Clitoria ternatea : Extraction Utilization as a Health Drink

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KEYWORDS

Clitoria ternateam, Flavonoid, Anthocyanin, Functional Beverage

ABSTRACT:

Introduction: *Clitoria ternatea* is a versatile plant that has been used in traditional medicine for centuries. Recently, it has attracted increasing attention due to its potential for broader exploitation. This plant contains various bioactive chemicals, such as flavonoids, alkaloids, and phenolic compounds, which exhibit antioxidant, anti-inflammatory, and antimicrobial properties. Despite its traditional use, comprehensive studies on its phytochemistry and health impacts are still required.

Objectives: The objective of this study was to evaluate the potential of *Clitoria ternatea* extract as a health drink. Specifically, the study aimed to identify the bioactive compounds contained in the extract, assess their impact on health, and review the plant's past applications.

Methods: A comprehensive literature review was conducted to gather and analyze existing research on the bioactive components of *Clitoria ternatea*, their known health effects, and the practical applications of the plant as a health drink in different contexts.

Results: The study revealed several insights into the health potential of *Clitoria ternatea*. The bioactive compounds present in the plant, such as flavonoids and phenolic compounds, were found to have positive effects on the immune system, diabetes management, cardiovascular health, and inflammation reduction. These findings highlight the considerable promise of *Clitoria ternatea* extract as a health-promoting beverage.

Conclusions: Based on the review, *Clitoria ternatea* shows great potential for development as a health drink. However, the determination of an appropriate dosage remains challenging due to a lack of sufficient human studies. Further research is needed to establish accurate and safe consumption guidelines.

1. Introduction

Clitoria ternatea, commonly referred to as 'blue pea,' is a perennial plant found naturally in numerous tropical regions, such as Guinea, Ghana, Malaysia, Indonesia, and Zimbabwe. However, it has also been brought to South Africa, America, and Australia's tropical regions. Due to its extensive geographic range, C. ternatea is also referred to by a variety of names in other parts of the world, including bunga biru, tembang telang (Indonesia), pokindong (Philippines), lan hu die (China), Kordofan pea (South Sudan), dangchan (Thailand), kajroti, aparajit (India), and cunha (Brazil). This plant is a member of the Fabaceae family, class Magnoliopsida, phylum Tracheophyte, and kingdom Plantae (Jeyaraj *et al*., 2021). It encompasses two variations: blue-flowered and white-flowered, distinguished by their distinct appearances. The blossoms, resembling conch shells, feature five petals each. The foliage is characterized by stipulate leaves, while the root system comprises a robust taproot with limited branching and numerous slender lateral roots. The primary root, thick in structure, extends to over two meters and exhibits several glaucous, purplish nodules (Ranaweera *et al*., 2021). *Clitoria ternatea* is esteemed for its ornamental value and utility in revegetation efforts, while also serving as a natural food colorant in Southeast Asian culinary practices. However, it is the plant's rich reservoir of bioactive compounds that has captured the attention of researchers and enthusiasts alike, propelling

it into the spotlight of modern functional food and beverage industries (Havananda and Luengwilai, 2019; Oguis *et al*., 2019).

In recent years, a palpable surge in public interest surrounding functional foods and beverages has reinvigorated the food industry, as consumers increasingly seek products offering holistic health benefits beyond basic nutrition (Multisona *et al*., 2023). Functional foods, as defined by the European Commission, encompass a category of food products intricately linked to the enhancement of overall health and well-being or the reduction of disease risk, owing to their ability to positively influence one or more physiological functions beyond traditional nutritional benefits (EFSA. 2021). These foods seamlessly integrate into a typical dietary regimen and are distinct from conventional dietary supplements typically found in pill or capsule form (Martirosyan *et al*., 2021). Serving as a bridge between conventional nutrition and medicinal properties, functional foods, whether in their natural state or after commercial processing, offer potential health advantages that extend beyond basic nutritional requirements (Shirodkar *et al*., 2023). Recent research underscores the manifold therapeutic potential of functional foods, demonstrating their capacity not only to prevent but also to treat various ailments (Nystrand *et al*., 2021). Regular consumption of functional foods over time has been shown to fortify the immune system, thereby enhancing resilience against both viral infections and chronic diseases (Swathi *et al*., 2021). From a pharmacological standpoint, functional foods exhibit diverse activities, including antimicrobial, antipyretic, anti-inflammatory, analgesic, diuretic, local anesthetic, and antidiabetic properties.

This burgeoning fascination underscores a paradigm shift towards wellness-oriented consumption patterns, with functional beverages emerging as convenient conduits for delivering vital nutrients and health-enhancing compounds to discerning consumer. Consequently, the revitalization of the beverage sector has paved the way for innovative formulations that harness the nutritional potency of botanical extracts, such as those derived from *Clitoria ternatea* (Dharnasekaran *et al*., 2019). This plant has a potential to be harnessed as a functional beverage because of its' high and healthy nutritional contents. This claim is implied by Clitoris ternatea various uses as traditional medicine. Its roots and leaves have been utilized to address infections, physical discomfort, and urogenital issues. The roots possess purgative, laxative, and diuretic properties, making them beneficial for conditions such as dyspepsia, constipation, pain, fever, eye conditions, enlarged abdominal organs, and skin and throat irritation. Moreover, C. ternatea is known to act as a tonic for the mind, enhancing mental ability, physical strength, and overall mental well-being, particularly in children. The roots and flowers are reported to have emmenagogue properties. Rheumatism and ear problems can be alleviated through the use of powdered roots. Additionally, the seeds of C. ternatea are utilized as laxatives, as well as for conditions like swelling joints, colic, dropsy, and abdominal expansion. The seeds are also known for their vermifugal and mildly emetic properties. In various cultures, C. ternatea is grown as an ornamental plant due to its beautiful blossom colors. In the Philippines, the young shoots, leaves, flowers, and delicate pods are consumed as vegetables (Torres *et al*., 2022). In Malaysia, the leaves are used for their green hue in meals, while the flowers are used to give rice cakes a vibrant blue color (Atikah *et al*., 2021).

However, further research regarding the potential of *Clitoria ternatea* to be used as functional beverages must be conducted further. Bioactive compounds of *Clitoria ternatea* and their activity in human body should be confirmed and evaluated. Right dosage of *Clitoria ternatea* for it to give positive effects, the effect of *Clitoria ternatea* to certain demographics such as kids, adults, and population with certain condition should be identified. Filling this gap will give us a more holistic and accurate description about the potential uses of this plant, helping its further development. Thus, this literature review is conducted to explore the nutritional contents and active contents of *Clitoria ternatea* and its' effect to the body in regards to the body immune system, cardiovascular disease, blood sugar level, and anti-inflammatory activity.

2. Methods

A comprehensive literature search was conducted using Google Scholar to identify relevant articles pertaining to Clitoria ternatea extracts and their associated health benefits. The search strategy

involved using a combination of keywords related to Clitoria ternatea and health benefits. The keywords utilized included "Clitoria ternatea extract," "health," "diabetes," "cardiovascular," "cancer," "inflammation," and "beverage." The search was limited to articles published within the last five years (2019-2024) to ensure the inclusion of recent research findings.

Articles were included if they met the following criteria: (1) focused on Clitoria ternatea extracts or derived compounds, (2) investigated the health benefits or medicinal properties of these extracts, (3) published in peer-reviewed journals, and (4) written in English and Indonesia. Studies involving both in vitro and in vivo experiments, as well as clinical trials and reviews, were considered for inclusion. Articles were excluded if they did not meet the inclusion criteria outlined above, were not available in full text, or were duplicate publications. Additionally, studies that primarily focused on other plant extracts or compounds unrelated to Clitoria ternatea were excluded from the review.

Table 1. Search Result of Several Keywords

Keywords	Article Found
"*Clitoria ternatea* extract"	331
"*Clitoria ternatea* extract" + "health"	244
"*Clitoria ternatea* extract" + "diabetes"	100
"*Clitoria ternatea* extract" + “cardiovascular"	70
"*Clitoria ternatea* extract" + “cancer"	139
"*Clitoria ternatea* extract" + “inflammation"	102
"*Clitoria ternatea* extract" + “beverage"	82

The search results were screened based on titles and abstracts to identify potentially relevant articles. Full-text articles meeting the inclusion criteria were then retrieved and further assessed for eligibility. Data extraction was performed independently by reviewer. The following information was extracted from each included study: authors, year of publication, study design, sample size, intervention details, outcomes measured, and key findings related to the health benefits of *Clitoria ternatea* extracts.

The quality of included studies was assessed using appropriate quality assessment tools depending on the study design. For experimental studies, the methodological quality was evaluated based on criteria such as sample size calculation, randomization, blinding, and control of potential confounders. For clinical trials and reviews, the quality assessment involved evaluating aspects such as study design, participant recruitment, data analysis, and reporting of results.

Finally, a narrative synthesis approach was employed to summarize the findings from the included studies. Relevant data were synthesized and organized according to the health benefits and medicinal properties of *Clitoria ternatea* extracts. Key findings were summarized, and common themes or patterns across studies were identified. Any discrepancies or conflicting results were discussed, and potential explanations or implications were considered.

3. Result & Discussion

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Clitoria ternatea (C. ternatea) flowers have been studied extensively and found to contain several bioactive components, as documented in the scientific literature. Various analytical processes have identified various phytochemical compounds in this flower, including flavonoids and anthocyanins, with delphinidin as the main coloring molecule. The anthocyanins in C. ternatea flowers, namely A1A3, B1B4, C1, and D1D3, contribute to the diverse color spectrum observed, ranging from dark blue to magenta, and are influenced by the pH of the environment around the plant. In addition, various flavonoids were also found such as rutin, myricetin, quercetin, and kaempferol, as well as glycosides such as quercetin-3-rutinoside and kaempferol-3-neohesperidoside. The presence of phytosterols, including campesterol, stigmasterol, and β-sitosterol has also been identified in C. ternatea flowers. These flavonoids and phytosterols, known for their antioxidant properties, are believed to play an important role in the bioactive functions of C. ternatea flowers (Sytar et al., 2021, Shirodkar et al., 2023, Zhang et al., 2021).

Anthocyanins, a class of polyphenolic compounds, are water-soluble vacuolar pigments that are found in various plants part. These compounds are responsible for the colors of various fruits and vegetables, and play an important role in the sensory properties of foods. In plants, anthocyanins function as a protective mechanism against UV damage and cold stress, contributing to color changes in organs such as flower petals during development. Its main function in the epidermis of flowers and fruit is to attract pollinating animals and insects, assisting seed dispersal and pollen dispersal. Additionally, evidence suggests their involvement in responding to adverse biotic and abiotic stresses. Some of the anthocyanidins such as delphinidin, pelargonidin, peonidin, petunidin, and malvidin is widely used as a natural food coloring. But it's colora and stability are influenced by pH, the presence of metal ions, temperature, light and oxygen. Apart from being used as food colorings, anthocyanins are also known to have potential nutraceutical benefits and offer many health effects (Blesso et al., 2019).

A study aimed to investigate the effects of daily consumption of anthocyanin extract on the efficacy of a single intake of extract prior to exercise. The findings of the study revealed that consuming extract one hour before a 30-minute rowing exercise resulted in a significant decrease in post-exercise-induced malondialdehyde (MDA) levels, indicating a reduction in oxidative stress. Moreover, daily extract consumption for a period of five weeks showed improvements in the resolution of acute inflammation and an increase in plasma IL-10, salivary beta-defensin 2 (BD2), and secretory IgA levels. Notably, there was no observed change in plasma antioxidant capacity; however, a positive correlation between plasma IL-10 and antioxidant capacity was observed after five weeks of extract consumption. In vitro studies using a differentiated myotubule cell-line suggested that IL-10 may play a role in modulating cellular antioxidant systems (Hurst *et al*., 2021). Another study aimed to explore the effects of an anthocyanin-rich Roselle aqueous extract on rats with obesity and hypercholesterolemia. Following a three-week intervention, the extract demonstrated significant reductions in body mass index (BMI), improvements in lipid profiles and liver enzymes, and positive histopathological changes in the liver, comparable to standard drugs (Noordin et al., 2019). Anthocyanins have also shown promise as potential alternatives to antibiotics for preventing foodborne diseases. Recent studies have highlighted their effectiveness as growth inhibitors against bacteria such as E. coli and Salmonella, with anthocyanins exhibiting a minimum inhibitory concentration (MIC) range of 10–400 mg/ml, while catechins have a range of 6–50 mg/ml. Additionally, both anthocyanins and catechins have been found to reduce the abundance of pathogenic bacteria, including those capable of toxin production, such as Desulfovibrio sp. and Enterococcus. Furthermore, these compounds have the ability to modulate the composition of intestinal microbes, promoting intestinal immunity and overall gut health, thus aiding in the control of foodborne diseases (Noordin *et al.*, 2019). Furthermore, anthocyanins have shown potential antithrombotic effects. In a study by Gaiz et al., the impact of anthocyanin compounds on platelet activation and aggregation, which are crucial factors in arterial thrombosis and cardiovascular disease (CVD), was investigated. Thirteen healthy adult participants provided fasting blood samples, and platelet activity was assessed using flow cytometry to measure the expression of platelet surface markers, specifically P-selectin (CD62P) and PAC-1. Platelet aggregation studies were conducted by stimulating platelets with different agonists, including adenosine diphosphate (ADP), collagen, and

arachidonic acid (AA). The study findings indicated that anthocyanin at a concentration of 50 mg/L significantly inhibited AA-induced platelet aggregation. Additionally, the expression of P-selectin was significantly suppressed by 50 mg/L anthocyanin, as observed through flow cytometry analysis. These findings suggest that anthocyanins have the potential to attenuate platelet function by reducing P-selectin expression and influencing the Thromboxane A2 pathway, specifically in response to AA stimulation. This study provides further evidence of the potential mechanism by which anthocyanins can decrease platelet aggregation and activation, thereby potentially reducing the risk of thrombosis (Gaiz *et al*., 2020).

Flavonoids, a class of polyphenolic phytochemicals found in plants, have demonstrated the ability to modulate immune responses and exhibit various health benefits. Previous studies have highlighted their potential in promoting anti-cancer T cell responses, reducing reactive oxygen species (ROS) production, and inhibiting inflammatory processes. (Martinez *et al*., 2019). Quercetin, a dietary flavonoid exists in the flower, known for its robust anti-inflammatory properties, has been observed to enhance macrophage M2 polarization and exert anti-inflammatory activity in LPS-stimulated murine peritoneal macrophages. The study conducted by Zhu *et al*. revealed that quercetin triggers TRPM2-dependent calcium influx, leading to calcium-dependent activation of AMPKα and ATF3, both of which are essential for mediating M2 macrophage polarization and facilitating the anti-inflammatory activity of quercetin. In a murine endotoxemia model, quercetin demonstrated improved survival and ameliorated acute lung injury. Furthermore, quercetin induced AMPKα phosphorylation, upregulated ATF3 expression, and promoted M2 macrophage polarization in the model mice. These findings suggest that quercetin promotes macrophage M2 polarization and provides protection against murine sepsis by inducing calcium-dependent activation of the AMPK-ATF3 pathway (Zhu *et al*., 2019). Research by Cui *et al*. suggest that quercetin, one of the flavonoids found in the flower, exerts protective effects against sepsis-induced lung injury through modulation of immune responses. Its ability to restore normal lung histology, decrease ROS levels, enhance ROS scavenging enzyme expression, and reduce HMGB1 expression supports its potential utility in immune modulation (Cui *et al*., 2019). Clinical trials have investigated the immunomodulatory activity of quercetin in various human inflammatory conditions, including prostatitis, cystitis, rheumatoid arthritis, hypercholesterolemia, cardiovascular diseases, metabolic syndrome, cancers, and inflammation induced by intensive exercise and respiratory infections. While contrasting results have been reported regarding its capability to inhibit the production of inflammatory mediators, some studies have shown promising outcomes. For instance, oral supplementation of quercetin demonstrated significant symptomatic improvement in patients with chronic prostatitis syndromes and interstitial cystitis, as well as a reduction in serum IL-1β and TNFα levels in patients with coronary artery disease. Moreover, high daily quercetin intake was found to lower CRP concentration and reduce fasting plasma glucose levels in patients with metabolic syndrome and related disorders. Limited evidence also suggests a potential decrease in the risk for respiratory infections with supplemental quercetin, particularly in physically fit individuals (Hosseini *et al*., 2021).

Rutin, a bioflavonoid found in *Clitoria ternatea*, has many positive activities such as anti-inflammatory and analgesic, antioxidant, antiviral, immune regulation and anticancer (Prasad *et al*., 2019). Recent evidence suggests that rutin shows promise in treating acute colitis. A study conducted by Sharma *et al*., found that rutin effectively suppressed the activation of the p38/MK2 and PI3K/Akt/GSK3β/MAPKs/NF-κB pathways, which are associated with colitis. Rutin treatment improved disease activity scores, colon length, goblet cell loss, and colon epithelial integrity. It also regulated the expression of oxi-inflammatory markers and cytokine ratios, helping to restore immune balance. Rutin demonstrated its ability to enhance epithelial integrity and modulate immune responses by affecting tight junction proteins, mucus-secreting proteins, and Treg expansion (Sharma *et al*., 2021). Rutin has been shown to have immunomodulatory and antioxidant effects in a mice model of cyclophosphamide-induced damage. Rutin was found to significantly improve the damage to the spleen and thymus, while reducing the levels of pro-inflammatory cytokines TNF-α and IL-6. It also exhibited the ability to regulate the expression of genes and proteins involved in the TLR4-MyD88-

NF-κB signaling pathway, promoting immune balance. Additionally, rutin demonstrated antioxidative properties by reducing oxidative stress markers, enhancing antioxidant enzyme activity, and activating the Nrf2/HO-1 signaling pathway (Lan *et al*., 2022).

Research on myricetin, a natural flavonoid, has shown its potential in cancer prevention and treatment, specifically in hepatocellular carcinoma (HCC). Studies have indicated that myricetin induces apoptosis and inhibits cell proliferation in HCC cell lines. It achieves this by targeting the YAP pathway, inhibiting the expression of YAP through the activation of LATS1/2 kinases. Additionally, myricetin enhances the sensitivity of HCC cells to cisplatin treatment. These findings suggest that myricetin could be valuable in the development of strategies for HCC prevention and therapy (Li et al., 2019). Myricetin has also demonstrated promising anti-diabetic activity through multiple mechanisms. Firstly, it activates the glucagon-like peptide-1 receptor (GLP-1R), stimulating insulin secretion and regulating blood sugar levels. This suggests its potential use in the prevention and treatment of type 2 diabetes mellitus (T2DM). Myricetin also inhibits enzymes involved in starch digestion, reducing postprandial hyperglycemia in T2DM patients. It inhibits cyclin-dependent kinase 5 (CDK5) and endoplasmic reticulum stress (ERS), protecting against pancreatic β-cell dysfunction in T2DM. Moreover, myricetin inhibits the aggregation of human pancreatic beta-amyloid polypeptides (hIAPP), which contribute to the development of T2DM. It also shows effects on signaling molecules and oxidative stress associated with diabetes complications. These diverse mechanisms highlight the potential therapeutic benefits of myricetin in the management of T2DM (Song et al., 2021). Another flavonoid, kaempferol, found in the flower, has shown positive effects on the immune system. Research suggests that kaempferol protects against cold-induced intestinal oxidative damage and improves immunity. It normalizes intestinal antioxidant activity and prevents the decrease in blood CD4+T cells and CD8+T cells levels induced by cold stress. Kaempferol also exhibits anti-inflammatory effects and shows potential in suppressing pro-inflammatory cytokines while increasing anti-inflammatory cytokines and CD4+T levels (Jia et al., 2019). Additionally, kaempferol has shown promise in attenuating diabetic retinopathy (DR) by targeting immune cell responses, particularly through the phenotypic shift in microglia. It inhibits proinflammatory responses and promotes an anti-inflammatory environment, preserving retinal integrity during DR progression. This highlights microglial cells as a potential therapeutic target in managing DR (AlBalawi et al., 2023).

Phytosterols found in plants have been associated with various positive effects on the body. Campesterol, for instance, shows promise as an effective anti-inflammatory agent for the management of Rheumatoid Arthritis (RA). Its ability to modulate cytokines and regulate immune responses presents a potential therapeutic approach for treating RA and improving the well-being of affected individuals (Nazir et al., 2023). Stigmasterol, another phytosterol, exhibits a range of pharmacological effects, including anticancer, anti-inflammatory, anti-diabetic, immunomodulatory, and neuroprotective properties. It triggers signaling pathways in various types of cancers, disrupts angiogenesis, and demonstrates chemoprotective activities. Stigmasterol also exhibits anti-inflammatory properties, improves glucose tolerance, and shows antiparasitic effects against certain strains of parasites. Additionally, it displays antimicrobial activity and has the potential to inhibit Candida albicans. Its neuroprotective effects involve the regulation of reactive oxygen species (ROS) and inhibition of acetylcholinesterase. These diverse properties highlight the potential therapeutic benefits of stigmasterol (Bakrim et al., 2022). Beta-sitosterol, another phytosterol, has shown promising anticancer activity against various types of cancers, interfering with signaling pathways involved in cell cycle regulation, apoptosis, proliferation, invasion, and inflammation. It also exhibits antioxidant effects, reduces levels of oxygen free radicals, and shows potential as an anti-diabetic agent. Beta-sitosterol demonstrates antimicrobial activity, anti-inflammatory properties, and acts as an immune modulator. It has shown promise in the treatment of AIDS by maintaining stable CD4 cell counts and slowing down viral replication rates. Moreover, beta-sitosterol has reported anti-arthritic activity, comparable antipyretic effects to aspirin, and potential in the treatment of pulmonary tuberculosis (Khan et al., 2022).

Bioactive compounds found in Clitoria ternatea L. possess a wide range of properties such as antioxidant, antidiabetic, antiobesity, anticancer, anti-inflammatory, antibiotic, and hepatoprotective effects. Experimental studies have unveiled promising outcomes across various health conditions. For instance, in mice, the ethanol extract of the flower demonstrated a significant decrease in blood sugar levels, comparable to the effects of a common antidiabetic medication. Additionally, it exhibited beneficial effects on cardiovascular health and oxidative stress reduction, emphasizing its potential therapeutic significance (Ginting et al., 2022). In the context of diabetes, studies involving rats have yielded compelling results. The administration of Clitoria ternatea flower extract (CTE) led to notable reductions in fasting blood glucose levels and markers of oxidative stress, demonstrating its potential as an antidiabetic and hepatoprotective agent. Notably, these studies highlighted improvements in pancreatic and liver function, coupled with antioxidant and anti-inflammatory properties, further underscoring the potential of CTE in managing diabetes and associated complications (Dewi et al., 2023; Widowati et al., 2023). Moreover, the application of Clitoria ternatea ethanolic extract (CTEE) showed promise in addressing dental peri-implantitis, showcasing antibacterial, anti-inflammatory, and antioxidant properties. The presence of active compounds, including anthocyanins, demonstrated antimicrobial and anti-inflammatory activities, positioning CTEE as a potential therapeutic option for dental peri-implantitis (Ramadhani et al., 2023).

While there is a scarcity of human intervention studies to establish precise dosages, traditional medicine has long utilized Clitoria ternatea safely. Numerous studies have delved into the advantages of incorporating Clitoria ternatea extract, also known as butterfly pea flower extract (BPFE), into food products. For instance, one study focused on infusing BPFE into various types of milk and evaluating the resultant yogurt for antioxidant activity and color intensity. The findings revealed that the addition of BPFE enhanced the antioxidant activity of the yogurt, with skim milk yogurt with BPFE demonstrating the highest antioxidant activity (Sutakwa et al., 2021). In another study, the effects of butterfly pea flowers in the form of tea-like products on controlling blood glucose levels were investigated. The results suggested that consuming dried butterfly pea flower soaked in hot water effectively regulated blood glucose levels, indicating its potential application as a functional food for managing blood glucose levels, particularly in the form of tea-like products (Adisakwattana et al., 2020). Furthermore, in Sri Lanka, three main Clitoria ternatea flower varieties were assessed for their elemental compositions and phytochemical properties. The study revealed varying levels of total phenolic content (TPC), total flavonoid content (TFC), ferric reducing antioxidant power (FRAP), and DPPH radical scavenging activity among these varieties. These findings emphasized the potential utilization of butterfly pea flowers in the production of herbal teas, herbal juices, and culinary purposes, underlining its suitability as a functional food ingredient and natural food colorant. The plant's extracts were also found to possess a wide range of pharmacological activities, including antioxidant properties, positioning it as a promising candidate for incorporation into various food products or as a pharmaceutical supplement (Vidana *et al*., 2021).

Given its bioactive compounds, including anthocyanins, flavonoids, and phenolic acid, *Clitoria ternatea* has the potential to be developed into a functional beverage. Its ability to change color with pH changes could also add an appealing visual aspect to such beverages. The plant's wide range of health-promoting activities, such as anti-diabetic, hypolipidemic, and neuro/cognitive enhancement, makes it an attractive candidate for functional beverage development (Shirotdkar *et al*., 2023).

4. Conclusions

In conclusion, the research conducted on Clitoria ternatea extract as a potential health drink has provided valuable insights into its health potential. The plant contains bioactive compounds such as flavonoids, alkaloids, and phenolic compounds, which have been associated with antioxidant, anti-inflammatory, and antimicrobial properties. These properties make Clitoria ternatea a promising candidate for the development of a healthy beverage that can target various demographics. The comprehensive literature review and evaluation of past implementations have shed light on the positive health effects of Clitoria ternatea extract. It has shown potential in modulating the immune system, managing diabetes, reducing cardiovascular risk factors, and mitigating inflammation. These findings

highlight the versatility of Clitoria ternatea extract and its potential to contribute to overall health and well-being. However, it is important to note that the current body of evidence is limited by the lack of human intervention studies. The absence of sufficient data makes it challenging to determine the appropriate dosage for consumption, which is a crucial aspect in developing a health drink. Further research is needed to bridge this gap and determine the optimal dosage and long-term effects of Clitoria ternatea extract.

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