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"Phytochemical pharmacological and medicinal uses of clitoria ternatea"

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ABSTRACT:

The growing global emphasis on plant research highlights the potential of medicinal plants in traditional healing systems. Clitoria ternatea, a plant with a rich history of therapeutic application, is valued for its diuretic and laxative properties, offering relief in urinary and gastrointestinal issues. It has been used to manage conditions like ophthalmopathy, bronchitis, asthma, tubercular glands, hemicrania, inflammation, and helminthiasis. The plant's pharmacological effects range from antioxidant and anticancer properties to analgesic and anti- inflammatory attributes. It also plays a role in diabetes management and has CNS-related activities. This study aims to establish the scientific basis for Clitoria ternatea's analgesic and anti-inflammatory properties by evaluating different extracts of the plant.

INTRODUCTION

The use of medicinal plants and herbs for health purposes is widespread around the world. Therefore, it is essential to subject these traditional remedies to scientific scrutiny to better understand their therapeutic potential, biological properties, and safety, which can help make informed decisions about their use(1-2). Many significant drugs and biologically active compounds have been derived from traditional medicinal plants, showcasing a wide range of pharmacological activities, including but not limited to antimicrobial, antioxidant, anticancer, hypolipidemic, cardiovascular, central nervous system, respiratory, immunological, anti-inflammatory, analgesic, antipyretic, and numerous other pharmacological effects (3-40).

One such plant of pharmacological importance is Clitoria ternatea, which has been the subject of extensive research. It contains a diverse array of chemical constituents, as indicated by preliminary phytochemical screening, including 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. Clitoria ternatea has exhibited numerous pharmacological effects, including antioxidant, hypolipidemic, anticancer, anti-inflammatory, analgesic, antipyretic, antidiabetic, central nervous system activity, antimicrobial, gastrointestinal, antiparasitic, and insecticidal properties, among others.

Plant Profile:

Synonyms: *Clitoria albiflora Mattei, Clitoria bracteata Poir, Clitoria mearnsii De Wild., Clitoria tanganicensis Micheli, Clitoria zanzibarensis Vatke* (41).

Taxonomic Classification:

Kingdom: Plantae; Subkingdom: Viridiplantae; Infrakingdom: Streptophyta; Division: Tracheophyta; Subdivision: Spermatophytina; Infradivision: Angiospermae; Class: Magnoliopsida; Superorder: Rosanae; Order: Fabales; Family: Fabaceae; Genus: Clitoria L.; Species: Clitoria ternatea (42-43).


Fig no 01: a. Blue Clitoria ternatea. B. White Clitoria ternatea

Languages	Name
Arabic	Mazerion Hidi, Baslat el-Zuhoor
Bengali	Aparajita
Chinese	die dou
French	Honte
German	Blaue klitorie
Hindi	Aparajita
Portuguese	Clitoria-azul
Punjabi	Koyal
Sanskrit	Girikarnika
Spanish	Zapotillo
Swedish	Himmelsart
Tamil	Kakkanam
Telugu	Dintena

Tab no 1: Different names in different languages.

Distribution: Clitoria ternatea has its origin in tropical Asia and has since spread to various regions, including Africa, Asia, Australia, North America, the Northwestern Pacific, South-Central Pacific, Southwestern Pacific, and Southern America. It is found in numerous countries across these regions, making it a widely distributed plant with significant pharmacological importance (41,43).

The diverse range of chemical compounds and pharmacological effects of Clitoria ternatea underscores its potential as a valuable natural resource in the field of traditional medicine and drug development. Further research and exploration of its therapeutic properties can provide valuable insights into its applications for various health-related purpos .

Botanical Description:

Clitoria ternatea is a perennial climbing or trailing herb, distinguished by its growth from a woody rootstock. The leaves are imparipinnate, typically displaying 2-4 pairs of leaflets and a terminal leaflet. These leaflets are ovate to elliptic-oblong, reaching dimensions of up to 6.5 x 4 cm, with a predominantly hairless upper surface and a pubescent lower surface. The plant produces axillary, solitary or paired, recuperate, and remarkably vibrant bright blue flowers. Its pod is linear-oblong, measuring 6-13 cm in length, flattened, and typically mucronate at the apex. The pod can be either hairless or finely pubescent.

Traditional Uses:

Clitoria ternatea has a rich history of traditional use. Its roots have been employed in the treatment of conditions such as ascites, abdominal enlargement, sore throat, and skin diseases. Although they were utilized as a purgative, their tendency to cause discomfort and tenderness led to caution in their usage. Additionally, the root was administered with honey and ghee to children as a general tonic, aiming to improve mental faculties, muscular strength, and complexion. Roots were also traditionally applied in cases of epilepsy and insanity. Seeds and leaves were widely recognized for their ability to serve as a brain tonic and enhance memory and intelligence. The juice and flowers were considered an antidote for snake bites, and crushed seeds were used to address issues related to swollen joints and urinary problems. (46-53).

Plant Parts Utilized: Various parts of the *Clitoria ternatea* plant have been utilized for medicinal purposes, including the leaves, seeds, bark, fruits, sprouts, and stems(54).

Physicochemical Characteristics:

Several physicochemical characteristics have been examined in *Clitoria ternatea*. Notably, total ash, acid insoluble ash, alcohol insoluble ash, and water-soluble extractives have been studied, with specific limits set for each parameter. The content of these components may vary across different parts of the plant, such as the stem, flower, leaves, seeds, and root, indicating the diversenature of this botanical specimen (55).

Chemical Constituents:

Clitoria ternatea boasts an array of chemical constituents. Preliminary phytochemical screening has identified compounds like 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. Notably, the seeds contain fatty acids like palmitic, stearic, oleic, linoleic, and linoleic acids, along with various other compounds such as cinnamic acid, anthoxanthin glycoside, a unique protein called finotin, water-soluble mucilage, delphinidin 3, 3', 5'-triglucoside, and beta-sitosterol (56-63).

Total Phenolic Compounds and Flavonoids:

The Clitoria ternatea flower extract has been analyzed for total phenolic compounds, flavonoids, and anthocyanins. The findings reveal the presence of these compounds in significant quantities, which can contribute to its potential health benefits (64).

Anthocyanin:

The flowers of Clitoria ternatea contain various anthocyanins, including ternatins and delphinidinglycosides, offering not only visual beauty but also potential health-promoting properties (66-68).

Additional Compounds:

Other constituents such as inositol, pentanal, cyclohexen, and various aromatic compounds havebeen isolated from different parts of the plant, contributing to its chemical diversity (71).

Pharmacological effects:

Antimicrobial Effect: Different extracts of Clitoria ternatea demonstrated inhibitory effects against a range of bacteria including Pseudomonas aeruginosa, Escherichia coli, Klebsiella pneumonia, Bacillus subtilis, Aeromonas formicans, Aeromonas hydrophila, and Streptococcus agalactiae. The ethyl acetate extract showed the most substantial zone of inhibition against Aeromonas formicans (18 mm), Aeromonas hydrophilia (19 mm), Bacillus subtilis (19 mm), and Pseudomonas aeruginosa (21 mm). Ethanol extract displayed significant inhibition against Aeromonas formicans (18 mm) and Escherichia coli (14 mm), while acetone extract exhibited maximum inhibition against Streptococcus agalactiae (19 mm) and Klebsiella pneumonia (17 mm).

Aqueous extracts of both seed and callus were prepared to evaluate antimicrobial activity against pathogenic fungi and bacteria. The seed extract showed a maximum zone of inhibition (22 ± 0.5mm) against Escherichia coli (NCIM 2645) at a concentration of 0.75 mg, with the minimum inhibition against Micrococcus flavus (NCIM 2376) (14 ± 1.0 mm). The callus extract exhibited maximum inhibition (16 ± 2.0 mm) against Salmonella typhi, with minimum inhibition against Escherichia coli (NCIM 2645) and Staphylococcus aureus (12 ± 1.0 mm and 12 ± 0.9 mm, respectively).

Methanol extracts of various parts of **Clitoria ternatea** were tested against several bacterial species, yeast species, and filamentous fungi. The leaf and root extracts were found to be the most effective against all tested organisms. The minimum inhibitory concentration (MIC), minimum bactericidal concentration (MBC), and minimum fungicidal activity (MFC) values ranged from
0.3 mg/ml to 100.00 mg/ml.

The antibacterial properties of Clitoria ternatea were investigated using organic solvent extracts (petroleum ether, ethyl acetate, and methanol) from the leaves. The results showed promising antibacterial activity against Bacillus cereus, Staphylococcus aureus, Klebsiella pneumonia, Proteus vulgaris, and Salmonella typhi. Methanol extract exhibited the most potent inhibitory activity.

An antifungal protein with a molecular mass of 14.3 kDa was isolated from Clitoria ternatea seeds. This protein displayed lytic activity against Micrococcus luteus and broad-spectrum fungicidal activity against clinically relevant yeasts such as Cryptococcus neoformans, Cryptococcus albidus, Cryptococcus laurentii, Candida albicans, and Candida parapsilosis. It also inhibited mycelial growth in several mold species.

The seed extract of Clitoria ternatea demonstrated strong antifungal activity against various fungi, while the callus extract showed only marginal antifungal activity.

Antiparasitic and Insecticidal Effects: The ethanolic extract of Clitoria ternatea paralyzed Indian earthworms within 15-20 minutes and caused death within 28-30 minutes. The anthelmintic activity of ethanolic extracts from different parts of Clitoria ternatea was evaluated on adult Indian earthworms (Pheretima posthuma). The root extract was the most potent, leading to faster paralysis and death of the earthworms. Subsequent extraction of the root with different solvents showed thatthe methanol extract was the most effective.

A comparative study of the anthelmintic activity of aqueous and ethanolic extracts of Clitoria ternatea leaves was conducted on Eisenia foetida. Both extracts exhibited significant anthelmintic activity, with the aqueous extract being particularly effective.

The mosquito larvicidal activity of Clitoria ternatea was tested against three major mosquito vectors: Aedes aegypti, Culex quinquefasciatus, and Anopheles stephensi. Among the methanol extracts of different plant parts, the seed extract was the most effective against the larvae of all three species.

Anti-inflammatory, Antipyretic, and Analgesic Effects: The ethanol extract of Clitoria ternatea root showed antihistaminic activity, inhibiting clonidine-induced catalepsy in mice. However, it did not inhibit haloperidol-induced catalepsy.

The methanol extract of Clitoria ternatea root exhibited antipyretic effects in rats with yeast- induced pyrexia, comparable to paracetamol.

The methanol extract of Clitoria ternatea root demonstrated anti-inflammatory activity, inhibiting rat paw edema caused by carrageenan and reducing vascular permeability induced by acetic acid in rats. The extract also reduced yeast-induced pyrexia in rats and the number of writhings in the acetic acid-induced writhing response in mice.

The analgesic and anti-inflammatory activity of Clitoria ternatea flower extract was tested in rats and mice, showing significant properties.

A methanolic extract of Clitoria ternatea leaves exhibited analgesic activities in mice, reducing acetic acid-induced writhing.

Anticancer Effect: Petroleum ether and ethanolic flower extracts of Clitoria ternatea displayed significant dose-dependent cytotoxic activity against cell lines.

Aqueous and methanol extracts of Clitoria ternatea flowers were evaluated for their antiproliferation activities on various cancer and normal cell lines, showing significant effects against MCF-7.

The methanol extract of leaves, seeds, and stem-bark of Clitoria ternatea demonstrated significant cytotoxic activity in a brine shrimp lethality bioassay test.

The ethanolic extract of Clitoria ternatea was found to have potent cytotoxic activity on DLA cell lines and increased survival time in mice.

Antioxidant Effects: Clitoria ternatea extracts, especially the methanol extract, exhibited potent in vitro free radical scavenging activity, as measured by the DPPH assay.

Different solvent extracts of Clitoria ternatea roots demonstrated significant antioxidant potential, inhibiting DPPH free radicals and showing reducing power and hydroxyl radicalscavenging activity.

The methanol extract of Clitoria ternatea leaves displayed strong antioxidant activity, as well ashepatoprotective effects against paracetamol-induced liver toxicity in mice, including the reduction of ALT, AST, and bilirubin levels.

Methanolic extracts of Clitoria ternatea leaf and root demonstrated antinociceptive action invarious pain models, with possible involvement of opioid receptors.

Antidiabetic Effects:

In the quest for potential antidiabetic treatments, researchers investigated Clitoria ternatea, particularly its leaves. They assessed methanol, water, petroleum ether, and chloroform extracts in diabetic rat models. Their findings indicated that Clitoria ternatea extracts, especially at 400 mg/kg, significantly lowered blood glucose levels in diabetic rats. While the 200 mg/kg dose also reduced glucose levels, it was not as effective as the 400 mg/kg dose. Moreover, the methanol extract demonstrated promising effects within 30 minutes of administration. Alloxan- induced diabetic rats also benefited from methanol extracts, as they experienced a significant reduction in blood glucose levels.

Aqueous extracts of Clitoria ternatea leaves and flowers showed positive effects in reducing serum glucose, glycosylated hemoglobin, and gluconeogenic enzyme activities while increasing insulin, glycogen levels, and glycolytic enzyme activity. These effects were consistent between leaf and flower extracts, suggesting their potential antidiabetic properties.

The combined leaf extracts of Clitoria ternatea and Trichosanthes dioica displayed a reduction inserum glucose levels in diabetic rats after a 28-day treatment period. This shows promise in managing diabetes-related complications, especially in juvenile diabetes.

Moreover, alcoholic root extracts from Clitoria ternatea had a protective effect on brain hippocampal regions and pancreatic tissues in juvenile diabetic rat models. This suggests thepotential use of these extracts to prevent complications in these areas.

Central Nervous System Effects:

Clitoria ternatea has a history of use as a brain tonic, believed to enhance memory and intelligence. Research has explored its impact on Alzheimer's disease, revealing potential benefits. The plant's aqueous methanol extract exhibited memory-enhancing properties and anxiolytic, antidepressant, and CNS-depressant effects. It increased acetylcholine levels in the hippocampus, contributing toimproved learning and memory.

Clitoria ternatea also demonstrated its efficacy in preventing memory impairment, enhancing dendritic development in amygdaloid neurons, and improving passive avoidance learning and retention. The alcoholic extracts of aerial and root parts showed promise in preventing electroshock-induced amnesia in rats, suggesting an influence on central cholinergic activity.

Furthermore, Clitoria ternatea extracts exhibited anti-compulsive effects by reducing marble- burying behavior, likely through enhanced serotonergic function.

Research on aqueous and hydroalcoholic extracts of Clitoria ternatea showed potential for treating cognitive deficits in neurological disorders by reducing oxidative stress, cholinesterase activity, and rho kinase expression.

Gastrointestinal Effects:

Clitoria ternatea's antiulcer potential was explored using various experimental models in rats, such as pylorus ligation and indomethacin-induced gastric ulcers. The alcoholic extracts exhibited significant antiulcer activity, particularly at higher doses, reducing parameters like gastric acid secretion, ulcer index, and increasing antioxidant parameters.

Hypolipidemic Effect:

The plant's hydroalcoholic extracts from the roots and seeds demonstrated antihyperlipidemic properties, effectively reducing total cholesterol, triglycerides, and other lipid levels. This suggestsits potential for managing hyperlipidemia.

Antihistaminic and Antiasthmatic Effects:

Ethanol extracts of Clitoria ternatea roots displayed antiasthmatic activity by decreasing eosinophilia, mast cell degranulation, and bronchoconstriction. This implies a bronchodilating effect and reduced bronchial hyperreactivity, possibly by stabilizing mast cells.

Immunomodulatory Activity:

Clitoria ternatea's seed and root extracts exhibited immunosuppressive effects, affecting humoral and cell-mediated immunity, as well as neutrophil adhesion and phagocytosis. These outcomes may result from the plant's anti-inflammatory and antioxidant properties, highlighting its potentialas an immunomodulatory agent

Anti-diabetic Effects:

Researchers explored the potential antidiabetic properties of Clitoria ternatea, particularly focusing on its leaves. They conducted assessments using methanol, water, petroleum ether, and chloroform extracts in rats with diabetes induced by Streptozotocin, examining both acute and subacute effects. The results highlighted that Clitoria ternatea extracts, especially at the dosage of 400 mg/kg, significantly lowered blood glucose levels in diabetic rats. The 200 mg/kg dose also demonstrated a blood glucose reduction effect, though less pronounced than the 400 mg/kg dose. Interestingly, in the case of the methanol extract, the 200 mg/kg and 400 mg/kg doses showed a similar impact, with the lower dose exhibiting a slight glucose level decrease at the 30-minute mark. Subacute experiments revealed that prolonged use of the extract at 200 mg/kg was more effective in controlling blood glucose levels compared to the 400 mg/kg dose. In a separate study, the methanol extract of Clitoria ternatea leaves, administered at 200 mg/kg and 400 mg/kg, significantly lowered blood glucose levels in rats with alloxan-induced diabetes after twelve hours.

Additionally, the aqueous extracts of Clitoria ternatea leaves and flowers, ranging from 50 mg/kg to 500 mg/kg, exhibited valuable antidiabetic effects in rats with alloxan-induced diabetes. These extracts, particularly at 400 mg/kg body weight, significantly reduced serum glucose levels, glycosylated hemoglobin, and the activity of gluconeogenic enzymes. Simultaneously, they elevated serum insulin levels, liver and skeletal muscle glycogen, and the activity of glycolytic enzymes. Both leaf and flowerextracts showed a consistent biochemical profile in these tests.

In another study, the combined leaf extracts of Clitoria ternatea and Trichosanthes dioica displayed significant reductions in serum glucose levels in rats with Streptozotocin-induced diabetes following a 28-day treatment period. These results offered promise for managing complications related to diabetes in juvenile patients.

Moreover, in juvenile diabetic rat models, an alcoholic root extract of Clitoria ternatea was administered to prevent potential complications in the brain's hippocampal area and pancreatic tissue. This extract, given at a dose of 100 mg/kg body weight daily, exhibited a protective effect.

After one month of treatment, histological studies showed significant prevention of complications in the hippocampal CA3 region and the pancreatic tissue.

The effect of the alcoholic root extract of Clitoria ternatea on the neurons of the frontal cortex and dentate gyrus was studied in young diabetic rats. The alcoholic root extract, administered at 100 mg/kg body weight, led to a significant increase in viable neurons, influencing the morphology ofneurons in the frontal cortex and dentate gyrus positively.

Furthermore, an aqueous extract of Clitoria ternatea flower exhibited inhibitory effects on the formation of advanced glycation end products (AGEs) and protein oxidation induced by fructose. AGE formation is a crucial factor in managing diabetic complications. Concentrations of this extract demonstrated a concentration-dependent inhibition of AGE formation, as well as significant reduction in fructosamine levels and protein oxidation. Additionally, the extract displayed strong antiglycation and antioxidant properties, showcasing its potential in preventing AGE-mediated diabetic complications.

Pancreatic regeneration potential was investigated using different fractions of ethanol extract from the aerial parts of Clitoria ternatea. The study evaluated their antidiabetic and antihyperlipidemic effects in rats with streptozotocin-induced diabetes. The most substantial pancreatic regeneration, antidiabetic, and antihyperlipidemic effects were observed with the ethanol extract and butanol- soluble fraction, administered at a dose of 200 mg/kg.

Central Nervous System Effects:

Clitoria ternatea has a long history of use as a brain tonic, believed to enhance memory and intelligence. To investigate its efficacy and identify the key bioactive compound contributing to this activity, its impact on Alzheimer's disease was studied. The aqueous extract of Clitoria ternatea revealed potential benefits in Alzheimer's disease through multiple mechanisms. The isolated compounds from the plant may serve as lead compounds for developing derivatives to enhance memory.

Shankhpushpi, a well-known Ayurvedic herb, is commonly used for various central nervous system (CNS) effects, particularly memory enhancement. Several plants, including Clitoria ternatea, are used under the name "shankhpushpi" in different regions of India. A study examined the memory-enhancing activity of Clitoria ternatea and compared it with other plants. Clitoria ternatea extract demonstrated significant memory enhancement and anxiolytic effects, particularly at doses of 200 mg/kg and 100 mg/kg, respectively. Among the studied plants, Clitoria ternatea exhibited significant antidepressant activity, whereas all three showed CNS-depressant effects at higher doses.

Treatment with 100 mg/kg of Clitoria ternatea aqueous root extract for 30 days in neonatal and young adult rats significantly increased acetylcholine content in their hippocampi compared to age-matched controls. The enhanced acetylcholine levels in the hippocampus indicated the neurochemical basis for improved learning and memory in these rats.

Mechanisms of memory enhancement with Clitoria ternatea aqueous root extract were further explored. Young adult rats were administered the extract for 30 days, resulting in improved passive avoidance learning and retention. Microscopic analysis of the amygdala revealed a significant increase in dendritic intersections, branching points, and dendritic processes in the extract-treatedrats, particularly in the 100 mg/kg group.

The efficacy of alcoholic extracts of the aerial and root parts of Clitoria ternatea in attenuating electroshock-induced amnesia in rats was examined. The extracts, at a 300 mg/kg dose, significantly improved memory retention, with the root parts showing greater effectiveness. The study also investigated the influence of Clitoria ternatea on central cholinergic activity by assessing acetylcholine content in the whole brain and acetylcholinesterase activity in various brain regions.

The spectrum of Clitoria ternatea's effects on the central nervous system was determined using a methanolic extract. This extract demonstrated nootropic, anxiolytic, antidepressant, anticonvulsant, and antistress activities. It decreased the time required to occupy the central platform, increased discrimination index, and reduced immobility duration in behavioral tests. Additionally, the extract reduced stress-induced ulcers and the convulsing action of pentylenetetrazol and maximum electroshock. The study suggested the involvement of various neurotransmitters in these effects.

Neonatal rat pups received either 50 mg/kg body weight or 100 mg/kg body weight of the aqueous root extract of Clitoria ternatea for 30 days. These rats were subjected to open field, two- compartment passive avoidance, and spatial learning tests. The results showed no changes in open field behavior but revealed improvements in retention and spatial learning performance, indicating the memory-enhancing property of the extract. These results suggested that the Clitoria ternatea extract might induce permanent changes in the brains of treated rats.

The effectiveness of Clitoria ternatea in the treatment of obsessive-compulsive disorder was experimentally investigated. The ethanolic extract of Clitoria ternatea was assessed for its influence on marble-burying behavior in mice, a common test for assessing obsessivecompulsive behavior. The results demonstrated that the extract significantly reduced marble-burying behavior, indicating an anti-compulsive effect. This effect might be attributed to enhanced serotonergic function and an influence on serotonin reuptake.

The effect of aqueous and hydroalcoholic extracts of Clitoria ternatea on biochemical and behavioral parameters related to cognitive impairment was studied both in vitro and in vivo. These extracts showed antioxidant and enzyme-inhibitory activities. The hydroalcoholic extract of Clitoria ternatea displayed potential for preventing cognitive impairment induced by streptozotocin. This effect was associated with the reduction of oxidative stress, cholinesterase activity, and the expression of rho kinase (ROCK II) in the brain.

A permanent polyherbal Ayurvedic formulation containing equal parts of Clitoria ternatea was studied for its behavioral effects and mode of action in a stress-induced depressive model. The formulation predominantly exhibited antidepressant rather than anxiolytic activity. Furthermore, it increased plasma noradrenaline and serotonin levels while decreasing corticosterone levels. This suggests that the formulation has significant antidepressant and anxiolytic activity, likely mediatedthrough adrenergic and serotonergic system activation.

Gastrointestinal Effects:

The antiulcer potential of aqueous and ethanolic extracts of Clitoria ternatea was evaluated using different experimentally induced ulcer models in rats. The ethanolic extract demonstrated significant antiulcer activity in pylorus ligation and indomethacin-induced gastric ulcers, affecting parameters such as gastric acid secretion, pH, total acidity, ulcer index, and antioxidant parameters.

Hypo-lipid emic Effect:

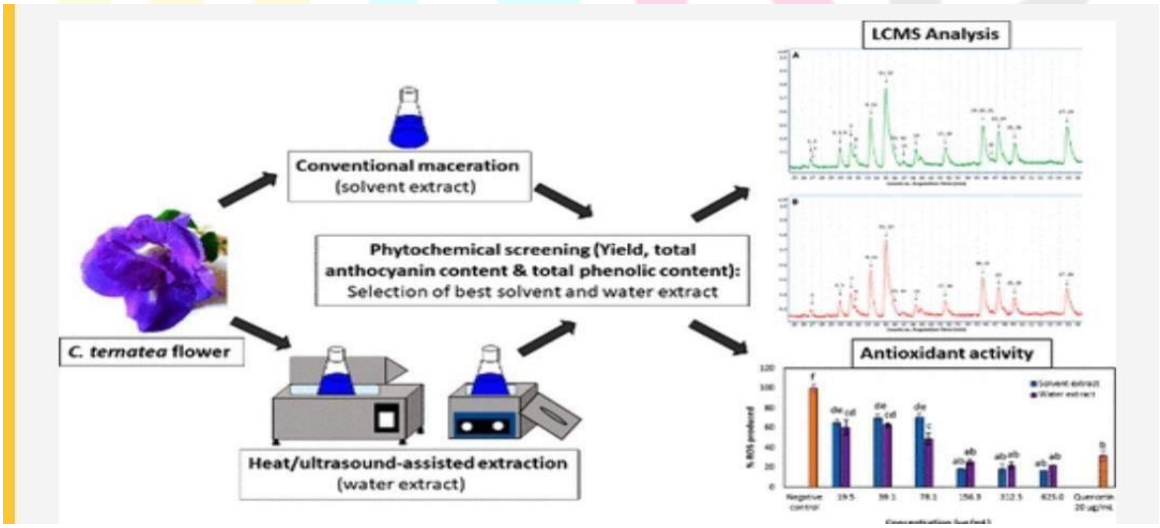
The anti-hyper-lipid emic potential of Clitoria ternatea was examined in rats with experimentally induced hyperlipidemia. The hydroalcoholic extract of Clitoria ternatea roots and seeds significantly reduced serum total cholesterol, triglycerides, very lowdensity lipoprotein cholesterol, and low-density lipoprotein cholesterol levels. It also normalized the atherogenic index and the HDL/LDL ratio.

Antihistaminic and Anti-asthmatic Effects:

An ethanol extract of Clitoria ternatea root demonstrated antiasthmatic activity by reducing leucocytosis and eosinophilia, protecting against mast cell degranulation and inhibiting the area of blue dye leakage in passive cutaneous anaphylaxis. Additionally, ethanol extract of Clitoria ternatea roots showed a 47.45% protection against histamine-induced bronchoconstriction in rats,indicating potential bronchodilating effects and reduced bronchial hyperreactivity.

Immuno-modulatory Activity:

Immunomodulatory activity of Clitoria ternatea seed and root extracts was investigated, specifically focusing on their effects on humoral and cell-mediated immune responses. The extracts displayed immunosuppressive effects, resulting in decreased primary and secondary antibody titers, decreased paw thickness in delayed type hypersensitivity response, and reduced neutrophil adhesion and phagocytosis. These immunomodulatory effects may be attributed to the plant's anti-inflammatory and antioxidant properties.



Conclusion:

This comprehensive review highlights the potential of Clitoria ternatea in healthcare, highlighting its phytochemical, pharmacological, and medicinal properties. The plant has shown antidiabetic effects, neuroprotective properties, and anti-inflammatory effects in diabetic rats. Its efficacy in the gastrointestinal system, antiulcer effects, lipid regulation, and antihistaminic and antiasthmatic properties further emphasize its role in managing various health conditions. Clitoria ternatea also has potential in immunomodulation, with its anti-inflammatory and antioxidant properties suggesting potential applications in managing autoimmune and inflammatory disorders. The diverse range of phytochemical compounds found in Clitoria ternatea contribute to its multifaceted therapeutic actions, including alkaloids, flavonoids, and saponins. Its botanical versatility and low toxicity make it a prime candidate for further research and development in the pharmaceutical and nutraceutical industries. The findings validate Clitoria ternatea's continued exploration and investigation, providing a foundation for future research and the development of innovative medicines and therapies to improve the lives of individuals with various health conditions.

Reference:

(Fabaceae) in Alloxan-induced Diabetes in Rats, Tropical Journal of Pharmaceutical Research,October 2009; 8 (5): 393-398

Rahman AKM Shahidur, Arslan Iqbal, Saha Rama, Talukder Nirupama, Khaleque Sma, Ali Husne Ara, Bioactivity guided cytotoxic activity of Clitorea ternatea utilizing brine shrimp letha liya bio assay, Bangladesh Journal of Physiology and Pharmacology,18-21.

Upwar Nitinkumar, Patel Roshan, Waseem Naheed, Mahobia NK, Evaluation of antidiarrhoeal activity of the root of Clitorea ternatea linn., International Journal of Pharmaceutical Sciences Review and Research,131-133.

Daisy P, Santosh Kanakappan, Rajathi M., Antihyperglycemic and antihyperlipidemic effects of Clitoria ternatea Linn. in alloxan-induced diabetic rats, African Journal of Microbiology Research,287-291

Shekhawat Neha, Vijayvergia Rekha, Comparative study of primary metabolites in different plant parts of Clitoria ternatea (L.), Guazuma ulmifolia (Lam.) & Madhuca indica (Gmel., J. Chem. Pharm 2010, 2(2): 168-171

Pandeya Krishna, Tiwari Kavindra Nath, Singh Jayanti, Verma Jay Prakash, Dubey Satya Deo, In vitro propagation of Clitoria ternatea L.: A rare medicinal plant, Journal of Medicinal Plants Research Vol. 4(8), pp. 664-668, 18 April, 2010

Khelemu S., Cardona C. and Segura G., Antimicrobial and Anti Insectisidal properties of isolates seeds of tropical forage legume Clitoria ternatea, Centro Internacional De Agricultura Tropical (CIAT)

Rai Kiranmai S., Neurogenic Potential of Clitoria ternatea Aqueous Root Extract– A Basis for Enhancing Learning and Memory, World Academy of Science, Engineering and Technology 70 2010,237-240

R.Shanmugasundram., Velusamy Kalpana Devi, Pious Soris Tresina, Arumugam Maruthupandian, Veerabahu Ramasamy Mohan, hepatoprotective activity of ethanol extract of Clitoria ternatea L. and Cassia angustofolia vahl leafs against ccl4 induced liver toxicity in rats, International research journal of pharmacy, 2010, 201205

Gupta Girish Kumar, Chahal Jagbir, Bhatia Manisha, Clitoria ternatea (L.): Old and new aspects,Journal of Pharmacy Research, 2010, 3(11), 2610-2614

Nahar Kamrun, Rahman Ashikur, Parvin Most. Nazma, Sarwar Shammy, Evaluation of Anthelmintic Activity of Aqueous Leaf Extract of Clitoria ternateaLinn. Stamford Journal of Pharmaceutical Sciences 46-48

Shekhawat Neha, Vijayvergia Rekha, Comparative study of primary metabolites in different plant parts of Clitoria ternatea (L.), Guazuma ulmifolia (Lam.) & Madhuca indica (Gmel., Journal of Chemical and Pharmaceutical Research2010, 2(2):

Jain Reshma A., Shukla Sangita H., Saluja Ajay K., In-Vitro Evaluation of Clitoria Ternatea Stem Extract for Antioxidant Property, IJPSR (2010), Vol. 1, Issue 12, 8894