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# Antimicrobial Activity from Leaf, Flower, Stem, and Root of *Clitoria ternatea* – A Review

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**Abstract.** Many pathogenic bacteria, viruses, and fungi contribute to the major human illness in which it can consequently lead to mortality. Normally, the infectious diseases such as chicken pox, malaria, and tuberculosis (TB) are the most common diseases occurring in today's world. Due to that, authorities and scientists have been trying to develop effective drugs to cure these infectious diseases. Many countries have been thrived to look for alternatives to plant sources as natural remedies. Moreover, the possibility of using natural plant extracts in the development of drugs has greater potential as it is considered safe for human after prolonged treatments. Malaysia possesses rich biodiversity in flora and fauna due to its tropical climate throughout the year and houses many medicinal plants. *Clitoria ternatea* is also known as butterfly pea flower in which is native to tropical Asian countries like Malaysia and Indonesia. *C. ternatea* possesses vibrant blue flowers and has antimicrobial properties that are beneficial to human health. All parts of *C. ternatea* have a potential of antimicrobial activity against *Staphylococcus aureus*, *Bacillus cereus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Streptococcus agalactiae* and *Aeromonas hydrophila*. Therefore, this paper will review *C. ternatea* as an antimicrobial agent against selected microorganisms using its leaf, flower, stem, and root.

**Keywords:** *Clitoria ternatea*, antimicrobial activity, butterfly pea flower, extraction solvents, pharmacology

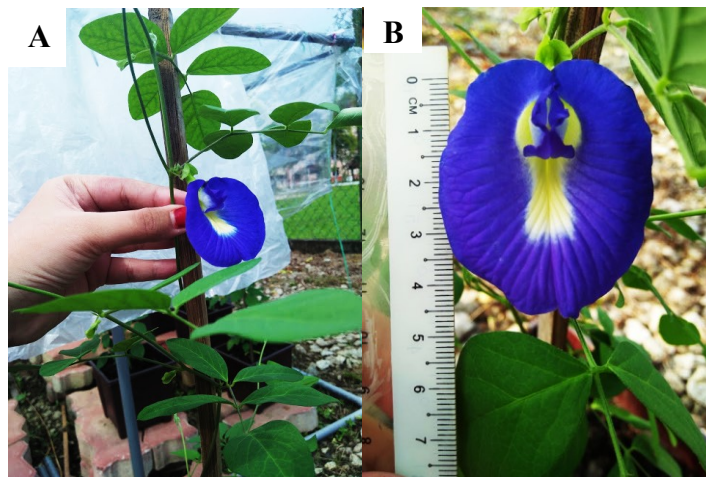
## INTRODUCTION

With the increase in world population, there is a corresponding increase in health issues due to high environmental pollution. Of great significance today are the infectious diseases caused mainly by animals and human. A person can become ill via direct or indirect contact with another infected person, or through consumption of contaminated water or food. The risk of illness becoming widespread increases due to the speed of modern transportation by air, sea, and land. Climate changes have also influenced the spreading of diseases, as it has been reported that the transmission of diseases can be deeply affected by local climate [1]. In addition, sewage overflows caused by floods due to heavy rains have helped to spread the diseases through contaminated water. Additionally, there is evidence that the transmission can also be airborne. On top of that, infectious diseases need to have a host to spread their transmission endogenous to the body system in bodily fluids or tissues. The occurrence of many new infectious diseases, for instance, Asian Lineage Avian Influenza A (H7N9), Ebola and Influenza A virus subtype H5N1, also known as H5N1, lead to serious harm to human health. An Ebola epidemic has killed thousands of the people of Africa in the year of 2014 [2]. Now is the time the researchers need to face the greatest challenges critically with concern to public health especially during infectious disease outbreaks. The American health care system was fully equipped and have the protective equipment to handle the cases of Ebola virus. However, infection was widespread due to contact with infected fluids similar to Human Immunodeficiency Virus (HIV) and was not

because of lack of protective equipment [3]. Moreover, the appearance of bacteria, viruses, parasites, fungi, and animals may trigger the spread of infection in certain conditions. Infectious diseases may affect the respiratory organs as well, due to the infection being endogenous to the system [4].

Notably, plants and animals live closely and are easily exposed to many symbiotic bacteria that attempt potent changes in their hosts. For instance, host resistance towards pathogens and parasitoids lead to the increasing defensive symbionts in their host [5]. Hence, the selection of host phenotypes may be significant to the evolution of the population of bacteria symbiont [6]. The tendency for microorganisms to have a high capacity to provoke host damage is by the aid of virulence factor expression and the ability to avoid the immune system [7]. The competence of microorganisms has been better understood in recent years as some research was done using isolated microbial species, which are able to produce antimicrobial compounds. Furthermore, there is some evidence that invertebrate organisms such as marine sponges could be potential to provide an alternative to antibiotics [8]. In the same way, plants used in traditional medicine in the past few decades play a very important role in human health [9]. In the case of antibiotics, penicillin has been discovered in the 1990s, which gave a medical science researchers high expectation of its ability. Although the antibiotic resistance in bacteria normally acts as antimicrobial agents, sometimes it may become inefficient to the susceptible bacteria [10]. In some cases, people may use antibiotics without knowing the significance of the uptake of a full dose of antibiotics. For instance, they will discontinue the course once they feel better which lead to inefficient treatment.

The development of pharmaceutical drugs derived from plants has allowed the treatment of diseases on a more effective scale. On the other hands, consuming the antimicrobial drugs may result in unfavorable side effects, for instance, kidney failure, strokes, and liver damage [11]. Research on plants as a source of treatment for incurable diseases has resulted in a huge demand for medicinal plants. It has been reported that plants have been considered as one of the most sought-after sources for the discovery of antimicrobial agent [12]. The secondary metabolites found in plants are mostly accountable for antimicrobial activity; the major phytoconstituents involved are terpenoids, phenolics, lectins, alkaloids, polyphenols, and polypeptides [13]. The use of medicinal plant could be potential as a natural antimicrobial agent. The usage of drugs has negatively affected the human body and has led to the multidrug-resistant bacteria that has become a global issue to public health [14]. With the beneficial value as an antimicrobial agent along with bioactive compounds, *Clitoria ternatea* is also seen to be a potential candidate to aid in public health (Fig. 1). Corresponding to the traditional medicine such as Ayurvedic medicine using *C. ternatea* has been used widely as a memory enhancer, antidepressant, antistress, sedative agent, anxiolytic and tranquilizing agent [15]. This traditional system is considered as an alternative method of medications in ancient times, as they are derived from non-toxic compounds. In other words, medicinal plants have been used in the preparation of herbal drugs, and it is a very strong component in the health system in India, using plants as a source of medicine [15]. Therefore, these plant extracts play such an interesting role in contributing to the outcomes of any tests. *C. ternatea* had been described as an effective natural treatment for many illnesses, as it possesses powerful antimicrobial properties against *Escherichia coli*, *Staphylococcus aureus* and *Vibrio cholera* where the leaf and root extracts were shown to possess bactericidal action [16].



**FIGURE 1.** (A): Blue flower of *Clitoria ternatea*, (B): The size of *C. ternatea* flower

# ANTIMICROBIAL PROPERTIES IN *CLITORIA TERNATEA*

## Leaves

Antimicrobial agents decrease infectious diseases in people and animals. The use of medicinal plant could be potential as a natural antimicrobial agent. The development of new tools for antibacterial agents could be useful as *Clitoria ternatea* is harmless and beneficial to human health. This legume has potential as an antibacterial agent as the crude extract was found to be more effective than the traditional antibiotics (Streptomycin) with response to combating the microorganisms [17]. The research has been done by performing the antibacterial activity of *C. ternatea* using disc diffusion method with different extraction such as methanol, petroleum ether, and ethyl acetate. Leaves of *C. ternatea* were tested against bacteria *Bacillus cereus* ( $1.2 \pm 0.8$  cm), *Proteus vulgaris* ( $0.1 \pm 0.0$  cm), *Salmonella typhi* ( $0.1 \pm 0.0$  cm), *Staphylococcus aureus* ( $0.2 \pm 0.1$  cm) and *Klebsiella pneumoniae* ( $0.8 \pm 0.2$  cm) using methanol extraction. *C. ternatea* leaves were shown to possess more potent inhibitory activity in the disc diffusion method when using methanol extracts [17]. Suffice to say that the potential for antimicrobial activity was clearly in methanol extracts. Subsequently, other substances have been synthesized from plants which can be used as antibiotics and which can be used for antimicrobial chemotherapy.

Other sources reported that the leaves of *C. ternatea* contained antimicrobial agents. One research investigated the phytochemical properties of *C. ternatea* and its active chemical ingredients [18]. In order to understand therapeutic dynamics of medicinal plants, the investigation of phytochemical along with biological screening is vital to perform. Therefore, *C. ternatea* has been demonstrated to have major phytoconstituents in total phenols ( $245.14 \pm 6.97$  mg TAE  $\cdot$  g<sup>-1</sup>) that relatively higher compared to tannins ( $78.75 \pm 2.09$  mg TAE  $\cdot$  g<sup>-1</sup>) and followed by flavonoids ( $0.48 \pm 0.96$  mg RE  $\cdot$  g<sup>-1</sup>). *C. ternatea* is presented as a source of therapeutic agent, whereas it functions as biological response modifiers in human and act as protectors against environmental stress in plants. Another research has been done using the ethanolic leaf extract of *C. ternatea* regarding antifungal activities as it can be used to shelter *Pisum sativum* seed from the combat of *Fusarium oxysporium* [19]. This shows that *C. ternatea* has the ability to function as an antifungal agent in the medicinal sector. Besides that, ethanol extract for leaf extract of *C. ternatea* has the possibility of curing candidiasis and cryptococcosis [20]. In Southern India, antiviral activity has been studied out by sorting out all of the medicinal plants that were rich sources of antiviral activities including *C. ternatea* [21]. This tropical Asian flower contained an impressive antiviral activity, as it has been tested with anti-coronavirus (MCV) extracts by using virucidal protocol.

## Flowers

Additionally, a research was done to investigate antimicrobial activity under minimum inhibitory concentration on *C. ternatea* flower (Fig. 1) using disc diffusion [22]. Extractions of aqueous, methanol, petroleum ether, hexane and chloroform were used against *Escherichia coli*, *K. pneumoniae*, and *Pseudomonas aeruginosa* and a positive control Amikacin was used. The study indicated that the inhibitory zone of methanol extract was between 16 mm to 26 mm, and in chloroform extract between 14 mm to 18 mm. In the aqueous extract, a zone of inhibition with a diameter of 12 mm was obtained while petroleum ether and hexane extract did not exhibit any antimicrobial properties. The results show that the methanol extracts possess high antimicrobial activity as compared to chloroform and hexane extracts.

In addition, research has been done by evaluating three medicinal plants from different parts. For instance, fruits of *Terminalia chebula*, blue flowers of *C. ternatea* and leaves of *Wedelia chinensis* were evaluated for antimicrobial activity using aqueous extract concentrations (5 %, 10 %, 25 %, and 50 %) [23]. Antimicrobial activity has been tested on pathogenic microorganisms in the oral cavity (*Streptococcus mutans*, *Lactobacillus casei*, and *S. aureus*) using agar well diffusion method. The diameter of the zone of inhibition was then measured. The results showed that *C. ternatea* had greater antimicrobial efficiency against *S. aureus* at 50 % concentration, which was indicated by an inhibition zone with a diameter of 10 mm [23].

## Stem and Root

There was also evidence to show that all parts of *C. ternatea* had a possibility in pharmaceutical implementations in which all parts of the white-flowered of *C. ternatea* (leaf, root, and stem) have been extracted [24]. Furthermore, the antibacterial activity of silver nanoparticles using *C. ternatea* was evaluated through disc diffusion against

*S. aureus*, *Bacillus subtilis*, *K. pneumoniae*, and *E. coli*. *E. coli* and *Klebsiella* sp. may cause food poisoning and diarrhea. Using plants for biomedical applications are considered safe compared to conventional methods. The successful outcome of synthesizing silver nanoparticles from leaf, root, and stem extracts of *C. ternatea* can lead to new medical applications [24]. In addition, using plants in the synthesis of nanoparticles do not require any high temperatures and can easily be scaled up as it is cost-effective, and extraction of water produced very low antibacterial properties, whereas the silver nitrate recorded in highest antibacterial activity. In addition, the presence of terpenoid provides antifungal, antiviral and antibacterial activities. Nevertheless, the antibacterial activity of *C. ternatea* was potent due to the presence of flavonoid in the plant.

Meanwhile, another study has been done to investigate the antimicrobial activities of methanol extracts using leaf, stems, seed and roots of *C. ternatea* against 12 bacterial species, two yeast species and three filamentous fungi [25]. The tested microorganisms consist of *B. cereus*, *B. subtilis*, *Bacillus thuringiensis*, *S. aureus*, *Streptococcus faecalis*, *E. coli*, *K. pneumoniae*, *P. aeruginosa*, *S. typhi*, *Enterobacter aerogenes*, *Proteus mirabilis*, *Herbaspirillum* spp., *Candida albicans*, *Saccharomyces cerevisiae*, *Rhizopus* spp., *Penicillium* spp., and *Aspergillus niger*. The antimicrobial activities using disc diffusion assay of leaf and root extracts *C. ternatea* showed the most effective against all of the tested organisms with a zone of inhibition 10 mm to 25 mm. Thus, the minimum inhibitory concentration (MIC), minimum bactericidal concentration (MBC), and minimum fungicidal concentration (MFC) of all parts of *C. ternatea* extracts were ranged from  $0.3 \text{ kg} \cdot \text{m}^{-3}$  to  $100 \text{ kg} \cdot \text{m}^{-3}$ . As the data shown, *C. ternatea* may serve as a discovery of natural plant-based medicine.

Generally, all the extracts from leaf, stem, flower, and root of *C. ternatea* possesses the antimicrobial activity which effective to cure the microbial diseases. For instance, an aqueous and hexane extracts in the whole plant *C. ternatea* (leaf, stem, flower, and root) showed significant antimicrobial action against the tested pathogen, however, in methanol extracts revealed maximum inhibition on *Shigella dysenteriae* ( $14 \pm 0.9 \text{ mm}$ ) [26]. The disc diffusion method determines the size of the area of chemical infiltration around the disc. Therefore, *C. ternatea* has strong antimicrobial properties and is influenced by the type of extraction used.

## CONCLUSION

Undoubtedly, natural medicine could be demanding as it is harmless and has low-cost production. The traditional medicine and medicinal plant could be considered as an alternative medicine to using drugs or chemicals to treat illnesses during ancient times. Research on phytomedicine should be recognized and established due to today's health issues. *Clitoria ternatea* will be a new antimicrobial agent by enhancing the existing of antibiotics with the extracts of *C. ternatea* as the new development for antimicrobial action. In the medical sector, it is hoped that further studies will be carried out in order to develop and use the beneficial compounds in *C. ternatea* to formulate new and powerful antimicrobial drugs of natural sources since the whole parts of plant *C. ternatea* show potential as an antimicrobial agent. Additionally, people can be educated on the benefits of *C. ternatea* as an antibacterial agent in the body system and which could be eaten raw.

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