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Review: A Potential Medicinal Herb *Clitorea Ternatea Linn*

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Abstract

Ayurveda and other Indian literature mention the use of plants in treatment of various human ailments. Research conducted in last few decades on plants mentioned in ancient literature or used traditionally for diseases. In the present scenario, demand for the herbal products is growing exponentially throughout the world and various pharmaceutical sectors are currently conducting extensive research on plant materials for their potential medicinal value. Keeping this point of view the present work has been presented to explore the Phytochemistry and pharmacological values of a potential medicinal herb known as *Clitoria ternatea linn*. The available literatures on this plant contain various phytoconstituents like, Flavonoids, Tannins, Saponins, Terpenoids, etc. which when pharmacologically tested proved to be medicinally significant. In vast research, all these phytochemicals has shown their variety of medicinal values, more potent compared to available allopathic medicines in some cases. Apart from that, *Clitoria ternatea linn* has shown its promising effect to promote the neurological health. Though much of scientific work has not been done on this plant, so in this context it needs to be heeded in all the medicinal and pharmaceutical concerns.

Key words: Clitoria, Flavonoids, ternatea, Aparajita, Shankpushpi.

INTRODUCTION

AYURVEDA:

The term "Ayurveda" is the combination of two Sanskrit words, Ayur (life) and Veda (science or knowledge).Thus, Ayurveda means "the science of life."[1]

The word “HERBS” has been derived from the Latin word, *“Herba”* and an old French word *“Herbe”.* Now a day, herb refers to any part of the plant like fruit, seed, stem, bark, flower, leaf, stigma or a root, as well as a non-woody plant. Earlier, the term “herb” was only applied to non-woody plants, including those that come from trees and shrubs. These medicinal plants are also used as food, flavonoids, medicine or perfume and also in certain spiritual activities.

Medicinal plants are considered as rich resources of ingredients which can be used in drug development either Pharmacopoeial, Non- Pharmacopoeial or synthetic drugs. A part from that, these plants play a critical role in the development of human cultures around the whole world. Moreover, some plants are considered as important source of nutrition and health benefits as a result of that they are recommended for their therapeutic values.[2,3]

The World Health Organization - WHO has estimated that major percentage of the population in developing countries depends primarily upon herbal medicine for basic healthcare, The traditional systems of medicine, commonly referred to as ‘Complementary and Alternative Medicine’ (CAM) are widely used and looked upon for possible and safe solutions to present day health and medical problems. Ayurveda, the Indian system of medicine practiced today has its roots in the Vedic thinking. Ayurveda follows its own unique philosophy and methodologies to address issues of health care. It prescribes variety of simple therapies as also certain complex treatments that could comprise of single ingredients, poly-ingredient formulations and combination of drugs, diet, lifestyle changes and therapies like massages, fomentation therapies, enemas and several other cleansing procedures as well. These treatments, oral medications or a combination of both are individualized in nature and ideally meant to be administered only after proper understanding of the ailment as per Ayurvedic diagnostics or nidaan. Since last 4-5 decades major changes have occurred in Ayurvedic education, practice, research and manufacturing of Ayurvedic products. Research in Ayurveda that began with search for new compounds from Ayurvedic plants and formulations based on pharmacological assertions and chemical moieties has come a long way with recent advances in biomedicine and technology. Research as part of learning and essential postgraduate training is expected to contribute towards overall growth of the sector.[4]

In the modern pharmacology, the action of drug is quite often correlated with its chemical structure or its active principle. However, in Ayurvedic pharmacology, the drug action is attributed to certain principles, that is namely *Rasa*, *Guna, Virya*, *Vipaka,* and *Prabhava* of the active principles of the drug. These five basics are known as Rasa-Panchaka (drug related five properties).The main goal of

Ayurveda is prevention as well as the promotion of the body's own capacity for maintenance and balance. Ayurveda is important to promote health, increase immunity and resistance-and to cure Disease. The two main aims of Ayurveda are maintenance of this equilibrium and its repair in case of any imbalance and derangement.[5]

CLITORIA TERNATEA

Clitoria ternatea is one of four herbs traditionally used as *Shankpushpi*, an Ayurvedic medicines used to promote neurological health. It shows promise in animal models for its memory enhancing effects, and has a wide spectrum of neurological benefits. *Clitoria ternatea* is reported to be a good brain tonic and good Nervine tonic. Extracts of this plant have been used as an ingredient in rejuvenating recipe and used for treatment of Neurological disorders and are considered to enhancing the intellect.[6]Plants have been one of the rich and important sources of medicine since the down of human civilization. Plants are the gift of nature to the mankind for treating different types of diseases.[3] Almost from prehistoric period, herbal medicine used for relieving from suffering caused by different disease in human are well documented in India and other countries. Even today they are in great use in these countries. Herbal medicine is a powerful weapon given by our nature to cure disease. Considering the importance of plants as sources of medicine even today people are adopting different herbal drugs for the treatment of various diseases.[1]

PLANT PROFILE

Synonyms:

- Hindi: Aparajita, koyala,
- English: blue-pea, blue bellvine, butterfly-pea, cordofan-pea, Darwin-pea
- Bengali: Aparajita,
- Punjabi: Koyal
- Sanskrit: Girikarnika, Vishnukranta-shankhpuspi, girikamu, asphota
- Tamil: akkanam
- Telugu: Dintena.[7]

Scientific Classification [8]:

Taxonomical classification of *Clitoria ternatea linn* plant are-

- Kingdom -plantae
- Subkingdom -tracheobionta
- Super division -spermatophyte

- Division -magnoliophyta
- Class -magnoliopsida
- Subclass -Rosidae
- Order -fabales
- Family -fabaceae
- Species -*Clitoria ternatea L*

Other species of Clitoria

- *Clitoria albi flora* Mattei
- *Clitoria amazonum* Benth
- *Clitoria Andrei* Fantz
- *Clitoria angustifolia* Kunth
- *Clitoria annua*J. Graham
- *Clitoria arborea* Benth.
- *Clitoria arborescens* R. Br.
- *Clitoria australis* Benth.
- *Clitoria biflora* Dalziel
- *Clitoria brachystegia* Benth.
- *Clitoria bracteata* Poir.
- *Clitoria brasiliana* L.
- *Clitoria cajanifolia*(*C. Presl*) Benth.[9]

Plant Distribution:

Clitoria Linn comprises 60 species distributed mostly within the tropical belt. A few species found in temperate areas. The mostly frequently reported species of *Clitoria linn* is *Clitoria ternatea.* This plant originated from tropical Asia and china India (Assam, Maharashtra, Kerala, Rajasthan, Tamil Nadu) later was distributed widely in South and Central America, Africa, East and West Indies, North America, Southern America, Australia, China and India, where it has become naturalized. This species is now widely grown as ornamental, fodder or medicinal plant. *Clitoria* genus is inconsequential, indigenous climber and a common garden flower found throughout the tropical and subtropical regions of the world. Now the genus becomes rare in humid and sub-humid lands of Asia, America, and Africa and also in semi-arid tropical Australia. It grows from sea level to 1800 and also grown as an ornamental in the warmer parts of the world and outspread from about 20°North latitude to the Salta district in Argentina at about 24°South latitude. In Africa it grows in grasslands, often on

seasonally-waterlogged black clays and in old cultivations whereas in Sudan it is grown for fodder or grazing and in Kenya it is grown in a mixture with *Chloris gayana*. In America, the species of this plant is spread from Florida to Texas and from New Jersey to Kentucky & Arkansas. It is commonly found in Jamaica, Puerto Rico, Turks, and Caicos Islands etc. It is found in all over India, especially in southern India up to an altitude of 1,500 m and in the Andaman Islands.[10]

MORPHOLOGICAL CHARACTERS

- **Leaves:** The Leaves are oblong, obtuse, 5-7 elliptic, imparipinnate, 3-5 cm long pubescent and have 2-4 pairs of leaflet The Inflorescence is axillaries.

Figure-1: *"Leaves & seed of Clitoria ternatea"*

- **Seed:** The seeds are olive, brown or black in color, often mottled, 4.5-7 mm long and 3-4 mm wide ternatea resemble a conch shell.
- **Stem:** *Clitoria ternatea L* plant is perennial climbing or twining fine stem 0.5-3 m long herbaceous plant, growing from a woody rootstock. It grows as a vine or creeper, doing well in moist, neutral soil.

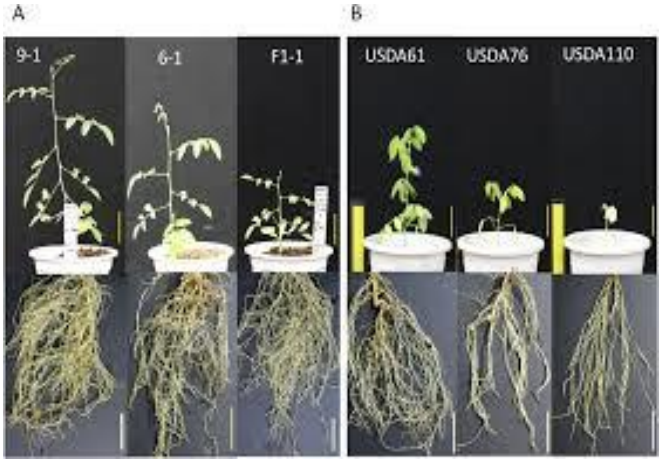


Figure-2: *"Root of Clitoria ternatea"*

- **Root:** The physiochemical properties of roots are Buffy brown in color, with characteristic odor and bitter in taste. *Clitoria ternatea* have both primary and secondary roots are thick,

hard with smooth surface and later are thin, fibrous in nature respectively. Its roots fix nitrogen; therefore this plant has been used to improve soil quality. The thick horizontal roots may grow bearing one to several purplish, glaucous, wiry stems with more than 2 m length.

- **Flower:** Flowers are bracteates, bracteolate, calyx big, tubular, bright or light blue or white, standard large, emarginated, wings oblong, keel incurved. *Clitoria* have cleistogamous and chasmogamous flowers i.e., self-pollinating and insect pollinating respectively. Flowers are about 4 cm long and 3 cm wide and 60 to 120 mm long like beans. Some varieties of this plant yield white flowers. Physical properties of flower like color, structure and position vary from species to species. The flowers of this plant are papilionaceous, axillary, solitary, pedicel 0.8 to 1.3 cm long with bright blue or white with yellow or orange center. The most striking feature about this plant is the color of its flowers, a vivid deep blue with light yellow markings. Flowering time of this plant is July – January.

Figure4- *"Flower of Clitoria ternatea"*

- **Fruit:** The fruits are 5 -7 cm long, flat pods with six to ten seeds in each pod. Fruiting time of this plant is July – January[10].

Figure-5- *"Fruit of Clitoria ternatea"*

AGRONOMIC CHARACTERS

- ***Soil:*** *Clitoria* is well adapted to grow in wide range of soil types (in between pH range5.5-8.9) from deep alluvial to sandy including calcareous soils. It extremely well adapted to heavy clay alkaline soils, and especially on clay soils but also grows well in moderate fertile soils. [11] *Clitoria ternatea* likes a rich, moist soil therefore the soil should be evenly moist at all times for well growth.[9]
- ***Water:*** It requires approximately 400 mm of rainfall but also performs well under irrigation areas and grows from drier areas like Kordo fan in the Sudan to the fairly drought tolerant in Zambia. Due to the nature of *Clitoria ternatea,* it cannot tolerate prolonged inundation or water logging but can tolerate short term flooding
- ***Sunlight:*** It is moderately shade-tolerant but can normally grow in full sunlight.
- ***Temperature:*** It needs moderate temperature down to 25ºC but not suited to locations with frequent or severe frosts, but it stands up well in hot summer temperatures and having low frost tolerance.
- ***Fertilizer:*** *C. ternatea* is normally grown in soil containing phosphorous (P) and Sulphur (S) which may be required as fertilizers if sown in the infertile soils.[9]
- ***Propagation:*** It contains around 20% of hard seed according to the seasonal conditions in where it is produced and grows rapidly in warm-moist weather. It is harvested manually by hands and is propagated from seed by cuttings [8].The seeds of *Clitoria ternatea* are covered by hard seed coats therefore do not germinate or imbibes water, but when stored for 6 months 15-20% germination can be obtained. The use of hot water, sulphuric acid(H2SO4), potassium hydroxide and soaking in 100 mg/L solution of Sodium cyanide (NaCN) has also improved germination and early plant growth while mechanical scarification increased germination of 6-month-old seed from 30% to 71%.[12]

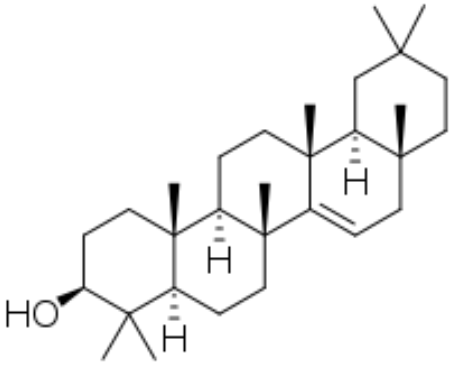
PHYTOCHEMICAL CONSTITUENTS

*Clitoria ternate*a contain wide range of secondary metabolites including triterpenoids, flavonol glycosides, anthocyanins and steroids. The major phyto-constituents present in *Clitoria ternatea* are the penta-cyclic-triterpenoids such as taraxerol,taraxerone, ternatins, alkaloids, flavonoids, saponins, tannins, carbohydrates, proteins, resins and starch. *Clitoria ternatea* contains glycoside steroids phenol anthocyanins, anthraquinones, volatile oils.

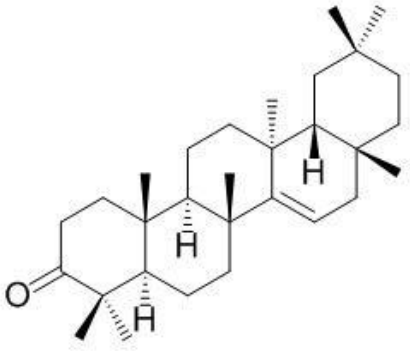
- ***Root:*** The root extract of plant reported for the presence of ternatins, alkaloids, flavonoids, saponins, tannins, carbohydrates, proteins, resins, starch, taraxerol and taraxerone.
- ***Leaves:*** Leaves of plant contain four kaempferol glycosides I II, III and IV.

- ***Seed:*** Phytochemical screening of seeds contain g-sitosterol, ß-sitosterol, and hexacosanol and anthocyanin glucoside palmitic, stearic, oleic, linoleic, and linolenic acids cinnamic acid, anthoxanthin glucoside, a highly basic small protein named finotin, water-soluble mucilage, delphinidin 3, 3', 5'-triglucoside.Seeds also contain nucleoprotein with its amino-acid sequence.
- ***Flower:*** Flowers is an important part of plant which contains a great variety of natural antioxidants, such as phenolic acids, flavonoids, anthocyanin and many other phenolic compounds. Phytochemical screening of flower showed that malonylated flavonol glycosides are found from the petals of flowers. Flower also contain five new phyto-constituents such as anthocyanins, ternatins A3, B3, B4, B2 and D2.flowers contain high concentration of flavonoids. Flavonoids show very effective antioxidants property. Flavonoids constitute a large group of naturally occurring plant phenolic compounds flavones, flavonol, isoflavones, flavonones and chalcones [10].

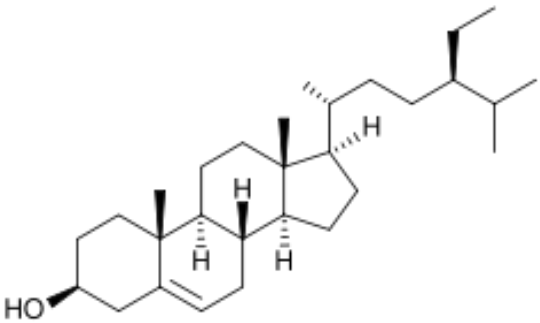
CHEMISTRY OF CONSTITUENTS



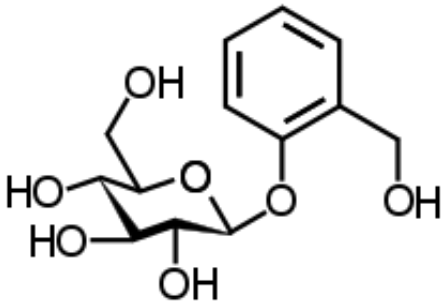
Taraxerol[13]



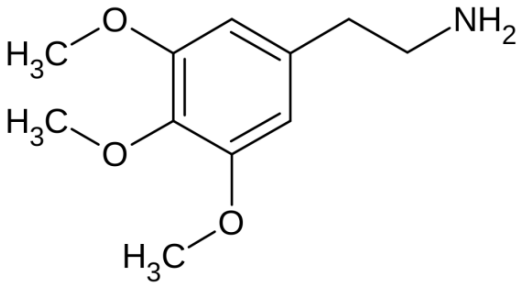
Taraxerone[14]



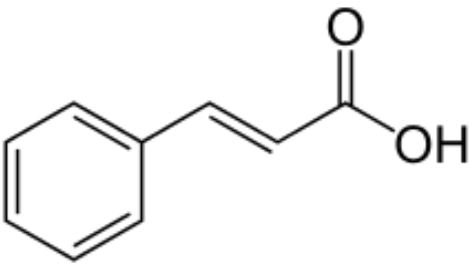
ß-sitosterol[15]



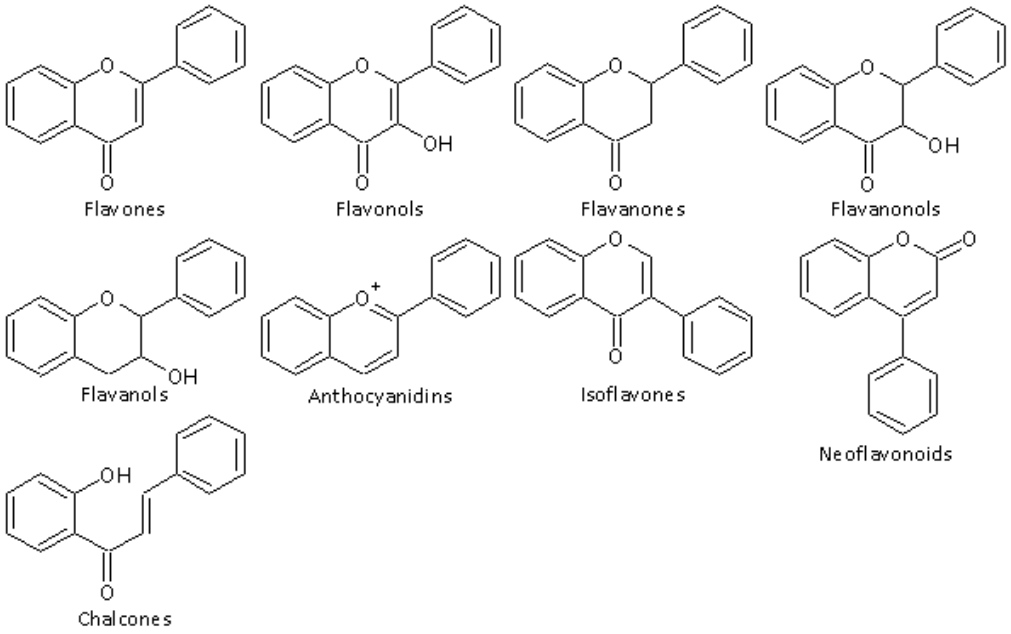
Glycoside[16]



Alkaloids[17]



Cinnamicacid[18]



Flavonoids [19]

TRADITIONAL USE

Clitoria is pungent in the post digestive effect, has cold potency, bitter in taste, and possesses light dry and sharp attributes. In Ayurveda 'Sankhapushpi' is one of the formulations which consists of the seeds and roots of *C. ternatea*, is used as a 'nerve tonic', alternative and laxative. It has been used for the treatment of various neurological disorders as an active ingredient in 'Medhya Rasayana'. By various group of persons it is considered as medicine which is useful in skin diseases, eye and throat infections also in urinary disorders, ulcers and antidote activity.[20]

Being a leguminous plant its roots forma symbiotic association with soil bacteria known as rhizobium which fixes atmospheric Nitrogen into a plant-usable form (a process called nitrogen-fixing), therefore, this plant is also used to improve soil quality through the decomposition of nitrogen-rich plant material.[21]

- ***Root:*** The roots have a sharp bitter or acrid taste and credited with cooling, laxative, diuretic, anthelmintic, anti-inflammatory properties. In the scientific studies it was found that root extracts of C. ternatea can raise the acetylcholine content and acetylcholine esterase activity in rat brain in a similar fashion to the standard cerebral drug pyritinol. In other treatments of various ailments like infections, as anthelmintics, antidote to animal stings, urino-genital disorders and body aches C. ternatea is also used [22]. Especially the roots of C. ternatea are useful in severe asthma, remittent fever and bronchitis. These are used to administer with ghee and honey as a tonic to children for boost up in their mental abilities, muscular strength, complexion, whooping cough, goiter and epilepsy. [23] Roots used by tribal to cause abortion and its paste applied on cattle stomach for curing abdominal swelling [9]. Research suggested that the methanolic extract of C. ternatea roots shown inotropic, anxiolytic, anticonvulsant and anti-stress activity in animals. The decoction or powder of root is given in rheumatism and ear disease. Root and leaves have emetic and antiperiodic [24].
- ***Seed:*** The use of seeds of *Clitoria ternatea* for medicinal purpose is both for external and internal applications. Fried seeds are recommended in ascites when given orally with hot water in powdered form with ghee and fennel. Seeds are also used in digestive disorders because they have purgative, cathartic and laxative action when used in combination with ginger powder. Seeds are also prescribed in cough, hepatic disorders, spleen and rheumatic infections. The seeds are safe for abdominal viscera, colic, dropsy and also for arthritis [9].
- ***Leaves:*** Leaves are used as emetic, diuretic, anti-periodic and laxative. The leaves are also very useful in the inflammation of mastoid lymph nodes when used with salt in paste form. The juice form has the ability to mitigate the toxins [22]. In combination with ginger juice, the fresh leaves are useful in hepatic fever, excessive sweating and also useful in inflammation around the ear and neighboring glands in juice form with common salt [9].
- ***Flower:*** Flowers are suggested and used for the treatment of scorpion sting and snake bite. In Cuba decoction of flowers with roots are considered emmenagogue [22].An infusion of flowers is used to promote menstruation and induce certain contraction. Flowers are also used to treat chlorosis and intestinal problems [24]. In experimentally induced diabetic mice, the ethanolic extract of flowers significantly lowers the serum sugar level [9].
- ***Stem:*** Stem is recommended for the treatment of snake bite and scorpion sting. The stem of the plant contains the phytochemicals which are mainly considered as brain tonic and is also useful for eye and throat infections, skin diseases, urinary troubles [24].

PHARMACOLOGICAL ACTIVITY

➢ ***Antimicrobial effect:***

- Ponnusamy S, *et* al. (2010) Different extracts of *Clitoria ternatea* showed inhibitory effects against *Pseudomonas aeruginosa, Escherichia coli, Klebsiella pneumonia, Bacillus subtilis, Aeromonas formicans, Aeromonas hydrophila* and *Streptococcus agalactiae*[25].
- Kamilla L, *et* al. (2009)The antimicrobial activities of the methanol extracts of the leaf, stems, flower, seed and roots of *Clitoria ternatea* were tested *in vitro* against 12 bacterial species, 2 yeast species, and 3 filamentous fungi by the agar diffusion and broth dilution methods. The leaf and root extracts were found to be most effective against all of the tested organisms [26].
- Niraj Kumar Singh, *et* al. (2017) The antimicrobial screening was evaluated against extended Spectrum Beta Lactamase (ESBL) producing *Salmonella enteritidis, Salmonella typhimurium, Klesiella pneumonia,* Entero-pathogenic *E.coli,* Uro-pathogenic *E.coli, Pseudomonas aureginosa* isolated from patients with urinary tract infection and acute gastroenteritis. Disc diffusion method was used to test the above mentioned extracts for their activity [9].

➢ ***Antiinflammatory antipyretic and analgesic effects:***

- B Parimala Devi, *et* al. (2003) *Clitoria ternatea* roots methanol extract when given by oral route to rats was found to inhibit both the rat paw oedema caused by carrageenin and vascular permeability induced by acetic acid in rats. Moreover, the extract exhibited a significant inhibition in yeast-induced pyrexia in rats. In the acetic acid-induced writhing response, the extract markedly reduced the number of writhings at doses of 200 and 400 mg/kg (p.o.) in mice [27].
- B Parimala Devi, *et* al. (2004) The methanol extract of blue flowered variety of *Clitoria ternatea* root, was evaluated for its anti-pyretic potential on normal body temperature and yeast-induced pyrexia in albino rats. Yeast suspension (10 ml/kg b/w) increased rectal temperature after 19 hours of subcutaneous injection. The extract, at doses of (200, 300 and 400 mg/kg b/w), produced significant reduction in normal body temperature and yeast-provoked elevated temperature in a dose-dependent manner. The effect extended up to 5 hours after the drug administration. The anti-pyretic effect of the extract was comparable to that of paracetamol (150 mg/kg)[28].
- Kumar Shyam, *et* al. (2012) The analgesic and anti-inflammatory activity of *Clitoria ternatea* flower extract were carried out in rats (carrageenan paw edema) and mice (hot plate). The petroleum ether (60-80◦C) extract possessed significant anti inflammatory and analgesic properties [29].

- Sarwar S, *et* al. (2014) The analgesic activities of the methanolic extract of *Clitoria ternatea* Lin leaves were examined at the doses of 200 and 400 mg/kg of body weight on mice. The analgesic activities were investigated using acetic acid induced writhing test.[30]

➢ ***Antidiabetic Effect***

- Manju Lata Zingare, *et* al, (2013) chronic administration of *Clitoria ternatea* plant extracts (100mg/kg) for 14 days reduces the blood glucose level of the diabetes induced animals (Wistar Albino rats) as compared to diabetic control group. There was significant decrease in the blood glucose level in the 7th and 14th days of the diabetes induction, showing antidiabetic effect. The effect was comparable to that of standard antidiabetic drug Glibenclamide [33].
- Abhishek Saxena, *et* al, (2016) The petroleum ether, chloroform, methanol and aqueous extract of *Clitoria ternatea* leaves (200 mg/kg and 400 mg/kg body wt) administered in animals. After administration of glucose in rats the rise in glucose level was observed in glucose control, extract treated and standard group. In rats treated with petroleum ether, chloroform, methanol and aqueous extract of *Clitoria ternatea* leaves, there was a significant reduction in plasma glucose level, while in glucose control rats the plasma glucose level increased that oral administration of these extract leaves exhibited significant antidiabetic effect in controlling the blood glucose level. It can thus be concluded that this plant extract promises an effective breakthrough in its potential development as a powerful oral therapeutic agent for controlling and managing diabetes mellitus [32].
- Chakraborthy, *et* al, (2018) Anti diabetic activity of ethanolic extract was evaluated in rats. Rats fed with ethanol extracts of flowers for 3 weeks significantly lowered serum sugar level in experimentally induced diabetes due to inhibition of the galactosidase and glucosidase activities but no inhibition of fructosidase activity was observed [31].

➢ ***Wound healing effect-***

- Y.B. Solanki, *et* al. (2012) A no. of model has been used for evaluation of wound healing activity of extract of *Clitoria ternatea*. Excision wound model, incision wound model, Dead-space wound model. *C. ternatea* seed and root extracts significantly improved wound healing in excision, incision and dead-space models when administered orally by gavage as well as applied topically as ointment. These effects are comparable to that of cotrimoxazole ointment. The finding of the study suggested that C. ternatea affects all three phases-inflammatory, proliferative and remodeling phases of wound healing. Plant extracts were found to contain phenolic compounds and seed extract was containing flavonol glycosides [34].

- Maity N, *et* al. (2012) The wound healing potential of standardized *Clitoria ternatea* leaf extract in terms of different enzymatic models, which are mostly associated with skin wound, was evaluated. The methanol extract and fractions were screened for its hyaluronidase, elastase, and matrix metalloproteinase-1 (MMP-1) inhibitory activity compared with standard oleanolic acid [35].

➢ ***Hepatoprotective effect-***

- Nithi anantham K, *et* al. (2011) The methanolic extract of *Clitoria ternatea* leaf at the dose of 200 mg/kg, p.o in mice showed the protective effect against paracetamol induced liver toxicity by decreasing the levels of aspartate aminotransferase, alanine amino transferase and billirubin along with histopathological improvement [36].
- Jayachitra A, *et* al. (2012) In previous study, the hepato-protective effect of white- and blue-flowered CT leave extract was evaluated in carbon tetrachloride induced hepato-toxicity in rats. They found that white-flowered CT leaves extract showed more hepato-protective effect than blue-flowered CT leaves, which may be attributed to its potential antioxidant effect [37].
- Chakraborthy, *et* al. (2018) Hepatoprotective effect against paracetamol induced liver toxicity in mice of methanolic extract (ME) of C. ternatea leaf and activity was measured by monitoring the levels of aspartate aminotransferase (AST), alanine amino-transferase (ALT) and bilirubin along with histopathological analysis. The results of the paracetamol induced liver toxicity experiments showed that mice treated with the ME of C. Ternatea leaf (200 mg/kg) showed a significant decrease in ALT, AST, and bilirubin levels, which were all elevated in the paracetamol group ($p < 0.01$).C ternatea leaf extract therapy also protective effects against histopathological alterations.[31]

➢ ***Antidiarrheal activity-***

- Ramdas Bhanudas Pandhare, *et* al. (2018) *C. ternatea* ethanol extract (CTE) (100–400 mg/kg, p.o.) produced dose-dependent and significant ($P < 0.05–0.01$) protection of rats against castor oil and $MgSO_4$-induced diarrhea, inhibited intestinal transit and delayed gastric emptying. CTE dose dependently and significantly delayed the onset of castor oil and $MgSO_4$-induced diarrhea, decreased the frequency of defecation and reduced the severity of diarrhea in the rats compared with loperamide (10 mg/kg, p. o).[38]

➢ ***Immunomodulatory activity-***

- Yogendra singh B Solanki, *et* al, (2010) Immunomodulatory activity of seed and root extracts of Clitoria ternatea was evaluated. Effects on humoral immune response were

investigated in SRBCs-sensitized rats. Effects on cell medicated immunity were studied by measuring delayed type hypersensitivity (DTH) response in SRBC-sensitized rats. Neutrophil recruiting and phagocytosis were measured by studying neutrophil adhesion and carbon clearance method respectively. Further the effects on hematological parameters were also studied. C. ternatea seed and root extracts showed significant immune supressive effects as evident from significant decrease in primary and secondary antibody titers in SRBCs-sensitized rats, paw thickness in DTH response, and neutrophil adhesion and In vitro Phagocytosis. The immunomodulatory effects of C. ternatea on humoral, cell mediated and non-specific immune response could be attributed to decreased immune cell sensitization, immune cell presentation and phagocytosis. The anti-inflammatory and antioxidant properties of plant might be playing major role in immunomodulatory activity [39].

- ***Effects in CNS-***

- Rai KS, *et* al. (2001) 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 as compared to age matched controls. [42]
- Shende V, *et* al. (2012) The effectiveness of *Clitoria ternatea* in the treatment of obsessive-compulsive was carried out experimentally. The influence of ethanolic extract of *Clitorea ternatea* was evaluated in marble-burying behavior in mice. The results revealed that ethanolic extract of *Clitorea ternatea* (EECT) (100, 200 and 400mg/kg) reduced the marble burying behavior in mice. It was clear that EECT exhibited significant anti-compulsive effect in marble-burying behavior test in mice and the effect may be attributed to enhanced serotonergic function and might have influence on 5-HT reuptake influence on 5-HT reuptake[43].
- Mehla J, *et* al. (2013) the effect of aqueous and hydro alcoholic extracts of *Clitoria ternatea* on biochemical and behavioral parameters related to cognitive impairment was studied *in vitro* and *in vivo*.[44]
- Prof Dr Ali Esmail Al-Snafi, (2016) Seeds and leaves of *Clitoria ternatea* have been widely used as brain tonic and believed to promote memory and intelligence. The activity of *Clitoria ternatea* in Alzheimer's disease was studied to investigate its efficacy. The result showed that the aqueous extract of *Clitoria ternatea* was beneficial in Alzheimer's disease through many mechanisms. C. Ternatea, a well-known drug in Ayurveda, is extensively used for different central nervous system (CNS) effects especially memory enhancement.[40]
- Gollen B, *et* al. (2018) the methanolic extract of aerial parts of *Clitoria ternatea* has shown anticonvulsant activity at dose of 100 mg/kg, p.o in both pentylene tetrazole (PTZ) and MES induced seizures in mice. [41]

➢ ***Local anaesthetic activity-***

- Kulkarni, (1988) the local anaesthetic effect of the ethanolic extract of aerial parts of CT was evaluated by using corneal anesthesia in rabbits and plexus anesthesia in frogs. They found that 10% solution of CT extract produced abolition of the foot withdrawal reflex in frog but did not show any surface anesthetic effect on rabbit cornea [45].

➢ ***Anticancer activity-***

- Mukalel Sankunni Latha, *et* al, (2012) the anticancer activity of Clitoria ternatea in Dalton's lymphoma (DLA) bearing mice was evaluated. Tumor was induced in mice by the intra-peritoneal injection of DLA cells. After 24 hours of tumor inoculation, methanol extract of Clitoria ternatea (MECT) was administered at doses of 100 and 200mg/kg body weight for 14 consecutive days. The effect of MECT was assessed using in vitro cytotoxicity, survival time, peritoneal cell count, hematological studies and antioxidant parameters. Treatment with MECT led to a decrease in tumor volume, packed cell volume and viable count [46].

➢ ***Diuretic activity-***

- Piala JJ, *et* al. (1962) *Clitoria ternatea* roots or their extract in 95% alcohol showed no significant diuretic effect in dogs when administered orally in non-toxic dose. Intravenous doses of the extract led to a moderate increase in the excretion of sodium and potassium in the urine, but at the same time, it showed signs of kidney damage [47].
- Quazi S, *et* al. (2014) the inhibition of *in vitro* calcium oxalate crystal (a common major component of most urinary stones) formation by various extract of *Clitoria ternatea* was investigates by titrimetric method. The inhibitory potency of alcoholic extract of *Clitoria ternatea* was found to be comparable to that of Cystone (a proprietary drug for dissolving kidney stones). Alcoholic extract of leaves of *Clitoria ternatea* showed higher calcium oxalate crystallization inhibition (72.99±1.2%) *in vitro* in comparison with cystone (90.55±1.27%) in terms of formation of calcium oxalate precipitation.[48]

➢ ***Gastrointestinal effect-***

- Rai SS, *et* al. (2015) the antiulcer potential of aqueous and ethanolic extracts of Clitoria ternatea was evaluated in different experimentally induced ulcer models in rats. Ethanolic extract (200 and 400mg/kg) and aqueous extract (200 and 400 mg/kg) of whole plant were examined in pylorus ligation and indomethacin-induced gastric ulcer in rats. Various parameters like volume of gastric acid secretion, pH, total acidity, ulcer index and antioxidant

parameters were determined and compared between extracts, standard and vehicle control group following ulcer induction. Among different dose of alcoholic extract, high dose showed significant antiulcer activity in pylorus ligation and indomethacin-induced ulceration [49].

➢ ***Hypolipidemic effect:***

- Prof. Esmail Ali, (2011) The anti-hyperlipidemia effect of *Clitoria ternatea* L. was studied in experimentally induced hyperlipidemia in rats. The poloxamer 407-induced acute hyperlipidemia and diet-induced hyperlipidemia models were used in this investigation. Oral administration of the hydroalcoholic extract of the roots and seeds of *Clitoria ternatea* resulted in a significant ($p < 0.05$) reduction of serum total cholesterol, triglycerides, very low-density lipoprotein cholesterol, and low-density lipoprotein cholesterol levels. The atherogenic index and the HDL/LDL ratio were also normalized after treatment in diet-induced hyperlipidemic rats. The effects were compared with atorvastatin (50 mg/kg, po) and gemfibrozil (50 mg/kg, po). [40]

➢ ***Anti Asthmatic activity-***

- Taur DJ, *et* al. (2016) Anti asthmatic activity of Clitoria ternatea root's ethanol extract(ECTR) was evaluated for preliminary phytochemical screening, acute toxicity studies and antiasthmatic activity using milk induced leucocytosis and eosinophilia in mice, egg albumin induced mast cell degranulation in rats and passive cutaneous anaphylaxis in rats result showed that the LD50 of ECTR is more than 1300 mg/kg. ECTR significantly decreases milk induced leucocytosis and eosinophilia protects egg albumin induced degranulation of mast cells in mice and inhibits area of blue dye leakage in passive cutaneous anaphylaxis in rats. Phytochemical studies observed the presence of steroids, saponin, flavonoids, and glycosides.[50]

Side Effect and Toxicity-

LD50 of ethanol extract of *Clitoria ternatea* root was more than 1,300 mg/kg in mice.[51] Acute oral toxicity study showed that there was no mortality up to 3000mg/kg in mice.[52]

After single dose 1000 mg/kg in rats, no death or any other disorders up to 72 hr[50]. The extract was found safe even at the dose of 2000 mg/kg body weight in rats.[53] There was no mortality observed at doses up to 2 g/kg (po) of the ethanol extract of the aerial parts of *Clitoria ternatea* in rats. During observation, the animals exhibited decreased mobility but no signs of convulsions or loss of writhing reflex. This result indicates that *Clitoria ternatea* has a low toxicity profile.[54]The mutagenic effect of the aqueous extract of *Clitoria ternatea* Linn was assessed by three test methods, *Bacillus*

*subtilis*rec assay, *Salmonella typhimurium* Ames' test and micronucleus test. The aqueous extract gave negative results, no mutagenic activities in both bacterial and mammalian cells.[55]

CONCLUSION-

Plants have been one of the rich and important sources of medicine since the down of human civilization. *Clitoria ternatea* is one of the herbs mentioned in all ancient scriptures of Ayurveda. *C. ternatea* belongs to family 'Fabaceae'; is cultivated throughout India. C. *Ternatea* has a wide spectrum of neurological benefits. They are well known in traditional herbal medicine for their diseases curing property. It contains major phytoconstituents such as the pentacyclic-triterpenoids such as taraxeroltaraxerone, ternatins, alkaloids, flavonoids, saponins, tannins, carbohydrates, proteins, resins and starch. *Clitoria ternatea* contains glycoside steroids phenol anthocyanins, anthraquinones volatile oils. Being a leguminous plant its roots forma symbiotic association with soil bacteria known as rhizobium which fixes atmospheric Nitrogen into a plant-usable form (aprocess called nitrogen-fixing), therefore, this plant is also used to improve soil quality through the decomposition of nitrogen-rich plant material. All part of *C. terna tea plant* has been widely screened for its various pharmacological activities. The study indicates that the Root extracts of C. ternatea can raise the acetylcholine content and acetylcholine esterase activity in rat brain in a similar fashion to the standard cerebral drug pyritinol. Seeds extract used in digestive disorders, hepatic disorders, spleen and rheumatic infections. Leaves extract are used as emetic, diuretic, anti-periodic and laxative and also very useful in the inflammation of mastoid lymph nodes, it have the ability to mitigate the toxins. Flowers extract are used for the treatment of scorpion sting and snake bite and infusion of flowers extract is used to promote menstruation. The ethanolic extract of flowers significantly lowers the serum sugar level. Stem extract is used as brain tonic and is also useful for eye and throat infections, skin diseases. *C. ternatea* have number of pharmacological activities such as Antimicrobial effect, Antiinflammatory effect, Antipyretic and analgesic effects, Antidiabetic Effect, Wound healing effect, Hepato protective effect, Antidiarrhoeal activity, Immuno modulatory activity, Effects in CNS, Gastrointestinal activity, Local anaesthetic activity, Anticancer activity, Diuretic activity, Hypolipidimic effect, Anti asthmatic activity.LD50 of ethanol extract of *Clitoria ternatea* root was more than 1,300 mg/kg in mice. The paper reviewed *Clitoria ternatea* as promising medicinal plant with wide range of pharmacological activities which could be utilized in several medical applications because of its effectiveness and safety.

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