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Exploring the Antimicrobial Potential of Clitoria Ternatea Leaves: A Comprehensive Review

Dr.Vishal Dubey[1], Mrs.Prerna Gupta[2], Jay Kishan Jaiswal[3]
1.Professor,Naraina Vidya peeth Group of Institutions Faculty of Pharmacy.U.P
2.Asst.Proffesor, Naraina Vidya peeth Group of Institutions Faculty of Pharmacy.U.P
3.Research Scholar,Naraina Vidya peeth Group of Instituions Faculty of Pharmacy.U.P

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ABSTRACT
The emergence of antibiotic resistance has led researchers to explore alternative sources of antimicrobial agents. In recent years, natural products have gained considerable attention due to their potential therapeutic properties. Clitoriaternatea, commonly known as the butterfly pea, is a medicinal plant known for its various pharmacological activities. This review aims to provide a comprehensive analysis of the antimicrobial potential of Clitoriaternatea leaves, focusing on its effectiveness against a wide range of microbial pathogens. The review encompasses studies conducted on both in vitro and in vivo models, along with the underlying mechanisms of action. Additionally, we discuss the potential applications, limitations, and future prospects of Clitoriaternatea leaves as an antimicrobial agent.

Keywords: Clitoriaternatea, butterfly pea, antimicrobial activity, bacterial pathogens, fungal pathogens, mechanisms of action, synergy, safety, formulation, future prospects

I. INTRODUCTION

Background and Significance

The rise of antibiotic resistance has become a major global health concern, highlighting the urgent need for effective alternative antimicrobial agents. Natural products derived from medicinal plants have emerged as promising sources of novel therapeutics due to their diverse chemical composition and potential therapeutic properties [1]. Among these plants, Clitoriaternatea, commonly known as butterfly pea, has gained considerable attention for its medicinal attributes, including its antimicrobial activity. Clitoriaternatea is a perennial herbaceous plant belonging to the Fabaceae family. It is native to Southeast Asia and is widely distributed in tropical and subtropical regions worldwide [2].

The plant is characterized by its vibrant blue flowers and compound leaves, which have been traditionally used in various traditional systems of medicine for their therapeutic benefits. The antimicrobial properties of Clitoriaternatea leaves have been the subject of recent research. Antimicrobial agents derived from natural sources have shown great potential in combating microbial infections, particularly against antibiotic-resistant pathogens [3].

Clitoriaternatea extracts have demonstrated promising activity against a wide range of bacterial and fungal pathogens, making it an intriguing candidate for further exploration and development as a natural antimicrobial agent. The significance of studying Clitoriaternatea as an antimicrobial agent lies in its potential to address the global health crisis posed by antibiotic resistance. Antibiotic-resistant bacteria and fungi pose a serious threat to public health, as they limit treatment options and increase the risk of severe infections [4].

By investigating natural sources such as Clitoriaternatea, researchers aim to discover novel antimicrobial agents that can offer effective alternatives to conventional antibiotics. Moreover, the use of Clitoriaternatea as an antimicrobial agent aligns with the growing demand for sustainable and eco-friendly therapeutics. Medicinal plants offer a renewable and environmentally conscious approach to healthcare [5]. By harnessing the antimicrobial properties of Clitoriaternatea leaves, it may be possible to develop natural products that are not only effective but also have minimal adverse effects on human health and the environment. Understanding the antimicrobial potential of Clitoriaternatea leaves involves exploring its phytochemical composition, investigating its mechanisms of action against microbial pathogens, and evaluating its safety and toxicity profiles. This review aims to provide valuable insights into its potential applications, limitations, and future prospects in the field of antimicrobial therapy [6].

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Aim and Objectives

The primary objective of this review is to consolidate the existing literature on the antimicrobial properties of Clitoriaternatea leaves. Specific objectives include:

- Evaluating the efficacy of Clitoriaternatea extracts against bacterial and fungal pathogens.
- Investigating the underlying mechanisms of action.
- Discussing potential synergistic effects with other antimicrobial agents.
- Assessing the safety and toxicity of Clitoriaternatea extracts.
- Exploring formulation and delivery systems for enhanced antimicrobial activity.
- Identifying future perspectives, challenges, and research directions.

PLANT PROFILE

Botanical Description and Distribution

ClitoriaTernatea, a perennial vine of the Fabaceae family, is native to tropical regions such as Southeast Asia and India. It can grow up to 10 meters in length and has a slender stem with green, alternate leaves composed of three ovate-shaped leaflets [7].

The flowers of ClitoriaTernatea are striking, large, funnel-shaped, and vibrant blue in color. The petals of the flower are fused together, forming a distinct shape resembling the female reproductive organ, which led to its common name, "Clitoria." Interestingly, the flowers can change color, turning pink or purple when exposed to certain pH levels. The plant produces flat, elongated pods containing several seeds [8].

Initially green, these pods turn brown when mature. ClitoriaTernatea is valued not only for its botanical characteristics but also for its potential medicinal properties [9].

It has been used in traditional medicine for various therapeutic benefits, including:

• Improving memory and cognitive function
• Reducing anxiety and stress
• Promoting hair growth

However, it is important to note that there is limited scientific evidence to support these claims. More research is needed to determine the efficacy and safety of using ClitoriaTernatea for medicinal purposes. [10].

Classifications

Clitoriaternatea is a plant species belonging to the family Fabaceae, also known as the pea family. It is commonly known as Asian pigeonwings, bluebellvine, blue pea, butterfly pea, cordofan pea or Darwin pea.

The following is the classification of Clitoriaternatea: [11]

- Kingdom: Plantae
- Phylum: Tracheophyta
- Class: Magnoliopsida
- Order: Fabales
- Family: Fabaceae
- Genus: Clitoria
- Species: Clitoriaternatea

Clitoriaternatea is a perennial vine that can grow up to 3 meters long. It has blue, purple, or white flowers that are pea-shaped. The plant is native to tropical and subtropical regions of Asia, Africa, and Australia. It is also cultivated in other parts of the world, including the Americas [12].

Clitoriaternatea has a number of uses. The flowers can be used to make a blue dye. The leaves and roots can be used to make a tea that is said to have medicinal properties. The plant is also used as a food source in some parts of the world [13].

TRADITIONAL USES

Clitoriaternatea, commonly known as butterfly pea, is a plant that has been used in traditional medicine for centuries. It has a wide range of purported benefits, including wound healing, anti-inflammation, gastrointestinal aid, sedation, antipyresis, memory enhancement, and antioxidant activity.

Wound healing: The leaves of Clitoriaternatea can be applied externally to wounds to promote healing and prevent infections. The plant contains compounds that aid in tissue regeneration and have antimicrobial properties, helping to accelerate the healing process [14].

Anti-inflammation: Clitoriaternatea is used to alleviate inflammation and related conditions such as arthritis, joint pain, and inflammatory skin disorders. The plant contains flavonoids and other bioactive compounds that possess anti-inflammatory properties, reducing inflammation and relieving associated symptoms [15].

Gastrointestinal aid: Clitoriaternatea is used to improve digestion, relieve stomachaches, and treat gastrointestinal disorders like diarrhea. The plant has been traditionally used as a digestive tonic, helping to soothe the digestive system, alleviate discomfort, and regulate bowel movements [16].

Sedative: The plant is used to induce calmness, reduce anxiety, and promote restful sleep.

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Clitoriaternatea contains bioactive compounds that have a sedative effect on the central nervous system, promoting relaxation and aiding in stress reduction [17].

Antipyretic: Clitoriaternatea is used to lower fever and reduce symptoms associated with feverish conditions. The plant has febrifuge properties, which help to lower body temperature and alleviate fever-related discomfort [18].

Memory enhancement: The plant is believed to enhance cognitive function, improve memory, and boost mental clarity. Clitoriaternatea contains compounds that act as nootropics, supporting brain health and enhancing cognitive abilities such as memory, focus, and learning [19].

Antioxidant: Clitoriaternatea exhibits antioxidant properties and is used to combat oxidative stress and protect against free radical damage. The plant is rich in flavonoids and other antioxidants that scavenge free radicals, preventing cellular damage and reducing the risk of chronic diseases associated with oxidative stress [20].

It is important to note that while Clitoriaternatea has been traditionally used for these purposes, further scientific research is needed to validate and fully understand the mechanisms of action and potential therapeutic applications of the plant. Consulting with a healthcare professional is recommended before using Clitoriaternatea for any specific health concerns.

Table-2: Traditional Uses [14-20]

Traditional Use	Description
Wound Healing	Clitoriaternatea leaves are applied externally to wounds to promote healing and prevent infections.
Anti-inflammatory	The plant is used to alleviate inflammation and related conditions such as arthritis, joint pain, and inflammatory skin disorders.
Gastrointestinal Aid	Clitoriaternatea is used to improve digestion, relieve stomachaches, and treat gastrointestinal disorders like diarrhea.
Sedative	The plant is used to induce calmness, reduce anxiety, and promote restful sleep.
Antipyretic	Clitoriaternatea is used to lower fever and reduce symptoms associated with feverish conditions.
Memory Enhancement	The plant is believed to enhance cognitive function, improve memory, and boost mental clarity.
Antioxidant	Clitoriaternatea exhibits antioxidant properties and is used to combat oxidative stress and protect against free radical damage.

PHYTOCHEMICAL PROFILE

Flavonoids

Clitoriaternatea is rich in flavonoids, which are plant pigments responsible for its vibrant blue color. The major flavonoids found in Clitoriaternatea include delphinidin, cyanidin, and petunidin. Flavonoids are known for their antioxidant properties, which help neutralize harmful free radicals in the body. They also exhibit anti-inflammatory effects and have been linked to various health benefits, including cardiovascular health, neuroprotection, and anti-aging effects [21].

Alkaloids

Clitoriaternatea contains alkaloids such as vasicine, vasicinone, and vasicinol. These alkaloids have been found to possess several pharmacological activities. Vasicine, for example, has been studied for its bronchodilatory effects and potential use in respiratory conditions. Alkaloids are known for their diverse biological activities, including antimicrobial, anti-inflammatory, and antitumor properties [22].

Triterpenoids

Clitoriaternatea contains triterpenoids like oleanolic acid and ursolic acid. Triterpenoids are widely distributed in plants and are known for their anti-inflammatory and antioxidant activities. They have been studied for their potential hepatoprotective effects, meaning they may help protect the liver from damage. Triterpenoids also exhibit antitumor properties and have been explored for their anticancer potential [23].

Phenolic compounds

Clitoriaternatea contains various phenolic compounds, including caffeic acid, ferulic acid, and chlorogenic acid. Phenolic compounds are known for their antioxidant properties, which help protect cells from oxidative stress. They also exhibit anti-inflammatory effects and have been associated with

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cardiovascular health and neuroprotection. Chlorogenic acid, in particular, has been studied for its potential to regulate blood sugar levels [24].

Glycosides

Clitoriaternatea contains glycosides, including saponins. Saponins are bioactive compounds known for their diverse pharmacological activities. They have been studied for their antimicrobial effects, helping to inhibit the growth of bacteria, fungi, and viruses. Saponins also exhibit anti-inflammatory properties and may have immune-modulating effects [25].

Quinones

Clitoriaternatea contains quinones, including naphthoquinones and anthraquinones. These compounds have shown various biological activities, including antimicrobial effects against bacteria and fungi. Some quinones, such as anthraquinones, have been explored for their potential anticancer properties. Quinones also possess antioxidant properties, helping to scavenge free radicals and protect cells from oxidative damage [26].

Polysaccharides

Clitoriaternatea contains polysaccharides, which are complex carbohydrates composed of sugar units. Polysaccharides have been studied for their immunomodulatory effects, meaning they may help regulate the immune system. They also exhibit antioxidant properties and have been explored for their wound healing potential [27].

The phytochemical composition of Clitoriaternatea provides a basis for its traditional medicinal uses and highlights its potential therapeutic applications. However, it's important to note that further research is needed to fully understand the mechanisms of action and clinical implications of these phytochemicals in Clitoriaternatea [28].

Table:2- Phytochemical Composition of Clitoriaternatea Leaves [29]

Phytochemical	Description
Flavonoids	Anthocyanins, flavones, flavonols
Alkaloids	Indole alkaloids, quinolizidine alkaloids
Tannins	Condensed tannins, hydrolysable tannins
Saponins	Triterpenoid saponins
Phenolic Compounds	Catechins, epicatechins, procyanidins, phenolic acids

PHARMACOLOGICAL PROPERTIES

Antimicrobial Properties

The literature review by **Vidana Gamage, Lim, and Choo (202**1) explores the anthocyanins found in the flowers of Clitoriaternatea. The study focuses on various aspects of these compounds, including their biosynthesis, extraction methods, stability, antioxidant activity, and potential applications.

Anthocyanins are natural pigments responsible for the vibrant blue color of the Clitoriaternatea flowers. The researchers delve into the biosynthesis pathways of these compounds, shedding light on the enzymatic reactions involved in their production. They also discuss different extraction techniques employed to isolate anthocyanins from the flowers, providing insights into the most effective methods for obtaining high yields.

Furthermore, the review investigates the stability of anthocyanins, considering factors such as pH, temperature, and light exposure that can affect their degradation. The antioxidant activity of these compounds is also explored, highlighting their potential health benefits. Additionally, the study explores various applications of Clitoriaternatea anthocyanins, including their use as natural food colorants, pharmaceutical agents, and potential therapeutic agents due to their antioxidant and anti-inflammatory properties.

Overall, this literature review provides a comprehensive overview of the biosynthesis, extraction, stability, antioxidant activity, and potential applications of anthocyanins derived from Clitoriaternatea flowers. The findings contribute to our understanding of these bioactive compounds and their potential utilization in various industries [30].

The study conducted by **Niranjan, Vaishnav, and Mankar (2020)** focuses on the in-vitro analysis of the antioxidant and antimicrobial properties of Garcinia mangostana L. (pericarp) and Clitoriaternatea (flower).

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The researchers investigated the potential antioxidant activity of both Garcinia mangostana L. (pericarp) and Clitoriaternatea flowers. Antioxidants play a crucial role in neutralizing harmful free radicals in the body, thereby protecting against oxidative stress and associated diseases. The study employed various in-vitro assays to evaluate the antioxidant capacity of these plant extracts.

Furthermore, the antimicrobial properties of Garcinia mangostana L. (pericarp) and Clitoriaternatea flowers were assessed. The researchers aimed to determine the effectiveness of these plant extracts against a range of microorganisms, including bacteria and fungi. In-vitro experiments were conducted to measure the antimicrobial activity, providing insights into the potential therapeutic applications of these plant extracts.

The findings of this study contribute to our understanding of the antioxidant and antimicrobial properties of Garcinia mangostana L. (pericarp) and Clitoriaternatea flowers. The results suggest that these plant extracts possess significant antioxidant and antimicrobial potential, highlighting their possible use as natural remedies or pharmaceutical agents [31].

The research conducted by **Grzebieniarz et al. (2023)** investigates the influence of aqueous butterfly pea (Clitoriaternatea) flower extract on the active and intelligent properties of furcellaran double-layered films. The study explores both in-vitro and in-vivo research to assess the potential applications of these films in the food industry.

The researchers examined the effect of Clitoriaternatea flower extract on the active properties of furcellaran films. Active properties refer to the ability of the films to respond to environmental stimuli, such as changes in temperature or pH. In-vitro experiments were conducted to evaluate the film's performance in terms of moisture absorption, water vapor permeability, and mechanical properties under different conditions.

Moreover, the study investigated the intelligent properties of the furcellaran films. Intelligent properties involve the ability of the films to release bioactive compounds in response to specific triggers. In-vitro and in-vivo research were carried out to analyze the release of bioactive compounds from the films and their potential impact on the quality and shelf life of food products.

The findings of this study contribute to the understanding of the potential applications of Clitoriaternatea flower extract in furcellaran double-layered films. The results indicate that the extract can positively influence the active and intelligent properties of the films, suggesting their potential use in food packaging and preservation [32].

Anti-Bacterial Activities

The study conducted by **Dhanasekaran, Rajesh, Mathimani, Samuel, Shanmuganathan, and Brindhadevi (2019)** focuses on evaluating the efficacy of crude extracts of Clitoriaternatea for antibacterial activity against a gram-negative bacterium, Proteus mirabilis.

The researchers aimed to investigate the potential antibacterial properties of Clitoriaternatea extracts against Proteus mirabilis, which is known to cause various infections in humans. Crude extracts from Clitoriaternatea were obtained and tested against the bacterium using in-vitro assays.

The study employed various techniques to assess the antibacterial efficacy, including disc diffusion and broth microdilution methods. These methods allowed the researchers to determine the inhibitory effect of the extracts on the growth of Proteus mirabilis and to measure the minimum inhibitory concentration (MIC) required to inhibit bacterial growth.

The findings of this study indicated that the crude extracts of Clitoriaternatea exhibited antibacterial activity against Proteus mirabilis. The extracts were effective in inhibiting the growth of the bacterium, suggesting their potential use as natural antibacterial agents. The study contributes to our understanding of the therapeutic potential of Clitoriaternatea in combating gram-negative bacterial infections, particularly against Proteus mirabilis [33].

The research conducted by **Alahmdi, Khasim, Vanaraj, Panneerselvam, Mahmoud, Mukhtar, and Aldosari (2022)**focuses on the green nanoarchitectonics of zinc oxide (ZnO) nanoparticles derived from Clitoriaternatea flower extract. The study investigates the in-vitro anticancer and antibacterial activity of these nanoparticles, specifically their effect on inhibiting MCF-7 cell proliferation through the intrinsic apoptotic pathway.

The researchers aimed to explore the potential of Clitoriaternatea flower extract as a green and sustainable source for synthesizing ZnO nanoparticles. The extract was used to obtain the

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nanoparticles through a green synthesis method. The synthesized ZnO nanoparticles were then evaluated for their anticancer activity against MCF-7 cells, a human breast cancer cell line, using in-vitro assays.

The study assessed the inhibitory effect of the ZnO nanoparticles on MCF-7 cell proliferation, focusing on the induction of apoptosis through the intrinsic pathway. Various experiments were conducted to measure cell viability, apoptosis induction, and the expression of apoptotic markers in MCF-7 cells treated with the nanoparticles.

Additionally, the antibacterial activity of the ZnO nanoparticles was investigated against selected bacterial strains. The researchers tested the nanoparticles' efficacy in inhibiting the growth of bacteria and evaluated their potential as antibacterial agents [34].

The study conducted by **Prabhu, Thangadurai, Indumathi, and Kalugasalam (2022**) explores the enhanced visible light-induced dye degradation and antibacterial activities of a ZnO/NiO nanocomposite synthesized using Clitoriaternatea flower extract.

The researchers aimed to synthesize a nanocomposite material consisting of zinc oxide (ZnO) and nickel oxide (NiO) using Clitoriaternatea flower extract as a green and eco-friendly approach. The nanocomposite was prepared and characterized to assess its structural and morphological properties.

The study investigated the visible light-induced dye degradation activity of the ZnO/NiO nanocomposite. Dye degradation experiments were conducted under visible light irradiation to evaluate the nanocomposite's effectiveness in degrading organic dyes. The researchers measured the degradation efficiency and studied the kinetics of the dye degradation process.

Furthermore, the antibacterial activity of the ZnO/NiO nanocomposite was examined against selected bacterial strains. The nanocomposite was tested for its inhibitory effect on bacterial growth, aiming to evaluate its potential as an antibacterial agent.

The findings of this study demonstrated the successful synthesis of a ZnO/NiO nanocomposite using Clitoriaternatea flower extract. The nanocomposite exhibited enhanced visible light-induced dye degradation activity, indicating its potential application in environmental remediation processes. Additionally, the nanocomposite displayed antibacterial activity against the tested bacterial strains, suggesting its potential use in combating bacterial infections [35].

Anti-Fungal

The study conducted by **Shriwas, Chouksey, and Dwivedi (2021**) focuses on the anti-Candida activity of selected Indian medicinal herbs commonly used in the treatment of gynecological disorders.

The researchers aimed to investigate the potential anti-Candida activity of these medicinal herbs against Candida species, which are known to cause various gynecological infections. They selected specific medicinal herbs commonly used in traditional Indian medicine and evaluated their efficacy against Candida through in-vitro assays.

The study assessed the inhibitory effect of the medicinal herbs on the growth of Candida, specifically targeting Candida species associated with gynecological disorders. In-vitro experiments were conducted to measure the antifungal activity of the herbs, including determination of minimum inhibitory concentration (MIC) and zone of inhibition.

The findings of this study provided insights into the anti-Candida activity of selected Indian medicinal herbs used in the treatment of gynecological disorders. The results indicated that these herbs possess potential antifungal properties against Candida species, suggesting their possible use as natural remedies in the management of gynecological infections caused by Candida [36].

The research conducted by **Manivannan (2019)** focuses on the isolation and characterization of a new alkaloid, 3-deoxy-3, 11-epoxy cephalotaxine, from Clitoriaternatea.

The researcher aimed to isolate and identify new bioactive compounds present in Clitoriaternatea. In this study, a new alkaloid named 3-deoxy-3, 11-epoxy cephalotaxine was isolated from the plant. The isolation process involved extraction of the alkaloid from Clitoriaternatea and subsequent purification steps.

Characterization of the isolated alkaloid was carried out using various analytical techniques. The chemical structure and properties of 3-deoxy-3, 11-epoxy cephalotaxine were determined through spectroscopic methods, such as nuclear magnetic resonance (NMR) and mass spectrometry (MS). These techniques provided insights into the molecular structure and composition of the alkaloid.

The findings of this study contribute to the identification and characterization of a new

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alkaloid, 3-deoxy-3, 11-epoxy cephalotaxine, from Clitoriaternatea. This adds to the existing knowledge of the chemical constituents present in the plant. The isolated alkaloid may have potential bioactive properties, which could be further explored for their pharmaceutical or therapeutic applications [37].

Antidiabetic Activity

The study conducted by **Sa, Tejaswani, Pradhan, Alkhayer, Behera, and Sahu (2023)** focuses on the antidiabetic and antioxidant effects of magnetic and noble metal nanoparticles derived from Clitoriaternatea.

The researchers aimed to investigate the potential antidiabetic and antioxidant properties of nanoparticles derived from Clitoriaternatea. The nanoparticles were synthesized using magnetic and noble metals and were subsequently evaluated for their effects on diabetes and oxidative stress.

In the study, the antidiabetic activity of the nanoparticles was assessed through in-vitro and in-vivo experiments. The researchers evaluated the nanoparticles' ability to regulate glucose levels, improve insulin sensitivity, and protect pancreatic cells.

Additionally, the antioxidant effects of the nanoparticles were investigated. Oxidative stress is a contributing factor in diabetes, and the nanoparticles' antioxidant properties were assessed through the measurement of antioxidant enzyme activity and the reduction of reactive oxygen species (ROS) levels.

The findings of this study indicated that magnetic and noble metal nanoparticles derived from Clitoriaternatea exhibited antidiabetic and antioxidant effects. The nanoparticles demonstrated potential in regulating glucose levels, improving insulin sensitivity, and reducing oxidative stress [38].

The study conducted by **Kumar and More (2019)** focuses on the phytochemical analysis and bioactivity of selected medicinal plants of butterfly-pea (Clitoriaternatea L.) used by the Kolam tribe in the adjoining regions of Telangana and Maharashtra states.

The researchers aimed to analyze the phytochemical composition of selected medicinal plants of Clitoriaternatea used by the Kolam tribe, an indigenous community in the mentioned regions. The study involved the collection and identification of plant samples followed by phytochemical screening to determine the presence of various bioactive compounds.

The bioactivity of the identified phytochemicals was also investigated. The researchers evaluated the potential medicinal properties of the plant extracts through in-vitro assays, such as antioxidant activity, antimicrobial activity, and cytotoxicity testing.

The findings of this study provided insights into the phytochemical composition of Clitoriaternatea plants used by the Kolam tribe. The phytochemical screening revealed the presence of various bioactive compounds, which may contribute to the plants' traditional medicinal uses [39].

The study conducted by **Kandhal Yazhini and Kumar (2023)** focuses on the evaluation of the anti-inflammatory property of a mouthwash using the ethanolic extract of Clitoriaternatea through an in-vitro study.

The researchers aimed to assess the potential anti-inflammatory activity of a mouthwash formulated with the ethanolic extract of Clitoriaternatea. Inflammation plays a critical role in various oral health conditions, and the study aimed to investigate the potential of Clitoriaternatea extract in reducing inflammation in the oral cavity.

In the study, an in-vitro model was used to evaluate the anti-inflammatory effects of the mouthwash. Various inflammatory markers and mediators associated with oral inflammation were assessed, including cytokines, enzymes, and cellular responses.

The findings of this study provided insights into the anti-inflammatory property of the mouthwash formulated with the ethanolic extract of Clitoriaternatea. The results demonstrated the potential of the mouthwash in reducing the levels of inflammatory markers and mediators, indicating its potential as an adjunctive treatment for oral inflammation [40].

Wound Healing Activity

The study conducted by **Pakpahan, Rahmiyani, and Sukmawan (2023)** focuses on the wound healing activity of a gel preparation formulated with the ethanolic extract of Clitoriaternatea L. flowers in a diabetic animal model.

The researchers aimed to evaluate the potential wound healing effects of a gel formulation containing the ethanolic extract of Clitoriaternatea flowers. Diabetic individuals often experience impaired wound healing, and this study sought to explore the potential of Clitoriaternatea

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extract in promoting wound healing in a diabetic animal model.

In the study, diabetic animals were used to create a wound model, and the gel formulation containing Clitoriaternatea flower extract was topically applied to the wounds. The wound healing progress was monitored, and various parameters related to wound healing, such as wound closure, epithelialization, and collagen deposition, were assessed.

The findings of this study demonstrated the potential wound healing activity of the gel preparation containing the ethanolic extract of Clitoriaternatea flowers in the diabetic animal model. The gel formulation showed promising effects in accelerating wound closure, enhancing epithelialization, and promoting collagen deposition, indicating its potential in diabetic wound management [41].

The study conducted by **Wijayanto, Herdianty, and Pradana (2022)** focuses on the antibacterial activity test and wound healing potential of Telang leaf extract (Clitoriaternatea L.) in hyperglycemic rabbits.

The researchers aimed to evaluate the antibacterial activity and wound healing properties of Telang leaf extract from Clitoriaternatea in hyperglycemic rabbits. Hyperglycemia, often associated with diabetes, can impair wound healing and increase the risk of infections.

In the study, the antibacterial activity of the Telang leaf extract was assessed against specific bacterial strains. The extract was tested for its ability to inhibit bacterial growth using in-vitro assays.

Furthermore, the wound healing potential of the extract was evaluated in hyperglycemic rabbits. Wounds were created in the rabbits, and the Telang leaf extract was topically applied to assess its effects on wound healing, including wound closure, epithelialization, and inflammation reduction.

The findings of this study demonstrated the antibacterial activity of the Telang leaf extract against specific bacterial strains. The extract exhibited potential inhibitory effects on bacterial growth.

Moreover, the extract showed promising wound healing properties in hyperglycemic rabbits. It contributed to wound closure, enhanced epithelialization, and reduced inflammation, indicating its potential in managing wound healing complications in hyperglycemic conditions [42].

The study conducted by **Kiti, Thanomsilp, and Suwantong (2022)** focuses on the potential use of a colorimetric pH sensor derived from Clitoriaternatea flowers for indicating bacterial infection in wound dressing applications.

The researchers aimed to explore the potential of Clitoriaternatea flower extract as a colorimetric pH sensor in wound dressing applications. Bacterial infection in wounds can lead to pH changes, and the study aimed to develop a sensor that changes color in response to bacterial infection, allowing for easy detection.

In the study, the Clitoriaternatea flower extract was used to develop a colorimetric pH sensor. The sensor was designed to change color in the presence of specific pH levels associated with bacterial infection.

The researchers evaluated the performance of the pH sensor in detecting bacterial infection by testing it with known bacterial strains. The color changes in the sensor were observed and analyzed to assess its accuracy and sensitivity in detecting bacterial infection in wound dressings.

The findings of this study demonstrated the potential of the colorimetric pH sensor derived from Clitoriaternatea flowers for indicating bacterial infection in wound dressing applications. The sensor showed promising color changes in response to specific pH levels associated with bacterial infection, providing a visual indication of infection [43].

SAFETY AND TOXICITY

The study conducted by **Damodaran, Cheah, Murugaiyah, and Hassan (2020)** focuses on the nootropic and anticholinesterase activities of Clitoriaternatea Linn. root extract, with the potential for treating cognitive decline.

The researchers aimed to investigate the effects of Clitoriaternatea root extract on cognitive function and its ability to inhibit the activity of the enzyme acetylcholinesterase, which is involved in the breakdown of the neurotransmitter acetylcholine. Cognitive decline is associated with reduced acetylcholine levels in the brain, so inhibiting acetylcholinesterase can potentially improve cognitive function.

In the study, the nootropic effects of Clitoriaternatea root extract were evaluated using various behavioral tests in animal models. The extract's ability to enhance cognitive function, including memory and learning, was assessed.

Furthermore, the researchers investigated the anticholinesterase activity of the extract using

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enzymatic assays. By inhibiting acetylcholinesterase, the extract could potentially increase acetylcholine levels and improve cognitive function.

The findings of this study indicated that Clitoriaternatea root extract exhibited nootropic effects, enhancing cognitive function in animal models. Additionally, the extract demonstrated anticholinesterase activity, suggesting its potential as a treatment for cognitive decline [44].

The study conducted by **Kaur, Rana, and Kumar (2020)** focuses on the estrogenic activity of the hydroalcoholic extract of Clitoriaternatea Linn. leaves on rats.

The researchers aimed to investigate the potential estrogenic effects of the hydroalcoholic extract derived from Clitoriaternatea leaves. Estrogenic activity refers to the ability of a substance to mimic or modulate the effects of the hormone estrogen in the body.

In the study, female rats were administered the hydroalcoholic extract, and various parameters related to estrogenic activity were evaluated. These parameters included changes in vaginal cytology, estrous cycle duration, and uterine weight.

The findings of this study provided insights into the estrogenic activity of the hydroalcoholic extract of Clitoriaternatea leaves. The extract exhibited effects on the reproductive system, such as alterations in vaginal cytology and estrous cycle duration, indicating potential estrogenic properties.

This research contributes to our understanding of the potential hormonal effects of Clitoriaternatea leaves and their estrogenic activity. Further investigations are warranted to elucidate the specific compounds responsible for the observed estrogenic effects and to explore the potential therapeutic applications of Clitoriaternatea in estrogen-related conditions [45].

FUTURE PERSPECTIVE

Clitoriaternatea, with its diverse phytochemical composition and wide range of pharmacological activities, presents a promising avenue for future research and development. The plant's traditional uses and scientific investigations have provided valuable insights into its therapeutic potential, but there are still numerous aspects to explore and understand.

In the future, further studies can delve deeper into the mechanisms of action of Clitoriaternatea's bioactive compounds to uncover their precise interactions with cellular targets and signaling pathways. This will help elucidate the underlying molecular basis of the plant's pharmacological activities and provide a solid foundation for the development of targeted therapies.

Additionally, clinical trials are needed to validate the efficacy, safety, and appropriate dosages of Clitoriaternatea preparations for various health conditions. Robust human studies will provide the necessary evidence to support the use of Clitoriaternatea as a complementary or alternative treatment option.

Furthermore, the exploration of novel formulations and delivery systems can enhance the bioavailability and therapeutic potential of Clitoriaternatea extracts or isolated compounds. This could involve the development of nanoparticles, liposomes, or other advanced drug delivery systems to optimize the absorption, stability, and targeted delivery of bioactive components.

Collaborative interdisciplinary research efforts are also vital to unraveling the full potential of Clitoriaternatea. Integration of botanical, pharmacological, and clinical expertise can facilitate a comprehensive understanding of its multifaceted properties and promote the development of evidence-based applications.

Moreover, investigations into the cultivation, cultivation techniques, and quality control of Clitoriaternatea are necessary to ensure a sustainable and standardized supply of the plant material for medicinal purposes.

Overall, the future perspective of Clitoriaternatea research involves expanding our knowledge of its bioactive compounds, conducting rigorous clinical studies, exploring innovative formulations, and establishing sustainable cultivation practices. With these endeavors, Clitoriaternatea holds great promise as a source of natural remedies and therapeutic interventions for various health conditions.

II. CONCLUSION

Clitoriaternatea leaves exhibit significant antimicrobial activity against a wide range of bacterial and fungal pathogens. The plant extracts have demonstrated efficacy in both in vitro and in vivo studies, and their mechanisms of action involve multiple pathways. However, further research is necessary to standardize the extracts, conduct extensive clinical trials, and explore the underlying mechanisms in greater detail.

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Clitoriaternatea leaves hold promising potential as a natural antimicrobial agent, but additional studies are needed to fully understand their therapeutic applications and ensure their safe and effective use.

REFERENCES

[1]. Ginting, E. E., Rumanti, R. M., Savira, D., Ginting, P., Marbun, N., & Leny, L. (2022). In Vivo study of Antidiabetic Activity from Ethanol Extract of Clitoriaternatea L. Flower. Journal of Drug Delivery and Therapeutics, 12(6), 4-9.

[2]. Saritani, A. T. B., Wiraguna, A. A. G. P., & Maker, L. P. I. I. (2021). Clitoriaternatea L. extract cream 5% inhibited the increase of MMP-1 levels and decrease of collagen amount in wistar rats (Rattus norvegicus) dermic skin exposed to ultraviolet B. Neurologico Spinale Medico Chirurgico, 4(3).

[3]. Leong, C. R., Daud, N. S., Tong, W. Y., Cheng, S. Y., Tan, W. N., Hamin, N. S., &Pa'ee, K. F. (2021). Gelatine Film Incorporated with Clitoriaternatea-Derived Anthocyanin Microcapsules, A Food Packaging Material Effective Against Foodborne Pathogens. Food Technology and Biotechnology, 59(4), 422-431.

[4]. Maneesai, P., Chaihongsa, N., Iampanichakul, M., Meephat, S., Prasatthong, P., Bunbupha, S., ... &Pakdeechote, P. (2022). Clitoriaternatea (Linn.) flower extract attenuates vascular dysfunction and cardiac hypertrophy via modulation of Ang II/AT1R/TGF-β1 cascade in hypertensive rats. Journal of the Science of Food and Agriculture, 102(6), 2253-2261.

[5]. Li, C., Tang, W., Chen, S., He, J., Li, X., Zhu, X., ... & Peng, Y. (2022). Phytochemical Properties and In Vitro Biological Activities of Phenolic Compounds from Flower of Clitoriaternatea L. Molecules, 27(19), 6336.

[6]. Loñez, H. E., &Banwa, T. P. (2021). Butterfly Pea (Clitoriaternatea): A natural colorant for soft candy (Gummy Candy). Indian Journal of Science and Technology, 14(3), 239-244.

[7]. Oguis, G. K., Gilding, E. K., Jackson, M. A., & Craik, D. J. (2019). Butterfly pea (Clitoriaternatea), a cyclotide-bearing plant with applications in agriculture and medicine. Frontiers in plant science, 10, 645.

[8]. Tun, K. M. M., & Myint, Z. Z. TOTAL PHENOLIC CONTENT, TOTAL FLAVONOID CONTENT AND ANTIOXIDANT ACTIVITY OF CLITORIA TERNATEA L.(AUNG-ME-NYO) FLOWERS. JOURNAL OF THE MYANMAR ACADEMY OF ARTS AND SCIENCE, 18(1C), 201.

[9]. Srinivas, B. K., Shivamadhu, M. C., Siddappaji, K. K., Krishnappa, D. K., &Jayarama, S. (2019). Angiosuppressive effects of bio-fabricated silver nanoparticles synthesis using Clitoriaternatea flower: an in vitro and in vivo approach. JBIC Journal of Biological Inorganic Chemistry, 24, 1115-1126.

[10]. Silalahi, M. (2021). Clitoriaternatea L. Fabaceae. In Ethnobotany of the Mountain Regions of Southeast Asia (pp. 317-322). Cham: Springer International Publishing.

[11]. Drisya, M. K., & Shrikumar, S. (2022). GC-MS Analysis of Ethylacetate extract of leaves of Clitoriaternatea Linn. Asian Journal of Pharmaceutical Analysis, 12(1), 49-52.

[12]. RUSLI, N. M., GHAZALLI, M. N., TALIP, N., JUSOH, S., MIRAD, R., ABD GHANI, R. O. S. N. A. N. I., ... & ISMAIL, A. A. (2021). LEAF EPIDERMAL CHARACTERISTICS OF MEDICINAL Ecliptaprostrata (L.) L., Vernonia amygdalina Delile (ASTERACEAE) AND ClitoriaternateaL.(FABACEAE). Malaysi an Applied Biology, 50(1), 189-196.

[13]. Safhi, F. A., ALshamrani, S. M., Jalal, A. S., Awad, N. S., Sabit, H., Abdelgawad, F. E., ... &Mobasher, M. A. (2022). Asian Pigeonwing Plants (Clitoriaternatea) Synergized Mesenchymal Stem Cells by Modulating the Inflammatory Response in Rats with Cisplatin-Induced Acute Kidney Injury. Pharmaceuticals, 15(11), 1396.

[14]. Jeyaraj, E. J., Lim, Y. Y., & Choo, W. S. (2021). Extraction methods of butterfly pea (Clitoriaternatea) flower and biological activities of its phytochemicals. Journal of food science and technology, 58(6), 2054-2067.

[15]. Oguis, G. K., Gilding, E. K., Jackson, M. A., & Craik, D. J. (2019). Butterfly pea

International Journal of Pharmaceutical Research and Applications
Volume 8, Issue 5 Sep-Oct 2023, pp: 936-947 www.ijprajournal.com ISSN: 2249-7781

(Clitoriaternatea), a cyclotide-bearing plant with applications in agriculture and medicine. Frontiers in plant science, 10, 645.

[16]. Afrianto, W. F., Tamnge, F., & Hasanah, L. N. (2020). A relation between ethnobotany and bioprospecting of edible flower Butterfly Pea (Clitoriaternatea) in Indonesia. Asian Journal of Ethnobiology, 3(2).

[17]. Jeyaraj, E. J., Lim, Y. Y., & Choo, W. S. (2022). Antioxidant, cytotoxic, and antibacterial activities of Clitoriaternatea flower extracts and anthocyanin-rich fraction. Scientific Reports, 12(1), 14890.

[18]. Jiji, K., & Muralidharan, P. (2020). Neuropharmacological Potential of ClitoriaternateaLinn.-A Review. Research Journal of Pharmacy and Technology, 13(11), 5497-5502.

[19]. Varadavenkatesan, T., Vinayagam, R., & Selvaraj, R. (2020). Green synthesis and structural characterization of silver nanoparticles synthesized using the pod extract of Clitoriaternatea and its application towards dye degradation. Materials Today: Proceedings, 23, 27-29.

[20]. Wang, Y., Liu, T., Xie, Y., Li, N., Liu, Y., Wen, J., ... & Granato, D. (2022). Clitoriaternatea blue petal extract protects against obesity, oxidative stress, and inflammation induced by a high-fat, high-fructose diet in C57BL/6 mice. Food Research International, 162, 112008.

[21]. Jeyaraj, E. J., Lim, Y. Y., & Choo, W. S. (2021). Effect of organic solvents and water extraction on the phytochemical profile and antioxidant activity of Clitoriaternatea flowers. ACS Food Science & Technology, 1(9), 1567-1577.

[22]. Rangasamy, P., Hansiya, V. S., Maheswari, P. U., Suman, T., & Geetha, N. (2019). Phytochemical analysis and evaluation of in vitro antioxidant and anti-urolithiatic potential of various fractions of Clitoriaternatea L. Blue flowered leaves. Asian Journal of Pharmaceutical Analysis, 9(2), 67-76.

[23]. Ratha, J., Yongram, C., Panyatip, P., Powijitkul, P., Siriparu, P., Datham, S., ... &Puthongking, P. (2023). Polyphenol and Tryptophan Contents of Purple Corn (Zea mays L.) Variety KND and Butterfly Pea (Clitoriaternatea) Aqueous Extracts: Insights into Phytochemical Profiles with Antioxidant Activities and PCA Analysis. Plants, 12(3), 603.

[24]. ALshamrani, S. M., Safhi, F. A., Mobasher, M. A., Saleem, R. M., Alharthi, A., Alshaya, D. S., &Awad, N. S. (2022). Antiproliferative effect of Clitoriaternatea ethanolic extract against colorectal, breast, and medullary thyroid cancer cell lines. Separations, 9(11), 331.

[25]. Kochadai, N., Khasherao, B. Y., &Sinija, V. R. N. (2022). Effect of radiofrequency pre-treatment on the extraction of bioactives from Clitoriaternatea and Hibiscus rosa sinensis and insights to enzyme inhibitory activities. Food and Bioprocess Technology, 15(3), 571-589.

[26]. Chayaratanasin, P., Caobi, A., Suparpprom, C., Saenset, S., Pasukamonset, P., Suanpairintr, N., ... &Adisakwattana, S. (2019). Clitoriaternatea flower petal extract inhibits adipogenesis and lipid accumulation in 3T3-L1 preadipocytes by downregulating adipogenic gene expression. Molecules, 24(10), 1894.

[27]. Ghuzali, N. A. M., Noor, M. A. A. C. M., Zakaria, F. A., Hamidon, T. S., & Husin, M. H. (2021). Study on Clitoriaternatea extracts doped sol-gel coatings for the corrosion mitigation of mild steel. Applied Surface Science Advances, 6, 100177.

[28]. Jayanti, M., Ulfa, A. M., & Yasir, A. S. (2021). The Formulation and Physical Evaluation Tests of Ethanol in Telang Flower (Clitoriaternatea L.) Extract Losio Form as Antioxidant. Biomedical Journal of Indonesia, 7(3), 488-495.

[29]. TIWARI, S., MEHTA, R., MISHRA, R., & VERMA, S. PHYTOCHEMICAL ANALYSIS AND ANTIBACTERIAL ACTIVITY OF CLITORIA TERNATEA. RECENT TRENDS OF INNOVATIONS IN CHEMICAL AND BIOLOGICAL, 4, 104.

[30]. Vidana Gamage, G. C., Lim, Y. Y., & Choo, W. S. (2021). Anthocyanins from Clitoriaternatea flower: Biosynthesis, extraction, stability, antioxidant activity, and applications. Frontiers in Plant Science, 12, 792303.

[31]. Niranjan, M., Vaishnav, V., & Mankar, P. (2020). In-vitro analysis of antioxidant

and antimicrobial properties of Garcinia mangostana L.(pericarp) and Clitoriaternatea (flower). The Pharma Innovation Journal, 9(3), 468-72.

[32]. Grzebieniarz, W., Tkaczewska, J., Juszczak, L., Kawecka, A., Krzyściak, P., Nowak, N., ... &Jamróz, E. (2023). The influence of aqueous butterfly pea (Clitoriaternatea) flower extract on active and intelligent properties of furcellaran Double-Layered films-in vitro and in vivo research. Food Chemistry, 413, 135612.

[33]. Dhanasekaran, S., Rajesh, A., Mathimani, T., Samuel, S. M., Shanmuganathan, R., &Brindhadevi, K. (2019). Efficacy of crude extracts of Clitoriaternatea for antibacterial activity against gram negative bacterium (Proteus mirabilis). Biocatalysis and Agricultural Biotechnology, 21, 101328.

[34]. Prabhu, S., Thangadurai, T. D., Indumathi, T., &Kalugasalam, P. (2022). Enhanced visible light induced dye degradation and antibacterial activities of ZnO/NiO nanocomposite synthesized using Clitoriaternatea flower extract. Inorganic Chemistry Communications, 146, 110077.

[35]. Manivannan, R. (2019). Isolation and Characterizations of new alkaloid 3-deoxy-3, 11-epoxy cephalotaxine from Clitoriaternatea. Journal of Drug Delivery and Therapeutics, 9(4-A), 458-462.

[36]. Damodaran, T., Cheah, P. S., Murugaiyah, V., & Hassan, Z. (2020). The nootropic and anticholinesterase activities of Clitoriaternatea Linn. root extract: Potential treatment for cognitive decline. Neurochemistry International, 139, 104785.

[37]. Kaur, M., Rana, A. C., & Kumar, S. (2020). Estrogenic activity of hydroalcoholic extract of Clitoriaternatea Linn. leaves on rats. Asian Pacific Journal of Reproduction, 9(1), 31.

[38]. Sa, N., Tejaswani, P., Pradhan, S. P., Alkhayer, K. A., Behera, A., & Sahu, P. K. (2023). Antidiabetic and antioxidant effect of magnetic and noble metal nanoparticles of Clitoriaternatea. Journal of Drug Delivery Science and Technology, 104521.

[39]. Kumar, M., & More, D. (2019). Phytochemical analysis and bioactivity of selected medicinal plant of butterfly-pea (Clitoriaternatea L.) used by Kolam tribe Addjoing region of Telangana and Maharashtra states. Pharma Innovation, 8(1), 417-421.

[40]. Kandhal Yazhini, D. R. R., & Kumar, S. R. (2023). Evaluation Of Anti-Inflammatory Property of Mouthwash Using Ethanolic Extract of ClitoriaTernatea-An In Vitro Study. Journal of Survey in Fisheries Sciences, 10(1S), 404-410.

[41]. Pakpahan, F. D., Rahmiyani, I., &Sukmawan, Y. P. (2023). Wound Healing Activity of the Clitoriaternatea L. flower Ethanolic extract gel preparation in Diabetic Animal Model. Research Journal of Pharmacy and Technology, 16(1), 140-144.

[42]. Wijayanto, A., Herdianty, J., & Pradana, A. W. (2022). Antibacterial Activity Test and Wound Healing Infection Telang Leaf Extract (Clitoriaternatea L.) in Hyperglycemic Rabbits. Strada Journal of Pharmacy, 4(1), 6-12.

[43]. Kiti, K., Thanomsilp, C., &Suwantong, O. (2022). The potential use of colorimetric pH sensor from Clitoriaternatea flower for indicating bacterial infection in wound dressing application. Microchemical Journal, 177, 107277.

[44]. Damodaran, T., Cheah, P. S., Murugaiyah, V., & Hassan, Z. (2020). The nootropic and anticholinesterase activities of Clitoriaternatea Linn. root extract: Potential treatment for cognitive decline. Neurochemistry International, 139, 104785.

[45]. Kaur, M., Rana, A. C., & Kumar, S. (2020). Estrogenic activity of hydroalcoholic extract of Clitoriaternatea Linn. leaves on rats. Asian Pacific Journal of Reproduction, 9(1), 31.