Int. J. Pharm. Sci. Rev. Res., ISSN: 0976 – 044X, 83(2), November – December 2023; Article No. 15, Pages: 99-105; **DOI:** 10.47583/ijpsrr.2023.v83i02.015

Review Article

Extraction Methods and Pharmacological Importance of *Clitoria ternatea* Plant

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Received: 14-10-2023; **Revised:** 23-11-2023; **Accepted:** 29-11-2023; **Published on:** 15-12-2023.

ABSTRACT

The plant *Clitoria ternatea* contained antharaquinone, anthocyanins, cardiac glycosides, stigmast4-ene-3-6dione, volatile oils, steroids, Carbohydrates, saponins, triterpenoids, phenols, flavonoids, flavanols having wide range of pharmacological activities, including insecticidal, antimicrobial, anticancer, anti-inflammatory, analgesic, antipyretic, CNS, antimicrobial, gastro-intestinal antiparasitic, and many other pharmacological actions. The pharmacological properties & extraction methods of *Clitoria ternatea* and its chemical make-up will be highlighted in this review.

Keywords: *Clitoria ternatea*, constituents, pharmacology, pharmacognosy, extraction.

INTRODUCTION

Around the world, a huge and growing number of patients use medicinal plants and herbs for health purposes. Therefore, it will be helpful to make informed decisions about their use to conduct scientific analysis of their therapeutic potential, biological characteristics, and safety [1-2]. Numerous important medications and physiologically active substances have been created from traditional medicinal herbs. Antimicrobial, antioxidant, anticancer, hypolipidemic, cardiovascular, respiratory, immunological, anti-inflammatory, analgesic, antipyretic, and many other pharmacological actions were all demonstrated by the plant[3]. *Clitoria ternatea* was found to contain a variety of phytochemicals, including tannins, phlobatannin, carbohydrates, saponins, triterpenoids, phenols, flavanoids, flavonol glycosides, proteins, alkaloids, antharaquinone, anthocyanins, cardiac glycosides, stigmast-4-ene-3,6-dione, volatile oils, and steroids. The plant exhibited a wide range of pharmacological properties, such as insecticidal, antimicrobial, anticancer, antiinflammatory, analgesic, antipyretic, anti-diabetic, CNS, and hypolipidemic effects. The chemical components, extraction techniques, and pharmacological effects of *Clitoria ternatea* will be highlighted in this review.

Plant profile:

Taxonomic classification:

Kingdom: Plantae,

Subkingdom: Viridaeplanta,

Infrakingdom: Streptophyta,

Division: Tracheophyta,

Subdivision: Spermatophytina,

Infrodivision: Angiospermae,

Class: Magnoliopsida,

Superorder: Rosanae,

Order: Fabales,

Family: Fabaceae,

Genus: *Clitoria L.*

Species: *Clitoria ternatea* [3].

Figure 1: *Clitoria ternatea*

Common names:

Arabic: Mazerion Hidi, Baslat el-Zuhoor; Bengali: Aparajita, English: blue-pea, bluebellvine, butterfly-pea, cordofan-pea, Darwin-pea; Hindi: Aparajita, Punjabi: Koyal; Sanskrit: Girikarnika, Vishnukranta; Tamil: Kakkanam and Telugu: Dintena[3].

Distribution:

Tropical Asia is where the plant originally came from, and it later spread widely to Africa, including Chad, Djibouti, Ethiopia, Somalia, Sudan, Kenya, Tanzania, Uganda, Burundi, Cameroon, Gabon, Sao Tome, Zaire, Benin, and Cote d'Ivoire; Gambia, Ghana, Guinea, Guinea-Bissau, Niger, Nigeria, Senegal, Sierra Leone, Togo; Malawi, Mozambique, Zambia Taiwan, Bangladesh, Bhutan, India, Pakistan, Sri Lanka, Maldives, Cambodia, Laos, Thailand, Vietnam, Indonesia, Malaysia, the Philippines, and Singapore; Australia; and North America (the United States and Mexico); Guam, the Northern Mariana Islands, Palau, and South America includes Antigua, Barbuda, Aruba, Bahamas, Barbados, Cayman Islands, Cuba, Guadeloupe, Haiti, Jamaica, Martinique, Montserrat, Netherlands Antilles, Puerto Rico, St. Kitts and Nevis, St. Vincent and Grenadines, and Virgin Islands (British). The Southwestern Pacific includes Fiji, Samoa, and Solomon Islands. Virgin Islands (U.S.), French Guiana, Suriname, Venezuela, Brazil, Colombia, Ecuador - Galapagos Islands, Peru, Paraguay, and Uruguay [4,5] are just a few of the countries that are included.

Description: perennial herb with a woody rootstock that climbs or trails. A terminal leaflet and 2-4 pairs of imparipinnate leaflets are present on each leaf. Oval to elliptic-oblong, up to 6.5 4 cm, largely hairless above, pubescent below leaflets. Axillary, resupinate, huge and beautiful, bright blue flowers that can be found alone or in pairs. 6-13 cm long, flattened, mucronate at the apex, hairless or delicately pubescent, linearoblong pod.

Traditional use: Ascetics, abdominal visceral expansion, sore throats, and skin conditions were all treated with root. Although they caused pain and gritting, they were not advised for use as purgatives. Children were given root as a general tonic for boosting mental abilities, physical stamina, and complexion tonics along with honey and ghee. Additionally utilized for epilepsy and insanity were roots. It was common practice to utilize seeds and leaves as a brain tonic and to enhance memory and intelligence. Snake bites were treated with juice and flowers. Crushed seeds are eaten with cold or hot water for urinary issues, and seeds were utilized in swollen joints [6].

Plants parts used: Medicine was made from the leaves, seeds, bark, fruits, sprouts, and stems[7].

EXTRACTION METHODS

Preparation of flower extract from *Clitoria ternatea*:

The fresh butterfly pea blossoms were first surface cleansed with tap water to get rid of any dirt or pollutants, washed with distilled water, and then let to air dry at room temperature. The flowers were then dehumidified by being dried for two hours at 60°C in a hot air oven. The dried flowers were processed into a fine powder using an electric blender before being kept in an airtight container. The aqueous *C.ternatea* extract was made by dissolving 0.01 g of the powder in 20 mL of DI water and stirring constantly for 5 minutes at room temperature. For all subsequent trials, the solution was filtered through Whatman No. 1 filter paper. At 4°C, the extract solution was kept.[8]

Extraction of pigments from flowers:

A fairly straightforward procedure was used to extract the pigments from the petals of *Clitoria ternatea,* as is detailed below. In a nutshell, the petals were broken into tiny bits and placed in a beaker filled with a specific amount of DI water. After 24 hours, the blue-colored solution was extracted from the combination using filter paper with a 50 mm pore diameter, and it was then put in a different test tube. According to Fourier Transform InfraRed (FTIR) analysis, the collected blue solution contains flavonoids, anthocyanins, polyphenolic chemicals, mono glycosides, di glycosides, etc. [9-11]

Preparation of root extract from *Clitoria ternatea*:

Wild CT roots were harvested right away, dried in the shade at room temperature to remove moisture, and then roughly ground in an electric grinder. The powdered materials were treated to hot continuous extraction using ethanol and Soxhlet apparatus. After mild heating, the extract was collected and condensed using a Rotar at vacuum evaporator. After weighing the concentrated extract and estimating the yield %, it was then stored. The extract was subjected to a number of preliminary phytochemical assays, as well as High Resolution Liquid Chromatograph Mass Spectrometer (HR LCMS) analysis.[11]

Preparation of methanolic extract:

About 100 g of the dried material was combined with 300 mL of methanol, and the mixture was allowed to soak for 4 days at 30 ± 2 °C. It was periodically swirled to ensure that the leaf powder completely dissolved in the methanol. Filtration via cheesecloth and filter paper (Whatman No. 1) was used to remove the sample from the solvents. The filtrate was then concentrated under vacuum to a volume of one-fifth using a rotary evaporator at 60 °C and sterilized by filtration using a 0.22-mm membrane. The resulting thick paste was further dried in a 40 °C oven. The resulting extract was stored at 4 °C for additional investigation. In this investigation, methanol was utilized for the extraction to simulate how traditional healers would produce plant extract as a decoction using water. The polarity of water and methanol is the highest among the polar protic solvents. Additionally, methanol use facilitates evaporation more readily than water does. [12-14]

Preparation of ethanolic extract:

Trichosanthes dioica and *Clitoria ternatea* leaves were cleaned with distilled water and dried separately for a number of days in the shade. A mechanical grinder was used to ground the shade-dried leaves into a coarse powder. The dried powdered materials were extracted in a soxhlet extractor using 70% ethanol. The extraction process was carried out until the last drop of the extracts lost all color. Using a rotating evaporator and a vacuum at

60°C, the extracts were concentrated. The extracts were stored in an oven at a temperature of 40 to 50°C for eight hours to allow the remaining solvent to evaporate. The dosages of the dried residues were chosen based on their prior antidiabetic investigations, and they were delivered through Intragastric Catheter Tube (IGC). [12-14]

PHARMACOLOGICAL EFFECTS

Antimicrobial Effect:

Pseudomonas aeruginosa, Escherichia coli, Klebsiella pneumonia, Bacillus subtilis, Aeromonas formicans, Aeromonas hydrophila, and Streptococcus agalactiae were all inhibited by various *Clitoria ternatea* extracts. A. formicans (18mm), A. hydrophilia (19mm), B. subtilis (19mm), and P. aeruginosa (21mm) were the bacteria that were most effectively inhibited by *Clitoria ternateas* ethanol and acetone extracts of the plant, respectively. From *Clitoria ternatea* seeds, one protein (finotin) was isolated. The growth of several significant fungal plant pathogens, including Rhizoctonia solani, Fusarium solani, Colletotrichum lindemuthianum, Lasiodiplodia theobromae, Pyricularia grisea, Bipolaris oryzae, and Colletotrichum gloeosporioides, was significantly inhibited by the protein finotin. Additionally, it prevented the pathogen Xanthomonas axonopodis pv. phaseoli from causing common bean bacterial blight. Additionally, Zabrotes subfasciatus and Acanthoscelides obtectus, two bean bruchids, are highly susceptible to finotins potent inhibitory effects.[8]

Anti-parasitic and Insecticidal:

The Indian earthworm Pheritima *posthuma*, when given an ethanolic extract of *Clitoria ternatea* (100 mg/ml), becomes paralyzed within 15-20 minutes and dies within 28–30 minutes. On adult Indian earthworms, *Pheretima posthuma*, ethanolic extracts of *Clitoria ternateas* flowers, leaves, stems, and roots were also tested for their anthelmintic activities. Results demonstrated that *Clitoria ternatea* roots paralyzed and killed earthworms more quickly. After subsequent extractions using petroleum ether, chloroform, ethyl acetate, and methanol, the extracts of the roots were tested for their ability to kill nematodes. *Clitoria ternatea* root methanol extract is more effective, according to the results.[9]

Anti-Inflammatory, Anti-Pyretic & Analgesic:

Ethanol extract of *Clitoria ternatea* Root (ECTR) was tested for antihistaminic action utilizing mouse models of catalepsy caused by clonidine and haloperidol at doses of 100, 125, and 150 mg/kg ip. Results demonstrated that clonidine-induced catalepsy was considerably ($P < 0.001$) inhibited by Chlor Pheniramine Maleate (CPM) and ECTR when compared to the control group, whereas haloperidol-induced catalepsy was not inhibited by CPM or ECTR. The antipyretic potential of the blue flowered type of *Clitoria ternatea* roots methanol extract (MECTR) on albino rats normal body temperature and yeast-induced pyrexia was assessed. After 19 hours of subcutaneous injection, the rectal temperature was raised by the yeast suspension (10 ml/kg bw). At dosages of (200, 300, and 400 mg/kg bw, oral), the extract significantly decreased resting body temperature and dose-dependently increased temperature induced by yeast. Up to five hours after the medicine was administered, the impact persisted. The extracts anti-pyretic activity was comparable to paracetamols (150 mg/kg bw, oral) [10].

Rats given a 200–400 mg/kg oral methanol extract of *Clitoria ternatea* roots showed reduced paw oedema from carrageenin and reduced vascular permeability from acetic acid. Additionally, animals exposed to yeast-induced pyrexia showed a substantial suppression by the extract. At dosages of 200 and 400 mg/kg oral, the extract significantly decreased the number of writhing`s in mice during the acetic acid-induced writhing response [11].

Rats with carrageenan paw edema and mice with a hot plate were used to test *Clitoria ternatea* flower extracts analgesic and anti-inflammatory effects. Significant anti-inflammatory and analgesic effects were detected in the petroleum ether (60-80°C) extract [12]. At doses of 200 and 400 mg/kg of body weight on mice, the methanolic extract of *Clitoria ternatea* Linn. Leaves was tested for its analgesic properties.

Anti-Cancer:

Using the trypan blue dye exclusion method, the *in vitro* cytotoxic effects of flower extracts of *Clitoria ternatea* (10, 50, 100, 200, and 500µg/ml) in petroleum ether and ethanol were investigated. Significant dose-dependent cell cytotoxic activity was detected in both extracts. Cell count was reduced by 8% for petroleum ether extract at a concentration of 10µg/ml, but by 100% at a concentration of 500µg/ml. For ethanolic extract, a drop in cell count of 1.33% was seen at a concentration of 10µg/ml, while an 80% reduction was seen at a concentration of 500µg/ml. On six different types of normal and cancer-origin cell lines, the cytotoxicity of the aqueous and methanol extracts of the flowers of *Clitoria ternatea* was assessed. These included the human ovarian cancer cell line (Caov-3), the human cervical cancer cell line (Hela), the human liver cancer cell line (HepG2), the human foreskin fibroblast cell line (Hs27), and the hormone-dependent breast cancer cell lines (MCF-7) and (MDA-MB-231). Colorimetric MTT (3-(4,5-dimethylthiazol-2-yl) 2,5-diphenyltetrazolium bromide) assay was used to assess the anti-proliferation properties of the extracts over the course of 24,48, and 72 hours. Results revealed that *Clitoria ternatea* water extract significantly affected MCF-7 ($p<0.05$), with an IC_{50} value of 175.35µg/ml [13].

Antioxidant:

By using them 1, 1-diphenyl-2-picryl-hydrazyl (DPPH) radical scavenging assay, the various solvent extracts of *Clitoria ternatea* leaf were evaluated for their *in vitro* capacity to scavenge free radicals. Regardless of extract concentration, all showed strong in vitro free radical scavenging activity. The petroleum ether, chloroform, and

methanol extracts were shown to be the three most effective extracts. The antioxidant potential of roots from the blue and white flowered types of *Clitoria ternatea* was investigated using petroleum ether, chloroform, and methanol extracts. The potential of antioxidants was assessed using the DPPH free radical scavenging assay, the reducing power assay, and the hydroxyl radical scavenging assay. *Clitoria ternatea* (CT) roots extracted with petroleum ether, chloroform, and methanol considerably reduced the amount of the DPPH free radical at concentrations between 50 and 600µg/ml. Extracts of the roots of the blue flowered variety of CT in petroleum ether, chloroform, and methanol had the strongest inhibition (49.11,35.42, and 70.67% at 600µg/ml, respectively). In a DPPH radical-scavenging experiment, methanol extracts of the CT blue and white flower types demonstrated extremely potent antioxidant activity. Additionally, CT extracts in methanol demonstrated notable reductive and hydroxyl radical scavenging activities. Comparatively to the blue flowered variant of CT, the white flowered variety of CT's methanol extract demonstrated significantly higher antioxidant activity. When compared to the control, methanol extract of CT (MECT) at all doses displayed antioxidant activity ($p<0.001$). Investigated for their antioxidant potential were *Clitoria ternateas* blue and white flowers as well as their leaves. They demonstrated noticeable antioxidant activity, and the sample from the plant that bears blue flowers was stronger in scavenging free radicals [14].

Anti-diabetic:

In Streptozotocin-induced diabetic rats, the acute and subacute hypoglycemic effects of methanol, water, petroleum ether, and chloroform extract of *Clitoria ternatea* leaves were assessed. In Streptozotocin-induced diabetic rats, the extract of *Clitoria ternatea* (200 and 400mg/kg) dramatically lowered blood glucose levels. While 200mg/kg similarly reduced glucose levels, it did not have the same effect as 400mg/kg. The outcome of the methanol extracts acute effect shown that doses of 200 and 400 mg/kg had remarkably similar effects, however at the early stage after 30 minutes, 200 mg/kg demonstrated a slight lowering of blood glucose levels. Subacute activity shown that the 200mg/kg dose of the extract is substantially more effective at controlling blood glucose levels over the long term than the 400mg/kg dose. In alloxan-induced diabetic rats, the hypoglycemic effects of methanol extract of *Clitoria ternatea* leaves (200 and 400mg/kg) were examined. Twelve hours after injection, the *Clitoria ternatea* extract significantly ($P<0.001$) decreased blood glucose levels in alloxan-induced diabetic rats [15]. In all of the biochemical assays that were conducted on streptozotocin (STZ)-induced diabetic Wistar rats, the effects of combined leaf extracts of *Clitoria ternatea* (CTL) and Trichosanthes dioica (TDL) were assessed. After 28-day treatment period, the results showed that the combined extracts considerably ($p<0.05$) reduced serum glucose [16]. Different ethanol extract fractions of the aerial portions of *Clitoria ternatea L.* were examined for their ability to regenerate pancreatic tissue. In streptozotocin-induced diabetic rats, the antidiabetic and antihyperlipidemic potential was assessed, and it`s *in vivo* and *in vitro* antioxidant activity was connected. In the initial screening, the extract and its fractions were tested for acute and subchronic anti-diabetic activity at doses between 100 and 200 mg/kg. The most effective extract and fractions underwent additional testing for pancreatic β-cell regeneration, antioxidant, and antihyperlipidemic activity. Ethanol extract and butanol soluble fraction had the strongest pancreatic regeneration activity, antidiabetic and antihyperlipidemic activity at a dose level of 200 mg/kg [17].

Central Nervous:

Clitoria ternatea seeds and leaves are frequently used as brain tonics and are thought to improve memory and intelligence. The effectiveness of *Clitoria ternatea* in treating Alzheimer's disease was examined, and the main bioactive component responsible for the action was determined. The results demonstrated that *Clitoria ternateas* aqueous extract was effective in treating Alzheimer's disease through a variety of ways. The isolated chemicals might serve as a starting point for discovering novel derivatives that could be used to enhance memory[18]. In comparison to age-matched controls, neonatal and young adult rats treated with 100 mg/kg of *Clitoria ternatea* aqueous root extract (CTR) for 30 days had considerably more Acetylcholine (ACh) in their hippocampi. Their increased learning and memory may have a neurochemical foundation due to an increase in ACh concentrations in their hippocampus [19].

Young adult (60 days old) Wistar rats of either sex were orally intubated for 30 days with 50 and 100 mg/kg bw of the aqueous root extract of *Clitoria ternatea* (CTR), along with age-matched saline controls, to study the mechanisms of memory enhancement. The results of the passive avoidance tests performed on these rats revealed a much higher rate of passive avoidance learning and retention. These rats amygdalas underwent Golgi staining processing, and the stained neurons were tracked with a camera lucida before being analyzed. In comparison to age-matched saline controls, CTR-treated rats showed a considerable increase in dendritic intersections, branching points, and dendritic processes emanating from the soma of amygdaloid neurons. This was notably true for the 100 mg/kg group of rats [20]. On the CNS, the range of *Clitoria ternatea* (CT) methanolic extract's action was identified. The CT's impact on cognitive behavior, anxiety, depressive symptoms, stress, and convulsions brought on by Maximal Electro Shock (MES) and PentyleneTetraZol (PTZ) was investigated.

Experimental research was done to see whether *Clitoria ternatea* was useful in treating obsessive-compulsive disorder. The effect of a *Clitorea ternatea* ethanolic extract on mice's marble-burying behavior was assessed. According to the findings, *Clitorea ternateas* Ethanolic

Extract (EECT) (100, 200, and 400 mg/kg) decreased the marble [21].

Gastrointestinal:

The antiulcer potential of *Clitoria ternatea* aqueous and ethanolic extracts was assessed in various experimentally produced ulcer types in rats. Rats with pylorus ligation and stomach ulcers brought on by indomethacin were given ethanolic extract (200 and 400mg/kg) and aqueous extract (200 and 400mg/kg) of the entire plant. Following ulcer induction, a number of measures including the volume of gastric acid secretion, pH, total acidity, ulcer index, and antioxidant parameters were measured and compared between the extracts, standard, and vehicle control group. High doses of the alcoholic extract demonstrated notable antiulcer action in pylorus ligation and indomethacin-induced ulceration, among other doses [22].

Hypolipidimic:

Rats with artificially generated hyperlipidemia were used to study *Clitoria ternatea L.*'s anti-hyperlipidemic effects. In this study, hyperlipidemia caused by food and acute hyperlipidemia caused by poloxamer 407 were both used as models. The levels of blood total cholesterol, triglycerides, very low-density lipoprotein cholesterol, and low-density lipoprotein cholesterol were significantly ($p<0.05$) decreased after oral administration of the hydroalcoholic extract of *Clitoria ternateas* roots and seeds. In rats with diet-induced hyperlipidemia, the atherogenic index and the HDL/LDL ratio also returned to normal following treatment. The effects were contrasted with those of gemfibrozil (50 mg/kg, oral) and atorvastatin (50 mg/kg, oral)[23].

Anti-histamics and Anti-asthamatic:

At dosages (100-150 mg/kg i.p), milk-induced leucocytosis and eosinophilia in mice, egg albumin-induced mast cell degranulations in rats, and passive cutaneous anaphylaxis in rats were used to test the antiasthmatic effect of *Clitoria ternatea* root ethanol extract (ECTR). The findings demonstrated that ECTR dramatically reduced milk-induced leucocytosis and eosinophilia, shielded mice against egg albumin-induced mast cell degranulations, and lowered area of blue dye leaking in passive cutaneous anaphylaxis in rats[24].

Clitoria ternatea root ethanol extract was tested for its ability to treat Wister rat bronchospasm brought on by histamine aerosol. Rats exposed to histamine-induced bronchoconstriction showed 47.45% protection when given the ethanolic extract of *Clitoria ternatea* (400 mg/kg, po). The findings demonstrated that the aqueous extract of *C. ternatea* not only has bronchodilating effect but also reduces bronchial hyperreactivity by preventing inflammatory cells from infiltrating the airways and by stabilizing the mast cell, which prevents the production of histamine-like mediators[25].

Immunomodulatory:

Sensitized Red Blood cells (SRBC)-sensitized rats were used to study the effects of *Clitoria ternatea* seed and root extracts on humoral immune response, while SRBC-sensitized rats were used to measure the effects on cell-mediated immunity by measuring Delayed Type Hypersensitivity (DTH) response. By examining neutrophil adhesion and the carbon clearance method, respectively, neutrophil recruitment and phagocytosis were assessed. Additionally, researchers looked into the effects on hematological parameters. SRBCs-sensitized rats primary and secondary antibody titers, paw thickness in the DTH response, neutrophil adherence, and *in vitro* phagocytosis all significantly decreased in response to *Clitoria ternatea* seed and root extracts. Reduced immune cell sensitization, immune cell presentation, and phagocytosis may be responsible for *Clitoria ternateas* immunomodulatory effects on humoral, cellular, and non-specific immune response. The authors came to the conclusion that plants anti-inflammatory and antioxidant characteristics may have a significant impact on immunomodulatory activity[26].

Diuretic and Anti Urolithiasis:

When given orally in a non-toxic dose, *Clitoria ternatea* roots or their extract in 95% alcohol had no discernible diuretic or natriuretic impact on dogs. A considerable increase in sodium and potassium excretion in the urine was caused by intravenous dosages of the extract, but it also caused kidney damage. The titrimetric approach was used to evaluate how different extracts of *Clitoria ternatea* affected the *in vitro* development of calcium oxalate crystals, which is a common primary component of most urinary stones. It was discovered that the inhibitory power of the alcohol extract of *Clitoria ternatea* was equivalent to that of Cystone, a patented medication for the removal of kidney stones. *In vitro*, an alcohol extract of *Clitoria ternatea* leaves demonstrated greater calcium oxalate crystallization inhibition (72.99 ± 1.2%) compared to cystone (90.55 ± 1.27%) in terms of calcium oxalate precipitation. [27]

Wound Healing:

Rats were used in experiments employing the excision, incision, and dead-space models to examine the wound healing properties of *Clitoria ternatea* seed and root extracts. When given orally by gavage as well as topically as an ointment, *Clitoria ternatea* seed and root extracts greatly improved wound healing in excision, incision, and dead-space models. These results were similar to what cotrimoxazole ointment produced. *Clitoria ternatea* affected the inflammatory, proliferative, and remodeling phases of wound healing, according to the study findings [28]. Standardized *Clitoria ternatea* leaf extract was tested for its ability to treat wounds using a variety of enzymatic models, most commonly those related to skin wounds [29].

Protective Effects:

The hepatoprotective efficacy of the roots of the blue and white flowered varieties of *Clitoria ternatea* (CT) against rat liver damage caused by carbon tetrachloride (CCl4) was investigated. The hepatoprotective activity was evaluated utilizing a variety of biochemical measures, including serum levels of alkaline phosphatase, glutamate pyruvate transaminase, and glutamate oxaloacetate transaminase phosphatase, total bilirubin, and liver tissue histopathology analyses. The markedly increased Total bilirubin, alkaline phosphatase, and serum transaminases all had considerably higher restored in the direction of normality with CT therapy. The improvement in the biochemistry was validated by liver slices are histopathologically examined [30].

Rats exposed to acetaminophen-induced toxicity were tested for the nephroprotective and antioxidant effects of an ethanol extract of *Clitoria ternateas* aerial parts. In acetaminophen-induced groups, biochemical investigations revealed an increase in blood urea and creatinine levels, as well as an increase in body weight and a decrease in uric acid levels. Treatment with two different dosages of *Clitoria ternatea* extracts greatly improved these values. According to antioxidant tests, renal Septo optic dysplasia (SOD), Computerized Axial Tomography (CAT), Growth Stimulating Hormone (GSH), and Glutathione Peroxidas (GPx) levels were considerably higher in APAP-treated animals, and MDA levels were lower in *Clitoria ternatea* ethanol extract-treated groups. The preventive properties of the *Clitoria ternatea* extract against acetaminophen-induced necrotic damage to renal tissues are also revealed by histopathological changes [31].

Testicular damage in rats induced with ketoconazole (KET) was studied, and the protective effect of *Clitoria ternatea* (CT) flower extracts with antioxidant activity was investigated. Male reproductive parameters studied included sperm concentration, serum testosterone level, histopathology of the testis, and testicular tyrosine phosphorylation levels. Using the 2,2-diphenyl 1-picrylhydrazyl (DPPH) and ferric reducing antioxidant power (FRAP) tests, the antioxidant activity of CT flower extracts was evaluated. Male rats were given testicular damage-causing KET (100 mg/kg bw) intraperitoneally injected for 7 days (induction period: Days 22–28) and CT flower extracts (10, 50, or 100 mg/kg BW) or distilled water via a stomach tube for 28 days (preventive period: Days 1-21).

The weights of the testicles, epididymis, vas deferens, and seminal vesicles, the concentration of sperm, the histological makeup and diameter of the testicles, and the levels of testicular tyrosine phosphorylation were all measured after the experiment on each animal. The CT flower extracts had a high reduction power and the ability to scavenge DPPH. The extract demonstrated no harmful effects on the male reproductive system at 100 mg/kg bw. CT flower extracts (50 and 100 mg/kg BW) significantly reduced the loss of reproductive organ weight parameters, testosterone levels, and sperm concentration in the CT+KET groups. In addition, rats given KET received protection from testicular injury thanks to CT flower extracts. Additionally, compared to other groups, the CT flower extracts dramatically increased the production of a testicular 50-kDa tyrosine phosphorylated protein in the CT100+KET group.

CONCLUSION

The *Clitoria ternatea* plant was examined as a potential medicinal plant with a variety of pharmacological activity and extraction methods. during the review 2 doses like 200 & 400mg/kg body weight were selected as an effective dose for pharmacological activity. In these 2 doses 400mg/kg body weight can be selected as a therapeutic dose for further pharmacological study up on review.

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Source of Support: The author(s) received no financial support for the research, authorship, and/or publication of this article.

Conflict of Interest: The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.