

## Clitoria Ternatea: An Emerging Plant with Applications in Medicine and Food

Shaily Saini<sup>(1)\*</sup>, Rambahadur<sup>(2)</sup>

U.G Student, Department of Pharmacy, Shri Ram Murli Smarak College of Engineering and Technology, Bareilly, 243202, Uttar Pradesh, India

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### ABSTRACT

Aparajita botanically known as Clitoria is a plant belonging to the Fabaceae family which acts as excellent memory enhancing, anxiolytic, antistress, nootropic, sedative, tranquilliser agent, etc. Aparajita is an ancient Indian medicinal herb. Its botanical name is Clitoria. It is mainly used as a brain tonic. The food industry relies heavily on dyes and food colorings. At that time, employing natural dyes rather than synthetic ones was becoming more popular. Because of its striking blue hue, Clitoria (CT/Blue pea) flower can be used as a natural dye. Different techniques were used to obtain Clitoria extraction, and each technique has a unique manufacturing procedure. This plant has a long history of usage in traditional medicine due to its abundance of bioactive substances. This plant was widely used in traditional medicine because it is rich in bioactive compounds. In treating diabetics, blood pressure, retinal damage, edema, and indigestion both the aerial and underground parts of this plant are being used. Researchers proved this plant's medicinal activities such as nootropic activity, antioxidant activity, analgesic activity, anti-inflammatory and antibacterial activity. Currently, this plant's uses are widely spread in the nanotechnology field as well.

**KEYWORDS:** Butterfly pea, Clitoria, ayurveda, antioxidants, and nanoparticles.

### I. INTRODUCTION

A plant from the family with a wide geographic distribution is called Clitoria. There are 58 different species of Clitoria, and they may be found all over the world, including in places like India, Sri Lanka, Malaysia, the Philippines, Australia, Indonesia, South Africa, and other nations bordering the Indian Ocean.

### SOIL AND CLIMATE PARAMETERS

It has a fibrous root structure, and loamy soil that is healthy and well-drained is best for its

growth. This plant is simple to grow but has a limited lifespan. It is a tropical plant that prefers temperatures between 19 and 28 degrees Celsius and moderate water depths between 700 and 1500 millimetres. Additionally, this plant has the capacity to endure drought for up to 7-8 months. (Oguis et al., 2019). There are different names used for Clitoria (CT) like Asian pigeon wing which is the English name for blue pea flower and 'blue pea', 'butterfly pea', 'bluebell', 'Kordofan- Pea', and 'Chandra kanta' are also known. (Vidana Gamage et al., 2021). Flowers, seeds, roots, and leaves are the edible parts of this plant that are being used in food industries, culinary uses, folk medicine & also in religious activities. In Asian countries, mostly Clitoria flower is blue/dark blue/purple colour but white and light-yellow colours are also seen.

### MORPHOLOGICAL CHARACTERISTICS

The blue pea flower has five petals attached to its sepals and corolla, which consists of two wings, two keels, and one banner with light yellow colour marks in the middle. The blue pea blossom is about 4 cm long and 3 cm wide. The blue pea plant is a climbing legume with extremely thin leaves that measure roughly 2.5–5 cm in length and 1.5–3.5 cm in width (Mukherjee et al., 2008). It is an evergreen plant with a fibrous root system and its large nodules can fix nitrogen into a usable form of plants, with the association of Rhizobium bacteria. Clitoria is a perennial plant that propagates by seeds that are black in colour and are located in pods that are about 7-11 cm long. (Suarna et al., 2021). CT flower is used for culinary purposes and its extracted dye is used as a natural colourant in the food industry and its roots and leaves are used for medicinal purposes and herbal drink preparations. (Chusak et al., 2019) Butterfly pea powder is the most famous product in the market which is made from the blue pea flower. Roots and seeds are mainly used in traditional medicine and

Young leaves can be used as side dishes.



It has health benefits like helping in digestion, improving eyesight, lowering blood pressure, and making the skin glowing. (Barik et al., 2007) , (Oguis et al., 2019). There are different types of bioactive compounds found in Clitoria which are Anthocyanin compounds, flavonoids, glycosides, steroids, resins, and phenols are some of them. These bioactive compounds of the CT plant help with Anti-diabetic activity, Antioxidant activity, Antibacterial activity, Anti- Inflammatory activity, and Analgesic activity (Chusak et al., 2019)], (Gupta et al., 2010)]. Clitoria is rich in anthocyanin compounds and it is the pigment that causes the deep blue colour of the CT flower. Therefore, it is used as a food colourant in the food industry. Anthocyanin is one of the most unstable food colourants found in nature and its stability depends upon temperature, pH, and other enzymatic activities. (Vidana Gamage et al., 2021).

#### NUTRITIONAL COMPOSITION

This legume plant is high in minerals like Calcium (1.5-25.9 g/kg), Phosphorous (0.3-3.9 g/kg), Potassium (7.7-23.0 g/kg), Sodium (0.3-1.1g/kg), Magnesium (3.2- 6g/kg), Manganese (28-91 mg/kg), Zinc (25- 44 mg/kg), Copper (6-9

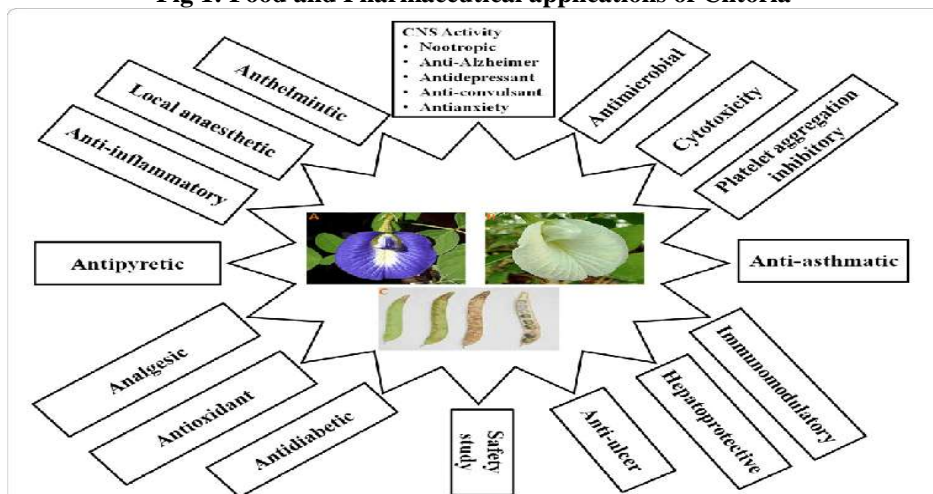
mg/kg) etc. Various types of fatty acids are also present in blue pea seeds & petals like Linoleic acid, Arachidic acid, Palmitic acid & Stearic acid which helps to boost up brain health. (Mukherjee et al., 2008) [12]. Crude protein and fibre contents are high in CT and because of its fibre content, it can be used as forage (Heuzéet al., 2016). The blue pea plant is loaded with Vitamin A, Vitamin C, and E. B and is also rich in polyphenols like flavonoids, phenolic acids, tannins, lignans, alkaloids, terpenoids, and coumarins. It plays an important role in free radical scavenging hence it can provide antioxidant properties mainly by leaves and flowers and anti-cancer properties. There are different types of extraction methods used to separate polyphenolic compounds of this plant and its quality depends upon the method and types of equipment used. Polyphenols found in roots are pentacyclic triterpenoids, taraxerol, and taraxerone. (Sing J et al., 2012). Nowadays scientists are researching BP (Blue Pea) for making different medicines, due to the presence of many functional compounds in this plant. Currently, blue pea tea is available in the market, and it has been a trending beverage in Asian countries. Specifically, “Starbucks” Asia launched a special edition of cold beverages using blue pea flowers. But only a few value-added products are available in the market. (Pasukamonset et al., 2017).

#### APPLICATION

Clitoria has gained significant interest in a number of fields: traditional medicine, food and agricultural applications (Oguis et al., 2019).

In Ayurveda, parts of CT have been used in treating health issues. Clitoria flowers are used all over the world as a food colourant and as ornamental flowers. In food applications, CT flowers are used as a promising candidate because of a wide range of pharmacotherapeutic properties, safety, and effectiveness. CT is used as a nitrogen-fixing and fodder crop (Jeyaraj et al., 2021).

**Fig 1: Food and Pharmaceutical applications of Clitoria**



## FOOD

The vibrant, deep-blue flowers of Clitoria are made possible by the presence of delphinidin anthocyanin. The world over, CT flower is utilised as a natural blue colourant in foods and beverages due to its high anthocyanin pigment level.

This colourant is frequently used in varying amounts to mocktails, cakes, ice cream, candies, and other classic dishes and desserts. It's also recognized for the purplish-blue colour of anthocyanins in its blossoms, which can be used as a natural culinary colouring. CT extract is often used as a food colourant. Because the colour parameter of CT may be utilised to correlate and anticipate the extract's pH value, there is a lot of room for CT flower extract to be developed further into more inventive uses: to monitor the pH intelligent packaging from CT. The bloom of CT has been utilised as a colourant in many meals, beverages, and sweets throughout Asia, in addition to the biological pigment. This colourant flower is commonly used in various quantities with rice, cookies, bread, flours, and desserts. CT colourant is particularly used in the local culinary scene. (Sutakwa et al., 2021). Considering positive health effects and attractive colourants in the food processing system, the demand for anthocyanin has been continuously increasing. CT flower rice is loaded with antioxidants. It has anti-inflammatory and anti-carcinogenic properties. It's linked to reducing cases of obesity, diabetes, and heart disease. And also, fresh pods, young shoots and leaves are used as a vegetable or as a side dish. The leaves' natural green colour is used in a variety of meals as a colourant (Chusak et al., 2019).

## MEDICINE

In Ayurveda, Clitoria possesses various pharmacological activities, including antidiabetic, nootropic, anaesthetic, antimicrobial, antipyretic, analgesic, antiinflammatory, antidepressant, antistress, diuretic, anticonvulsant, anxiolytic, insecticidal properties (Saptarini et al., 2015). Researchers have shown that CT can be used in cancer and diabetes which are considered to be some newly emerging diseases. Scientists have found in various experiments that CT is showing hypoglycemic activity as it lowers the level of blood glucose. In a study, the blood glucose levels were significantly decreased when CT leaves extract and CT flowers extract in aqueous form (400 mg/kg) were given orally to alloxan-induced diabetic like conditions in rats (Daisy et al., 2009). Same could be seen when CT leaves methanolic extract was treated for Streptozotocin-induced diabetic rats at single dose treatment for 15 days (Mishra et al., 2015). The aqueous extract of CT leaves (@ 100 mg/kg) for alloxan-induced diabetic like conditions in rats caused a reduction in the level of blood glucose when rats were treated for 14 days (Gunjan et al., 2010). The CT seeds also possess antidiabetic properties, in a study the antidiabetic effect was shown when the CT seeds ethanolic extract was used in the rats treatment for Streptozotocin-induced diabetes like conditions (Kalyan et al., 2011). In a study conducted by Sharma and Majumdar, CT flowers ethanolic extract also decreased the blood glucose level when treated for alloxan-induced diabetic like conditions in rats (Sharma et al., 1990). All over the world, the lives of many people are affected by cancer, another emerging disease like diabetes.

In a study conducted by Kumar et al. The cytotoxic effect was also shown by ethanolic and petroleum ether extracts of CT flower in the trypan blue dye exclusion method (Kumar et al., 2011). CT seed also showed anticancer activity as it was showing a decrease in packed cell volume, tumour volume, viable count, and an increase in tumour-bearing mice's lifespan (Latha et al., 2013). Therefore, researchers have demonstrated CT as a good anticancer drug. CT possesses antimicrobial properties, as it works against microorganisms like bacteria, and fungi. In a study, the methanolic extract of CT flowers was found to work against *E. coli*, *P. aeruginosa*, and *K. pneumonia* (Uma et al., 2009). In another study, the methanolic extract of CT flowers was found to work against *Bacillus* with MIC (Minimum inhibitory concentration) values between 12.5-25 mg/ml (Kamilla et al., 2014). In a study, CT leaves methanolic extract is also reported as bactericidal activity in *Klebsiella pneumoniae*, *Bacillus cereus*, *Salmonella*, *Staphylococcus aureus* and *Proteus vulgaris* (Anand et al., 2011). In other studies, anthocyanins of CT flower ethanol extract paste showed antibacterial activity against *K. pneumonia* and the MIC (value was between 1.6-25 mg/ml (Leong et al., 2017). In another study, an isolated protein called finotin from CT seeds showed antimicrobial properties (Kelemu et al., 2004).

In Ayurveda, CT has been used in the treatment of serious liver problems as it is showing

promising hepatoprotective effects. In a study, CT leaves methanolic extract (@200 mg/kg) was used against paracetamol induced liver toxicity in mice. It showed a protective effect as it decreases the alanine aminotransferase level, bilirubin along level, aspartate aminotransferase level and improves histopathological levels (Nithianantham et al., 2011). In another study, hepatoprotective activity was found to have in the extract of CT leaves in carbon tetrachloride-induced hepatotoxicity in rats. More hepatoprotective effect was shown in the extracts of white-flowered CT leaves than in the extracts of blue-flowered CT leaves (Jayachitra et al., 2012). Some Antioxidant activities are also possessed by CT. In a study, antioxidant activity was shown when rats were treated with the aqueous extract of CT flowers against ketoconazole-induced testicular damage (Iamsaard et al., 2014). In one study CT extracts (@400 mg/mL) were found to protect canine erythrocytes against hemolysis and oxidative damage as CT showed antioxidant activity (Phruksanan et al., 2014)[47]. The aqueous extract of CT flowers (Kamkam et al., 2009). methanolic extract of CT leaves (Nithianantham et al., 2011) methanolic and acetone extract of CT flowers (Jain et al., 2010)], aqueous extract of CT flower petals (Phruksa Net al., 2014).

**Fig 2: Functional compounds of Clitoria**



### Nanoscience For Future Improvement

Several studies conducted various methodologies to synthesise a variety of nanoparticles from blue peas. Silver nanoparticles, which have antifungal, anti-inflammatory, antiangiogenic, and anti-permeability properties, are employed in the medical industry like Antibacterial agents in catheters that have been surgically placed to prevent infection effects generated in surgery (Gurunathan et al., 2009). Nanocrystalline silver particles offer a wide range of uses in biomolecular detection and diagnostics, antimicrobials and treatments, catalysis, and microelectronics (Sahayaraj et al., 2011). For silver nanoparticles synthesis, fresh flowers of CT were randomly picked and washed thoroughly in tap water for about 5 min. Then CT petals were removed from the flower and kept for drying in the tray at room temperature. Next preparation of curd extract, in here finely crushed dried 10g of flower petals mixed with 100ml of methanol and filter it using watchman 1 filter paper. And the filter obtained dried in a vacuum drier and the powder was stored at 40C. Add 100 ml distilled water to the powder to get the aqueous extract. Then do the UV-VIS Spectral analysis; 1 ml of aqueous flower extract was added into the 10 ml of 5mM Silver Nitrate, then the drop of Ag<sup>+</sup> to AgO (silver oxide) remained shown by determining the UV. VIS is spectrum at time range from 5- 120 min within the range of 400-480 nm wavelengths in a spectrophotometer. Finally, the sample was deduced by Scanning Electrons Microscope for the analysis of the size and the presence of silver nanoparticles. The opinion of that practical was plants have been considered a leading candidate for nanoparticle synthesis. Those biogenic nanoparticles are less expensive, easier to make, and more environmentally friendly. Clitoria flower extract showed a lot of promise. Lowering effect on Ag<sup>+</sup> silver nanoparticles reduction at the temperature in the room UV Vis Spectroscopy was used to characterise the samples. The production of silver nanoparticles was confirmed by SEM (scanning electron microscope). The particles produced ranged in size from 5 to 50 nm, with a diameter of 5 to 50 nm. The shape that is consistent

(cubic or spherical). The particles also tend to stick together. Aggregate, implying that they could be beneficial in applications that require the process of coating materials Nanoparticles with a wide range of sizes and characteristics can be obtained by tapping the many plants in the wild environment. (Anitha et al., 2013). Moreover, nanoparticles made by biological techniques have been used in human healthcare systems like nanomedicine, diagnosis, and commercial product manufacturing (Bar et al., 2009; Cruz et al., 2010). Nanoparticles have been found to have a variety of biological functions due to their unique physical and chemical properties (Haverkamp et al., 2009). Plant extracts have recently been utilised to make a variety of environmentally benign metal nanoparticles, including silver (Ag), zinc oxide (ZnO), gold (Au), magnesium oxide (MgO), titanium oxide (TiO<sub>2</sub>), platinum (Pt), and nanoparticles of iron oxide (Fe<sub>3</sub>O<sub>4</sub>) (Zhan et al., 2011 & Masarovicova et al., 2013)].

Characterization of ZnO nanoparticles (UV-VIS spectra analysis) the UV-VIS spectrophotometer was used to measure ZnO nanoparticles' absorption spectrum produced by lowering metal ion concentrations in solutions of various extracts. The current study looks at how to make nanoparticles of ZnO from diverse sources of the healing properties of CT. It ensures that the technique is environmentally friendly and that the approach can be obtained easily for future needs. Because of the significance of this plant, the nano compositions could be useful in the prevention and treatment of patients, according to Ayurveda a variety of illnesses. (Jogam et al., 2020). In another experiment Biosynthesis of silver and gold nanoparticles with the help of ultrasound and the Clitoria flower. UV-Vis spectrophotometric analysis and the scanning electron microscopy (SEM), transmission electron microscope (TEM) and x-ray diffraction, are the methods used to detect nanoparticles. The impact of the ultrasound approach on the nanoparticles' physicochemical properties as compared to that of the reflux method. The antibacterial activity of the nanoparticles was tested by different bacteria to see how the character affected their biological activity.

**Table 1: Nutritional composition of Clitoria**

Component	Amount (%)
Moisture.	92.4-0.11
Ash	0.15-1.40
Fat	2.5-0.11
Protein	0.02-0.32
Crude Fibre	0.2-2.0
Carbohydrate	2.23-0.3
Potassium	1.2506-0.235
Manganese	0.0249-0.003
Sodium	0.1413-0.003
Zinc	0.5980-0.006
Arsenic	<0.0001
Nickel	0.001267-0.0001
Boron	0.0150-0.002
calcium	3.0953-0.09
Cobalt	<0.0001
Chromium	0.0007-0.0
Copper	0.0103-0.007
Iron	0.1441-0.007
Magnesium	2.2306-0.134
Molybdenum	0.0001-0.0001X5.7
Selenium	<0.0001
Cadmium	<0.0001
Lead	0.002333-0.0002

## II. CONCLUSIONS

Clitoria has a long tradition and is found in several countries. It is not an ornamental flower but also a good medicinal plant which has numerous benefits. It has been experimented several years back by various scientists and have found a number of pharmacological uses as well. With the advancement of technology and Ayurvedic traditional medicine and the improvement of scientific research, different classes of plant species and their leading compounds have been studied. Extractions obtained through different methods of the roots, seeds, flowers, and leaves of CT have been experimented in Ayurvedic studies. Earlier different parts of Clitoria have been used for the treatment of Asthma, skin diseases, constipation, fever, Inflammation, Indigestion, snakebite and scorpion sting, etc. Later on, this plant is used for many pharmacological activities such as, memory enhancer (by increasing acetylcholine content), act as a good stress, anxiety, and depression reliever, to gain calmness in mind and helps to have a good sleep. Moreover, it helps to lower the body temperature and also acts as a good pain reliever, the seeds are used to treat when joints in different

parts of the body get swollen. It can be used to treat when difficulties in urination occur and improves the flow of urination, treat boils, blisters, and ulcers, and act as a neutralizer for poisons that enter the body. One of the most important benefits of this plant is its antidiabetic activity. Furthermore, it shows properties like antiseizure, tranquillising, sedative, antimicrobial, insecticidal, and inhibition of blood platelet aggregation, etc. Extractions of this plant are also useful to treat many diseases still where the proper medications have not been discovered such as cancers, neuro problems, kidney-related disorders, hyperglycemia, urinary disorder, goitre, disorders in the respiratory system, etc. This plant has a good source of evidence to be used as a memory enhancer. and anxiolytic agent. Nowadays different parts of Butterfly pea are incorporated into foods. When considering nanosciences and technology new nanomaterials and concepts have developed.

Those can be used to produce energy by using sources like glucose, movement, light, etc. It gives a great conversion efficiency. These nanoparticles are helpful to minimise its side effects and also improving the bioavailability of Clitoria ternatea. The plant has various important

phytochemicals. The main phytochemicals enriched in *Clitoria* are flavonoids, anthocyanins, alkaloids, saponins, tannins, taraxerol, and taraxerone. Due to the presence of Anthocyanins, it gives a blue purplish colour so that it can also be used as a natural food dye.

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