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MINI REVIEW

A potential of Telang tree (*Clitoria ternatea*) in human health

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Abstract

Clitoria ternatea (CT) or commonly known as telang tree originates from the Fabaceae family. The flower of this tree has vivid, deep-blue and white colouration and it is usually used as a natural colourant in food preparation especially in the local culinary scene such as for the preparation of nasi kerabu and kuih tekan. Moreover, this plant could act as a food source for the livestock due to the taste and nutritious value it has. Besides that, parts of the plant such as its leaves, flowers, and roots are believed to possess sought-after medicinal values such as analgesic, antipyretic and anti-inflammatory properties. The plant also possesses a number of advantages such as antioxidant, antidiabetic, antimicrobial, antihelminthic, hepaprotective and antiasthmatic properties that are beneficial and useful in reducing health disorders. For the purpose of this study, the chemical composition such as proximate analysis of flowers, leaves and also active compound were also included in the review.

1. Introduction

Plants have long been used to treat diseases because they contain many natural ingredients, such as phenolic compounds. *Clitoria ternatea* (CT), commonly known as telang (Malaysia), butterfly pea, kordofan pea (Sudan), cunha (Brazil) or pokindang (Philippines) is from the Fabaceae family. The plant is 90.00 to 162.00 cm tall. It is a long-lived perennial herb with an erect habit (Kalamani and Michael Gomez, 2001). Besides that, according to Gomez and Kalamani (2003), CT has solitary flowers with vivid, deep-blue and white colouration. The flowers are also 6.00 to 12.00 cm long. Furthermore, it also contains 6 to 8 brown or black-coloured seeds per pod which are slightly pubescent or glabrous. Moreover, the butterfly pea is self-pollinated by nature, but it also exists because of cross-pollination due to the identification of genotype segregation (Cook *et al*., 2005).

The flowers of CT, or the telang flower, widely used as a natural colourant ranging from drink (Duhard *et al*., 1997) to food (Patras *et al*., 2010) industries and it is sensitive to temperature and pH changes. Besides that, it was used to color the nasi kerabu blue which is a famous dish in Kelantan. Usually, nasi kerabu (blue-coloured rice) is eaten with grilled chicken or fried fish coated with flour, fish crackers, salted egg and other local herbs. Many reports have been published on the medicinal effects of CTs such as antipyretic, analgesic and anti-inflammatory (Mukherjee *et al*., 2008). These properties are good for one's health and well-being because they help to reduce health disorders. In addition, this flower is also used as a source of food for livestock. It is highly preferred by livestock because of its mild and acceptable taste over other types of legumes (Gomez and Kalamani, 2003). Therefore, the present review is aimed to compile a comprehensive review of CT plant that covers its botanical characteristics, phytochemistry and pharmacology activities particularly derived from flowers, roots and leaves extracts.

2. Proximate and mineral analysis of Telang

A proximate and mineral analysis of CT flowers has been reported by Neda *et al*. (2013). The analysis conducted on the flowers provides a strong basis for emphasizing the nutritional value of CT (Table 1 and Table 2).

Calcium is a very important form of mineral for the body because it is necessary for the formation of strong and healthy bones and teeth, blood clotting and skeletal development (Forbes, 2012). Heavy metal content such as the content of cadmium and arsenic in telang flower was below 0.0001 mg/100 g and did not exceed the limit set by (Codex, 1995). The limit has been set at 4.00 mg/100 g and 0.05 mg/100 g, respectively. Moreover,

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lead and nickel found in the flower was within the acceptable range with less than 0.2 mg/kg (National standard of China on Maximum Levels of Contaminants in Foods, 2005) and 150µg/day/men (Food Standards Australia New Zealand 2003), respectively.

Besides that, proximate and mineral analyses of telang leaves have been reported by Deshmukh and Jadhav (2014). This report aimed to examine nutritional composition and mineral of leaves. Fresh telang leaves contained the highest amount of moisture with 74.51%. Moreover, protein constituents have been ranked second after moisture with 14.99% value. Much higher protein content in the leaves of CT could be useful to work against retardation, muscle wasting, oedema and abnormal swelling of the belly (kwashiorkor). Other significant components such as ash, crude fiber, and fat contain at 8.73±0.22%, 8.45±0.05% and 5.50±0.10%, respectively. The least significant component of the telang leaves is the carbohydrate, which measured at only 0.08±0.00%.

Table 1. Proximate analysis of Telang flower

Consitituent	Percentage (%)
Moisture	92.40
Ash	0.45
Fat	2.50
Protein	0.32
Crude fiber	2.10
Carbohydrate	2.23

Table 2. Mineral analysis of Telang flower

Mineral	Value (mg/g)
Calcium	3.10
Magnesium	2.23
Potassium	1.25

3. Chemical analysis

The major constituents found in CT are flavonoids, anthocyanins, alkaloids, ternatins, saponins, tannins, taraxerol, and taraxerone. According to Kazuma *et al.* (2003), to be specific 14 types of flavonol glycosides have been identified in the CT plants by using spectroscopy. The compounds are quercetin 3-(2^G-rhamnosylrutinoside), kaempferol 3-(2^G-rhamnosylrutinoside), kaempferol 3-neohesperidoside, quercetin 3-neohesperidoside, myricetin 3-neohesperidoside, kaempferol 3-rutinoside, quercetin 3-rutinoside, myricetin 3-rutinoside, kaempferol 3-glucoside, quercetin 3-glucoside, myricetin 3-glucoside, kaempferol 3-O-(2″-O- α-rhamnosyl-6″-O-malonyl)- β-glucoside, quercetin 3-O-(2″-O- α-rhamnosyl-6″-O-malonyl)- β-glucoside and myricetin 3-O-(2″-O- α-rhamnosyl-6″-O-malonyl)- β-glucoside. Moreover, kaempferol 3-glucoside, quercetin 3-glucoside and myricetin 3-glucoside compounds were also identified (Slimestad *et al*., 1995).

4. Biological effects

4.1 Antioxidant activity

The antioxidant activity of the aqueous extractions of CT flowers showed a much higher scavenging activity compared to methanol-based extracts (Rabeta and An Nabil, 2013). Besides that, when the concentrations of extracts were increased, the percentage of the extracts to scavenge off free radicals also increased (Ramaswamy *et al*., 2011). This finding was supported by Rabeta and An Nabil (2013), where the concentration samples of both water and methanol were 25.00 µg/mL, 50.00 µg/mL, 100.00 µg/mL and 125.00 µg/mL while the scavenging activity was 32.67±1.16%, 353.33±3.06%, 411.33±1.16% and 422.67±3.06%, respectively in methanol.

On the other hand, the water content was 390.67±2.31%, 401.33±3.06%, 449.33±2.31% and 490.67±4.62%, respectively. In this activity, anthocyanin acts as antioxidant agents that protect the plant's cells from damage caused by high light, through the absorption of blue-green ultraviolet rays which will produce reactive oxygen species, also known as ROS (Mazza and Miniati, 1993).

4.2 Antidiabetic activity

A few studies have been carried out to examine and investigate the potentials of CT flowers that can be used as natural substances to reduce blood glucose level. A report by Gunjan *et al*. (2010) stated that the glucose level tested in diabetic rats significantly decreased after 14 days of administering with CT flower extract with 150 mg/kg body weight.

Moreover, administrations of telang flower and leaf extracts on these rats after being injected with alloxan resulted in a significantly decreased level of serum glucose, total cholesterol, triglycerides, urea, blood glucose, glycosylated haemoglobin, and creatine while serum insulin, HDL-cholesterol, protein, skeletal muscle and glycogen content level were increased (Daisy *et al*., 2009). In addition, the rat treated with CT flower extracts showed a positive antidiabetic activity against hyperglycaemic and hyperlipidaemic which can prevent it from liver and renal damage.

4.3 Antimicrobial activity

This plant is a natural product that may provide a new source of antimicrobial agents which has an

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enormous therapeutic potential to heal a significant number of infectious diseases. Examples of microorganisms that have gained resistance to antimicrobials include *Staphylococcus aureus*, *Candida albicans*, *Shigella dysenteriae*, *Streptococcus faecalis*, *Salmonella enterica* serovar Typhi, *S. enterica* serovar Enteritidis and *Escherichia coli* (Barbour *et al*., 2004).

A previous study conducted by Anand *et al*. (2011) reported that the methanolic and petroleum ether extracts of the CT leaves are the greatest protection against *Bacillus cereus* and *S. enterica* serovar Typhi, respectively, each with a larger inhibition zone. Besides that, an earlier study carried out by Shekhawat and Vijayvergia, (2010) highlighted that methanolic extraction of *Clitoria ternatea* showed the maximum zone of inhibition against bacterial species such as *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa* and *S. enterica* serovar Typhi with zone of inhibition at 10, 12, 16 and 13 mm, respectively.

Moreover, the antifungal activity of *Clitoria ternatea* methanol extract also showed that maximum zone of inhibition against the fungal species such as *Aspergillus niger*, *Penicillium chrysogenum*, *Aspergillus flavous* and *Fusarium oxiporum* with inhibition zone at 10, 7, 12 and 11 mm, respectively.

4.4 Antihelmintic activity

Several studies investigating the anti-helmintic activity of CT against Indian earthworms, known as *Pheretima posthuma* in root extracts (Khadatkar *et al*., 2008) and leaf extracts (Salhan *et al*., 2011; Sarojini *et al*., 2012) were carried out. Different types of solvent were used in these experiments such as petroleum ether, ethyl acetate, methanol, ethanol and other aqueous extracts with various concentrations measured at 10.00 mg/mL, 25.00 mg/mL, 50.00 mg/mL and 100.00 mg/mL. The results obtained from these studies showed that alcoholic extracts from the roots resulted in having the shortest time for the earthworm to be paralyzed at 4.27 min and dead at 10.58 min using a 50.00 mg/mL concentration. Moreover, root extracts of methanol, ethyl acetate and petroleum ether showed time for the earthworms to be paralyzed was at 5.63 min, 6.28 min and 16.28 min while the time took for death to occur was at 11.92 min, 21.59 min and 45.92 min, respectively (Khadatkar *et al*., 2008).

A positive correlation was found between the concentration of extracts and time taken for the earthworms to be paralyzed and dead. When increasing the concentration of the extracts from 10.00-100.00 mg/mL, the time taken for the earthworms to be paralyzed and dead were decreased (Khadatkar *et al*., 2008; Salhan *et al*., 2011; Sarojini *et al*., 2012). Besides that, the anti-helminthic property is generally understood to mean killing the earthworms either by starving or paralyzing them due to no storage of energy to fulfill their metabolic needs. A possible explanation for this can be attributed to phenolics which contain tannins that bind and free protein in gastrointestinal tract of host animals (Athnasiadou *et al*., 2001) or glycoproteins on the cuticle of the parasites (Thompson and Geary, 1995) which cause damage to the mucopolysaccharides layer and lead to death (Chandrashekhar *et al*. 2008).

4.5 Hepatoprotective activity

Recently, in vitro studies have shown that CT extracts can act as a strong hepatoprotective agent against paracetamol (Nithianantham *et al*., 2011) and carbon tetrachloride, CCl_4 (Shanmugasundaram *et al*., 2010) found in induced rat. According to Nithianantham *et al*. (2011), rats treated with CT leaf extracts showed positive results in protecting themselves against damage caused by paracetamol. Interestingly, the treated group with CT extracts was observed to possess a reduced level of enzymes such as aspartate aminotransferase (AST), alanine aminotransferase (ALT) and bilirubin compared to a raised level in AST, ALT, and bilirubin in paracetamol-treated group.

Moreover, this finding supports the findings of Shanmugasundaram *et al*. (2010) which highlighted that ethanol extracts of CT leaf (EECT) showed a significant hepatoprotection against carbon tetrachloride, CCl_4 in induced rats. A group of rats treated with CT extracts experienced a significant reduction in total bilirubin, conjugated bilirubin and unconjugated bilirubin at 1.66±0.05 mg/L 0.35±0.02 mg/L and 1.76±0.05 mg/L, respectively. This result may be explained by the fact that the presence of phenolic and flavonoid compounds in CT leaf extracts has improved the regeneration ability of the liver (Shanmugasundaram *et al*., 2010; Nithianantham *et al*., 2011; Nithianantham *et al*., 2013).

4.6 Antiasthmatics activity

Several studies investigating anti-asthmatic activity were carried out on CT root extracts (Taur and Patil, 2011; Chauhan *et al*., 2012). In her study, Taur and Patil (2011) found that, when mice administered with a higher concentration of root extracts through injection, the total of leucocytes and eosinophilia counts decreased after 24 hours. Further analysis showed that rats which were pretreated with root extracts showed a positive result in an inhibited area of blue dye leakage with 66.51% to 71.70% of inhibition. This is largely due to anti-histamine and anti-inflammatory mechanisms found in the root extracts.

Moreover, Chauhan *et al*. (2012) also found that rats treated with CT root extracts have shown a positive result in delaying the time for the appearance of pre-convulsive dysponea after exposing them to histamine aerosol. The time for pre-convulsive dysponea kept increasing after these rats were treated with root extracts at the first and fourth hours with 44.20±1.07 s and 56.40±2.00 s, respectively. A possible explanation for these results is due to the presence of flavonoid and saponin found in the root extracts of this CT plant.

4.7 Neuropharmacological activity

A considerable amount of literature has been published on improving cognitive behavior from CT root extract (Rai *et al*., 2001; Rai *et al*., 2002). In an investigation of improving learning and memory, Rai *et al*. (2001) found that administered with 100 mg/kg of aqueous root extract have significantly increased acetylcholine (Ach) content in hippocampus of neonatal rats from 52.79±12.36 to 68.83±9.87 nmol/g tissue while for young adult's rats were from 33.9±6.92 to 52.79±12.36 nmol/g tissue. Besides that, intubated of neonatal rat pups with 50 and 100 mg/kg of aqueous root extract for 30 days also showed improvement retention of passive avoidance and spatial learning tests which increased the percentage of the correct response (Rai *et al*., 2001).

CT root extract was believed to have permanent changes in the brain which is strongly related to the improvement of learning abilities (Rai *et al*., 2002). This extract also induced the increasing of dendritic arborization in the brain structure namely hippocampal neurons and amygdala which leads increasing of protein synthesis such as acetylcholinesterase (Rai *et al*., 2001). In addition, the aqueous root extract was also boost the synthesis of neurotransmitter such as acetylcholine which is a good memory enhancer and learning abilities similar to synthetic drugs such as Nefiracetam (Van der Schyf *et al*., 2006), dehydroepiandrosterone sulfate (Moore *et al*. 1995) and FG7142 (Rhodes *et al*., 1996).

5. Conclusion

Clitoria ternatea or telang tree is found to possess a significant number of advantages and natural properties against several diseases and ailments in the human body. Based on this review, it is hoped that the telang tree can be cultivated as one of the leading crops in the world that will be accepted by medical practitioners due to its natural properties and effectiveness in combating several well-known diseases and ailments.

Conflict of Interest

We declare that we have no conflict of interest.

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