Review on Ethnomedicinal uses of Memory Boosting Herb, Butterfly Pea, *Clitoria ternatea*

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Abstract

*Clitoria ternatea* (Family: Fabaceae) is one of the traditional medicinal plants used as “Shanka Pushpi” an Ayurvedic medicine used to boost or enhance neurological health. The plant contains alkaloid, flavonoid, taraxerol, taraxerone, triterpenoid and anthocyanin as active chemicals that bring about its biological effects. Its extracts possess a wide range of pharmacological activities including antibacterial, anti-diabetic, anti-diarrheal, anti-fungal, anti-helmintic, anti-inflammatory, antimicrobial, antioxidant, and antipyretic activities, hypolipidemia, immunomodulatory, and wound healing. This review is an attempt to compile information on various ethnomedicinal uses of memory boosting herb, butterfly pea, *Clitoria ternatea*. **Conclusion:** It has a wide spectrum of neuropharmacological benefits such as nootropic, anti-depressant, anti-stress, anxiolytic, and anticonvulsant activities.

Keywords: Butterfly Pea, *Clitoria ternatea*, Herb, Memory, Neuropharmacology, Plant

1. Introduction

Alzheimer’s disease is a multifactorial neurodegenerative disorder affecting multiple clinical domains involving cognitive functioning, behavioral aspects, and functional-physical skills, the causes and the progression are still not well-understood. National estimates, one-third or 32% of people age 85 and older in the United States has Alzheimer’s disease. Charern boon and Phanasathit evaluated the 62 patients who were diagnosed as having Alzheimer’s disease, according to the National Institute of Neurological and Communicative Disorders and Stroke and Alzheimer’s Disease and Related Disorders Association (NINCDS-ADRDA) criteria and received global Clinical Dementia Rating scale score of at least stage one. They used the Neuropsychiatric Inventory Questionnaire and the Thai Mental State Examination, the most common symptoms were apathetic, aberrant motor behavior, sleep and eating problems, agitation, aggression, euphoria and memory complaints. The pathological features that have been identified in the central nervous system in Alzheimer’s disease are senile plaques and neurofibrillary tangles, oxidative and inflammatory processes, neurotransmitter disturbances, and cholinergic deficit. Thus, attempts to restore these features have been a rational target for drugs used to treat the symptoms of Alzheimer’s disease. Approaches to enhance cholinergic function have included stimulation of cholinergic receptors or prolonging the availability of acetylcholine released into the neuronal synaptic cleft by inhibiting the acetylcholine hydrolysis by acetylcholinesterase. Currently available treatment i.e., acetylcholinesterase inhibitors (rivastigmine, galantamine, and donepezil) and N-methyl-D-aspartate.

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receptor antagonist (memantine) contribute minimal impact on the disease and target late aspects of the disease. These drugs decelerate the progression of the disease, provide symptomatic relief, but fail to achieve a definite cure. Traditional practices of medicine, plants have been used to enhance cognitive function and to alleviate other symptoms associated with Alzheimer’s disease.

2. Nomenclature

There are around 60 global species belonging to genus Clitoria, which originated from the tropical equatorial Asia, and later was distributed widely in South and Central America, East and West Indies, Africa, Australia. The vernacular name of Clitoria ternatea is also known as butterfly pea, blue pea, (English), aparajita (Bengali), cunha (Brazilian), lan hu die, lan hua dou (Chinese), aparajit (Hindi), kajroti (India), bunga biru, tembang telang (Indonesian), bunga biru, kacang telang (Khmer), ang san dam, bang san dam (Lao), bunga telang (Malaysian), cunhã, fula criqua (Portuguese), aparajita (Sanskrit), clitoria azul, azulejo, conchitis, bejuco de conchitas (Spanish), kakkattan, sangupushpam (Tamil), nalla ghentana (Telugu), un-chan, uang-chan, dang-chan (Thai), mavi kelebek sarmaşıği (Turkish), and chi đầu biếc (Vietnamese).

3. Morphological Characters

Clitoria ternatea (Figure 1.) is an ornamental perennial climber, twining fine stems, up to 2-3 m in height,
growing wild and also in gardens, bearing conspicuous blue or white flowers resembling a conch-shell. The root system consists of a fairly stout taproot with few branches and many slender lateral roots. The thick horizontal root, which may grow to more than 2 m long, bears one to several purplish, glaucous, wiry stems. The leaves are pinnate, petioles 2-2.5 cm long; stipules 4 mm long, linear, acute. Leaflets 5-7, sub coriaceous, 2.5-5 by 2-3.2 cm, elliptic-oblong, obtuse or caule; stipules filiform. The flowers are solitary, deep blue to blue, mauve or sometimes white, with an orange center, very short pedicellate and 4-5 cm long. The pods are flat, linear, beaked, 6-12 cm long, 0.7-1.2 mm wide and slightly pubescent with up to 10 seeds. The seeds are yellowish-brown or blackish in color and sub-globe or oval in shape, 4.5-7.0 mm long and 3-4 mm wide.10,12

4. Phytochemical Substances

The analysis of *C. ternatea* leaves were reported the amount of ash (8.7 %), moisture (74.5 %), crude fiber (8.5 %), protein (14.9 %), and carbohydrate (0.1 %). Among the various macronutrients estimated in the leaf, nitrogen (2.4 g) was present in the highest quantity, followed by potassium (1.6 g), calcium (0.8 g), phosphorus (0.7 g), magnesium (0.6 g) sodium (0.3 g), iron (6.3 mg), zinc (4.4 mg), manganese (3.2 mg) and copper (2.2 mg) per 100 g.13 Moreover, *C. ternatea* root was reported the highest amount of carbohydrate (64.1 %), followed by protein (14.4 %), ash (9.5 %), and crude fiber (0.7 %). Magnesium (3.4 µg/ml) was present in the highest mineral, followed by zinc (2.1 µg/ml), manganese (0.5 µg/ml), iron (0.3 µg/ml) and copper (0.2 µg/ml).14

The major phytoconstituents found in *C. ternatea* are the pentacyclic triterpenoids such as taraxerol and taraxerone,15 ternatins,16,17 alkaloids, flavonoids, saponins, tannins,18 and anthocyanins19,20. In more detail, in16 reported three flavonol glycosides from the petals of *C. ternatea*, their structures were identified using spectroscopy shown as kaempferol 3-O-(2”-O-alpha-rhamnosyl-6”-O-malonyl)-beta-glucoside, quercetin 3-O-(2”-O-alpha-rhamnosyl-6”-O-malonyl)-beta-glucoside, and myricetin 3-O-(2”, 6”-di-O-alpha-rhamnosyl)-beta-glucoside. Author in17 also identified ternatins structures comprising 15 delphinidin 3-O-(6”-O-malonyl)-beta-glucoside derivatives substituted at both the 3’-and 5’-OH groups with glucose or acylated glucose chains of various length, and which are responsible for blue anthocyanin petal color in *C. ternatea*. In addition, the color of the anthocyanins is widely used as a natural food coloring, can range from deep blue to magenta depending on the pH of a surrounding.19

Author in21 evaluated the activities of phytoconstituents such as Varidifloreone: 1a,2,3,5,6,7a,7b-octahydro-1,1,4,7-tetramethyl-,[1aR- (1aâ,7a,7â,7bâ)]-[C15H22] has anti-tumor, antibacterial and anti-inflammatory activities. Homoptercarpin: 6H-benzofuro[3,2-c][1]benzopyran,6a,11a-dihydro-3,9-dimethoxy-,[6aR-cis]-[C17H16O4], and Procarpin 1H-cycloprop[e]azulene [C37H24O3] have antimicrobial activities. Isoparvifuran [C16H4O3], Hexadecanoic acid [C16H36O2], Myo-Inositol, 4-C-methyl- [C7H14O6], 1,2,3,5-Cyclohexanetetrol, (1a,2a,3a,5a)- [C6H12O4], and Propane, 1,1-diethoxy-[C7H16O2] have antioxidant, anti-diabetic, anti-tumor and sedative activities. They were identified from ethanol extract of *C. ternatea* by using a gas chromatograph-mass spectrograph.21 Moreover,22 identified the major chemical constituents in the methanol extract of flowers were inositol (33.6 %), cyclohexen, 1-methyl-4-(1-methylethylidene) (7.1 %), acetic acid, cyano- (6.5 %) and hirsutene (5.7 %).

5. Traditional Uses

*C. ternatea* is traditionally used for anti-bacterial,23,24 anti-fungal,24 anti-helminthic,25-27, anti-diarrheal,28 antioxidant,29-31 anti-hyperlipidemic,32,33 anti-pyretic,34 and anti-diabetic activities,35-36, immunomodulatory,32 wound healing property,37 hepatic,38 renal,21 and urogenital diseases.38

6. Neuropharmacological Effects

*C. ternatea* is reported to be a good “Mehvya” (toning the brain) drug mainly used in the treatment of “Masakida roga” (mental illness). Author in29 reported intraperitoneal administration of alcoholic extract of stem, flower, leaf and fruit of *C. ternatea* to rats and mice, has been reported to produce sedation and diminished alertness. Taranalli and Cheeramkuzy20 reported oral treatment with alcoholic extract of aerial...
and root parts of *C. ternatea* at 300 and 500 mg/kg in rats in attenuating electroshock-induced amnesia, has been reported to improve memory retention, increase acetylcholine content and acetylcholinesterase activity in the different regions of the brain, viz., cerebral cortex, midbrain, medulla oblongata and cerebellum. Author in\(^4\) studied the 50 and 100 mg/kg of *C. ternatea* aqueous root extract for 30 days in neonatal rat (7 days old) via behavioral tests as follows open field behavior test, passive avoidance test, and spatial learning test. The extract was significantly improved retention and spatial learning performance, indicating the memory enhancing. Author in\(^5\) also reported the 100 mg/kg of *C. ternatea* aqueous root extract for 30 days in neonatal and young adult age groups of rat, significantly increased acetylcholine content in their hippocampus. It may be the neurochemical basis for their improved learning and memory. Author in\(^6\) investigated the spectrum of activity of the methanolic extract of the aerial parts of *C. ternatea* on the central nervous system. They studied the effects on the cognitive behavior, anxiety, stress and convulsions induced by pentylenetetrazol and maximum electroshock in mice and rats. They also studied the effects on behavior mediated via dopamine (haloperidol-induced catalepsy), noradrenaline (clonidine-induced hypothermia), serotonin (lithium-induced head twitches) and acetylcholine (sodium nitrite-induced respiratory arrest). The results showed that the *C. ternatea* extract decreased time required to occupy the central platform or transfer latency in the elevated plus maze and increased discrimination index in the object recognition test, indicating nootropic activity. The extract increased occupancy in the open arm of elevated plus maze by 160% and in the lit box of the light/dark exploration test by 157%, indicating its anxiolytic activity. It decreased the duration of immobility in the tail suspension test, indicating its antidepressant activity. It reduced stress-induced ulcers, indicating its anti-stress activity. It reduced the convulsing action of pentylentetrazol and maximum electroshock-induced seizures, indicating its anticonvulsant activity. Author in\(^7\) reported the ethanolic extract of *C. ternatea* (100, 200 and 400 mg/kg) after 60 minutes oral administration, reduced the marble burying behavior and loco motor activity in mice, indicated that this plant can modulate obsessive compulsive disorder, which is a disabling psychiatric condition. Author in\(^8\) studied the anti-analgesic activity of methanolic extract of *C. ternatea* leaves (200 and 400 mg/kg) using acetic acid induced writhing test, and studied the anti-depressant activity by using hole cross and open field tests. The results showed this plant inhibited 82.67 and 87.87 % of writhing test and also decreased motor activity and exploratory behavior of mice in the hole cross and open field test in dose dependence.

Author in\(^9\) evaluated the potential use of standard Ayurvedic formulation name “Vayasthapana Rasayana” as an anti-oxidant to fight age-related problems. This formulation consists of equal parts of *Asparagus racemosus, Boerhaavia diffusa, C. ternatea, Centella asiatica, Phyllanthus emblica, Terminalia chebula* and *Tinospora cordifolia*. The other polyherbal formulation name “Rheumatone” using five medicinal plants *C. ternatea, Sida cordifolia, Cleodendron serratum, Bacopa monnieri* and *Cardiospermum halicacabum* has the enzymatic antioxidant activity. There was a reduction in the levels of super oxide dismutase, catalase, peroxidase and glutathione peroxidase in the liver and kidney of arthritic rats\(^9\). The commercial product, Perment, a polyherbal Ayurvedic formulation that contains equal parts of *C. ternatea, Withania somnifera, A. racemosus*, and *B. monniera*, is used clinically as mood elevators\(^7\). The 75 and 150 mg/kg of Perment predominantly exhibited antidepressant action than anxiolytic activity. Further Perment increased the plasma noradrenaline and serotonin levels in stressed rats but decreased adrenal corticosterone level\(^7\).

In conclusion, it was suggested that an increase in acetylcholine in the hippocampus may be the neurochemicals basis for improved learning and memory. The other mechanism is a neurogenic growth promoter that will increase in survival, growth and development of the newborn neurons, critical for the repair and restoration of the normal neural circuitry in various diseases. The present article reviews that *C. ternatea* may also be the memory booster or enhancer in any disorders related to loss of learning ability and disorders of memory as in Alzheimer’s disease.

### 7. Conflict of Interests

The authors do not have any conflict of interest to declare.
8. References


