Int J Pharm Bio Sci. 2013;4(4):789-794.

67. Bar H, Bhui DK, Sahoo GP, Sarkar P, De SP, Misra A. Green synthesis of silver nanoparticles using latex of Jatropha curcas. Colloids and surfaces A: Physicochemical and engineering aspects. 2009;339(1-3):134- 139.

68. Cruz D, Falé PL, Mourato A, Vaz PD, Serralheiro ML, Lino ARL. Preparation and physicochemical characterization of Ag nanoparticles biosynthesized by Lippia citriodora (Lemon Verbena). Colloids and surfaces B: biointerfaces. 2010;81(1):67-73.

69. Haverkamp RG, Marshall AT. The mechanism of metal nanoparticle formation in plants: Limits on accumulation. Journal of Nanoparticle Research. 2009;11(6):1453-1463.

70. Sabir S, Arshad M, Chaudhari SK. Zinc oxide nanoparticles for revolutionizing agriculture: synthesis and applications. The Scientific World Journal, 2014.

71. Zhan G, Huang J, Lin L, Lin W, Emmanuel K, Li Q. Synthesis of gold nanoparticles by Cacumen Platycladi leaf extract and its simulated solution: Toward the plant-mediated biosynthetic mechanism. Journal of Nanoparticle Research. 2011;13(10):4957-4968.

72. Masarovicova E, Králová K. Metal nanoparticles and plants/nanoczastki metaliczne I rosliny. Ecological Chemistry and Engineering. 2013;20(1):9.

73. Kim JS, Kuk E, Yu KN, Kim JH, Park SJ, Lee HJ, et al. Antimicrobial effects of silver nanoparticles. Nanomedicine: Nanotechnology, biology and medicine. 2007;3(1):95-101.

74. Aromal SA, Philip D. Green synthesis of gold nanoparticles using Trigonella foenum-graecum and its size-dependent catalytic activity. Spectrochimica acta Part A: molecular and biomolecular spectroscopy. 2012;97:1-5.

75. Jogam P, Sandhya D, Shekhawat MS, Alok A, Manokari M, Abbagani S, et al. Genetic stability analysis using DNA barcoding and molecular markers and foliar micro-morphological analysis of in vitro regenerated and in vivo grown plants of Artemisia vulgaris L. Industrial Crops and Products. 2020;151:112476.

76. Fatimah I, Hidayat H, Nugroho BH, Husein S. Ultrasound-assisted biosynthesis of silver and gold nanoparticles using Clitoria ternatea flower. South African Journal of Chemical Engineering. 2020;34:97-106.

77. Nair V, Bang WY, Schreckinger E, Andarwulan N, Cisneros- Zevallos L. Protective role of ternatin anthocyanins and quercetin glycosides from butterfly pea (Clitoria ternatea Leguminosae) blue flower petals against lipopolysaccharide (LPS)-induced inflammation in macrophage cells. Journal of agricultural and food chemistry. 2015;63(28):6355-6365.

78. Margret AA, Begum TN, Parthasarathy S, Suvaithenamudhan S. A strategy to employ Clitoria ternatea as a prospective brain drug confronting monoamine oxidase (mao) against neurodegenerative diseases and depression. Natural Products and Bioprospecting. 2015;5(6):293-306.

79. Jiji K, Muralidharan P. Neuropharmacological Potential of Clitoria ternatea Linn. A Review. Research Journal of Pharmacy and Technology. 2020;13(11):5497-5502.

80. Shen J, Kromidas L, Schultz T, Bhatia S. An in silico skin absorption model for fragrance materials. Food and chemical toxicology. 2014;74:164-176.

81. Taranalli AD, Cheeramkuzhy TC. Influence of Clitoria ternatea extracts on memory and central cholinergic activity in rats. Pharmaceutical biology. 2000;38(1):51-56.

82. Rai KS, Murthy KD, Karanth KS, Nalini K, Rao MS, Srinivasan KK. Clitoria ternatea root extract enhances acetylcholine content in rat hippocampus. Fitoterapia. 2002;73(7-8):685-689.

83. Lijon MB, Meghla NS, Jahedi E, Rahman MA, Hossain I. Phytochemistry and pharmacological activities of Clitoria ternatea. International Journal of Natural and Social Sciences. 2017;4(1):01-10.

84. Rai KS, Murthy KD, Rao MS, Karanth KS. Altered dendritic arborization of amygdala neurons in young adult rats orally intubated with Clitorea ternatea aqueous root extract. Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives. 2005;19(7):592-598.

85. Taur DJ, Patil RY. Antihistaminic activity of Clitoria ternatea L. roots. Journal of basic and clinical pharmacy. 2010;2(1):41.

86. Rai KS, Murthy KD, Karantha KS, Rao MS. Clitoria ternatea (Linn) root extract treatment during growth spurt period enhances learning and memory in rats. Indian Journal of Physiology and Pharmacology. 2001;45(3):305-313.

87. Ravishankar MV, Rohini HN. Effect of Clitoria ternatea Linn plant root extract on the neuron of frontal cortex and dentate gyrus of young diabetic rats: A preliminary investigation. The Experiment. 2013;16(4):1138-1144.

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

89. Parvathi M, Ravishankar K. Evaluation of antidepressant, motor coordination and locomotor activities of ethanolic root extract of Clitoria ternatea. Journal of Natural Remedies. 2013;13(1):19-24.