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Role of Clitoria ternatea Phytochemicals in Neuroprotection and Their Therapeutic Potential in Alzheimer's Disease: A Comprehensive Review

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ABSTRACT

Alzheimer's disease (AD) is a progressive neurodegenerative disorder characterized by cognitive decline, synaptic dysfunction, oxidative stress, and neuroinflammation. Despite advances in symptomatic treatments, there remains a crucial need for safe and effective disease-modifying therapies. *Clitoria ternatea* (butterfly pea) is a medicinal plant rich in bioactive phytochemicals, including flavonoids, anthocyanins, and terpenoids, with demonstrated antioxidant, anti-inflammatory, and neuroprotective properties. This comprehensive review synthesizes current evidence on the neuroprotective potential of *Clitoria ternatea* phytochemicals and explores their therapeutic implications for AD. Preclinical studies indicate that key constituents such as delphinidin and other polyphenols can attenuate oxidative stress, inhibit inflammatory pathways, modulate cholinergic activity, and reduce amyloid-beta aggregation—hallmarks of AD pathophysiology. Additionally, neurobehavioral improvements have been observed in animal models following treatment with *C. ternatea* extracts, suggesting enhancement of memory and cognitive function. Mechanistically, the multifaceted bioactivity of these phytochemicals involves modulation of cellular antioxidant defenses, suppression of neuroinflammatory mediators, and regulation of signaling pathways associated with neuronal survival. While these findings substantiate the therapeutic promise of *Clitoria ternatea* in neuroprotection, clinical evidence remains limited. Future research should emphasize well-designed clinical trials, standardized extract formulations, and mechanistic studies to validate translational relevance. In conclusion, *Clitoria ternatea* phytochemicals represent a promising natural candidate for AD management, meriting further investigation for integration into neurotherapeutic strategies.

Introduction

Alzheimer's disease (AD) is the most prevalent neurodegenerative disorder and the leading cause of dementia worldwide, posing an escalating public health challenge due to aging populations. It is clinically characterized by progressive cognitive impairment, memory loss, and behavioral disturbances, while neuropathological hallmarks include extracellular amyloid-β (Aβ) plaques, intracellular neurofibrillary tangles composed of hyperphosphorylated tau protein, synaptic dysfunction, oxidative stress, and chronic neuroinflammation. Despite extensive research, currently available pharmacological treatments provide only symptomatic relief and do not effectively halt or reverse disease progression, highlighting an urgent need for novel, safe, and multi-targeted therapeutic approaches.

Natural products and plant-derived phytochemicals have gained increasing attention in neurodegenerative disease research owing to their structural diversity, biological compatibility, and ability to modulate multiple pathological pathways simultaneously. Many phytochemicals exhibit antioxidant, anti-inflammatory, anti-apoptotic, and cholinesterase inhibitory activities, which are particularly relevant to AD pathogenesis. Consequently, medicinal plants used in traditional systems of medicine are being systematically explored as potential sources of neuroprotective agents.

Clitoria ternatea L., commonly known as butterfly pea, is a perennial herb widely distributed in tropical and subtropical regions and extensively used in traditional Ayurvedic, Chinese, and Southeast Asian medicine. The plant has been historically recognized for its cognitive-enhancing, anxiolytic, antidepressant, and anti-aging properties. Phytochemical investigations have revealed that *C. ternatea* is rich in bioactive compounds such as flavonoids, anthocyanins (notably ternatins), alkaloids, saponins, and terpenoids, many of which possess strong antioxidant and anti-inflammatory activities. Emerging experimental evidence suggests that these phytochemicals exert significant neuroprotective effects through modulation of oxidative stress, inhibition of neuroinflammatory mediators, enhancement of cholinergic transmission, and protection against neuronal degeneration.

Recent preclinical studies using in vitro and in vivo models of neurodegeneration have demonstrated that extracts and isolated compounds from *C. ternatea* can improve learning and

memory, reduce Aβ-induced neurotoxicity, and regulate molecular signaling pathways associated with neuronal survival and synaptic plasticity. These multi-mechanistic actions align closely with the complex and multifactorial nature of AD, supporting the therapeutic relevance of *C. ternatea* phytochemicals as potential disease-modifying agents.

This comprehensive review aims to critically evaluate the role of *Clitoria ternatea* phytochemicals in neuroprotection and their therapeutic potential in Alzheimer's disease. The review summarizes the phytochemical profile of the plant, discusses its neuroprotective mechanisms in the context of AD pathology, and highlights current limitations and future research directions. By consolidating existing evidence, this article seeks to provide a scientific foundation for the development of *C. ternatea*-based interventions in the prevention and management of Alzheimer's disease.

Cognitive Impairment or Neuro-degradation:

Cognitive impairment is a symptom or description of thinking problems (memory, focus, judgment), whereas neuro-degradation refers to the underlying physical breakdown of brain cells or tissue, which is often the cause of severe cognitive decline (neurocognitive diseases, dementia, Alzheimer's). Mild impairment (MCI) is less severe than significant neurocognitive illnesses, but it might increase the risk of dementia. In essence, cognitive impairment (difficult thinking) is produced by neuro-degradation (such as neuron loss). Neurodegenerative illnesses, such as Parkinson's disease, Alzheimer's disease, Lewy-body dementia, and cerebrovascular dementia, cause a gradual decline in behavior and cognition that ultimately results in severe dementia. By 2050, there will be 1.1 billion persons over 65 worldwide, according to current demographic projections, which will result in 37 million cases of dementia. Given the enormous public health and socioeconomic burden, it is evident that the need of therapeutic intervention aimed at either finding a cure or preventing sickness onset cannot be stressed. Nowadays, the human population is aging faster. This leads to increased dependence rates, and social and health services need to adapt to this aging population. One of the changes this group has experienced is frailty. It is characterized as a syndrome that is clinically detectable and linked to the aging of many physiological systems that result in a state of vulnerability. The pathophysiology of frailty, which seems to have a complicated genesis, is determined by a number of interrelated elements. The four main causes of frailty, according to Morley et al.,

are atherosclerosis, sarcopenia, cognitive decline, and malnutrition, together with the associated metabolic alterations. Malnutrition is associated with cognitive impairment or functional loss, while inadequate nutrition is known to predispose to cognitive fragility. Additionally, dietary factors that may impact vascular risk factors may worsen dementia in people with cognitive fragility. This study aims to provide an overview of the nutritional components that have been investigated thus far and that may be involved in the development of frailty, namely cognitive impairment. The progressive dysfunction of specific neuronal groups determines the clinical manifestation of neurodegenerative illnesses. Misfolded proteins accumulate both intracellularly and extracellularly in many neurodegenerative protein-pathies, which is associated with neuronal death. Some of the main fundamental processes include deficiencies in the ubiquitin-proteosome-autophagy system, oxidative stress and free radical production, mitochondrial dysfunction, impaired bioenergetics, neurotrophin dysfunction, "neuroinflammatory" processes, and (secondary) disruptions of neuronal Golgi apparatus and axonal transport. Over an extended period of time, a number of interrelated events culminate in programmed cell death. Current study has shown both intraindividual variances and overlap across diverse symptoms, despite the fact that neurodegenerative disorders are classified using major components of protein deposits or established genetic mechanisms. Synergistic mechanisms between sick proteins reveal common pathogenic pathways. The basic mechanisms of neurodegeneration and cell death have been clarified by animal models and other research, creating new opportunities for preventative and therapeutic strategies.

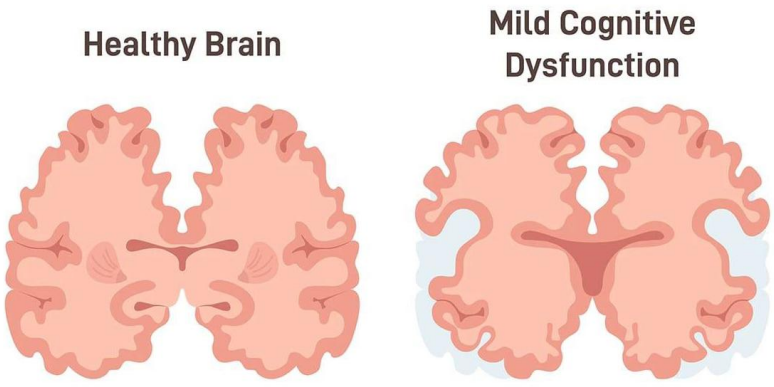


Fig: 1.1Difference between Normal Brain and Damaged Brain

Signs and Symptoms :

Alzheimer's disease is a progressive neurodegenerative disorder characterized by a continuum of cognitive, behavioral, and functional impairments that worsen over time. The earliest clinical manifestations typically involve mild cognitive impairment, particularly deficits in short-term and episodic memory, reduced attention span, and impaired learning ability. These early symptoms are closely associated with hippocampal dysfunction, synaptic loss, and oxidative stress, which represent key targets for neuroprotective interventions.

As the disease advances, patients develop more pronounced cognitive deficits, including language impairment (aphasia), reduced visuospatial perception, and compromised executive function. Difficulties in performing routine daily activities, disorientation to time and place, and impaired decision-making are commonly observed. Behavioral and psychological symptoms such as anxiety, depression, irritability, agitation, and sleep disturbances frequently accompany cognitive decline, reflecting underlying neuroinflammatory processes and neurotransmitter imbalances.

In later stages, severe neurodegeneration leads to profound memory loss, loss of verbal communication, and complete dependence on caregivers. Neuropsychiatric manifestations, including apathy, hallucinations, and delusions, may occur, along with motor dysfunction and impaired swallowing. These advanced symptoms are the result of extensive neuronal loss and widespread cortical and hippocampal atrophy. The progression of these signs and symptoms is strongly linked to pathological mechanisms such as amyloid-β accumulation, tau hyperphosphorylation, oxidative stress, and chronic neuroinflammation. Phytochemicals present in *Clitoria ternatea*, including flavonoids and anthocyanins, have demonstrated antioxidant, anti-inflammatory, and neuroprotective properties that may help attenuate neuronal damage underlying these clinical manifestations. Therefore, understanding the signs and symptoms of Alzheimer's disease provides a critical clinical framework for evaluating the therapeutic potential of *Clitoria ternatea* phytochemicals in mitigating disease progression and preserving cognitive function.

Causes :

Alzheimer's disease is a multifactorial neurodegenerative disorder arising from a complex interplay of genetic, molecular, environmental, and lifestyle-related factors. The primary pathological causes include the accumulation of amyloid-β (Aβ) peptides forming extracellular plaques and the intracellular aggregation of hyperphosphorylated tau protein into neurofibrillary tangles. These abnormalities disrupt synaptic communication, impair neuronal transport systems, and ultimately lead to neuronal loss in critical brain regions involved in cognition and memory.

Oxidative stress is a major contributing factor in the pathogenesis of Alzheimer's disease. Excessive production of reactive oxygen species and impaired antioxidant defense mechanisms result in lipid peroxidation, protein oxidation, and DNA damage, thereby accelerating neuronal dysfunction and cell death. Mitochondrial dysfunction further exacerbates oxidative damage and energy deficits within neurons.

Chronic neuroinflammation also plays a central role in disease development. Sustained activation of microglia and astrocytes leads to the release of pro-inflammatory cytokines, chemokines, and neurotoxic mediators, which contribute to synaptic loss and neuronal degeneration. In addition, dysregulation of the cholinergic system, particularly reduced acetylcholine levels and increased acetylcholinesterase activity, is closely associated with cognitive decline in Alzheimer's disease.

Genetic factors, including mutations in amyloid precursor protein and presenilin genes, as well as the presence of the apolipoprotein E ε4 allele, significantly increase susceptibility to Alzheimer's disease. Aging remains the strongest risk factor, with age-related declines in neuronal repair mechanisms, antioxidant capacity, and synaptic plasticity further predisposing individuals to neurodegeneration. Environmental influences and lifestyle factors such as metabolic disorders, cardiovascular disease, poor diet, and chronic stress may also contribute to disease onset and progression.

The multifactorial etiology of Alzheimer's disease highlights the need for therapeutic approaches capable of targeting multiple pathological pathways simultaneously. Phytochemicals derived from *Clitoria ternatea*, including flavonoids and anthocyanins, have

been shown to modulate oxidative stress, neuroinflammation, amyloid aggregation, and cholinergic dysfunction, suggesting their potential utility in addressing the underlying causes of Alzheimer's disease rather than merely alleviating symptoms.

Neuroprotective Mechanisms:

Cholinergic Restoration: Extracts, particularly from the roots, act as cholinesterase inhibitors. They inhibit both Acetylcholinesterase (AChE) and Butyrylcholinesterase (BChE), leading to increased levels of acetylcholine (ACh) in the brain, which is essential for memory and cognitive function.

Reduction of Amyloid Beta (Aβ) Aggregation: Specific compounds like cyclotides (cyclic peptides) and clitorienolactones help prevent the formation of Aβ aggregates. Research shows that bioactive fractions can significantly reverse the accumulation of amyloid-beta plaques in the hippocampus.

Antioxidant Defense: Phytochemicals such as flavonoids, anthocyanins, and phenols neutralize free radicals. They reduce lipid peroxidation (MDA levels) and increase the levels of endogenous antioxidants like Superoxide Dismutase (SOD), Catalase (CAT), and Glutathione (GSH).

Anti-neuroinflammatory Action: The plant's extract targets inducible Nitric Oxide Synthase (iNOS), resulting in decreased nitric oxide (NO) production and a reduced inflammatory response in activated brain cells (BV-2 microglial cells).

Enhanced Synaptic Plasticity: *C. ternatea* promotes neurogenesis and increases dendritic arborization in the hippocampus. It rescues impaired Long-Term Potentiation (LTP) and regulates molecular synaptic signaling proteins (like PSD-95 and synaptophysin) to improve communication between neurons.

Glutamate Modulation: It helps regulate levels of glutamate, an excitatory neurotransmitter that can become neurotoxic in excess, thereby protecting neurons from cell death

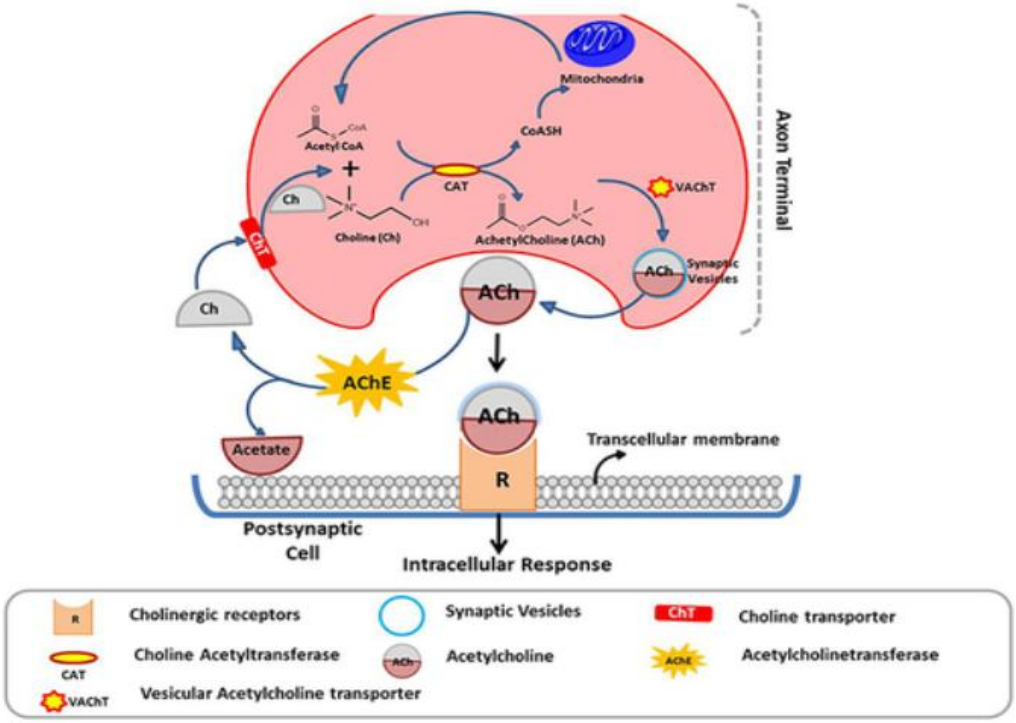


Figure 2 Biosynthesis of acetylcholine and cholinergic transmission.

Important Neurotransmitter Modes of Action Include :

Neurotransmitter dysregulation is a central feature of cognitive impairment and neurodegeneration in Alzheimer's disease. Multiple neurotransmitter systems contribute to learning, memory, behavior, and neuronal survival, and their impairment accelerates disease progression. Phytochemicals from *Clitoria ternatea* may exert neuroprotective effects by modulating these key neurotransmitter pathways.

Cholinergic system: The cholinergic system plays a crucial role in memory formation and cognitive processing. Alzheimer's disease is associated with decreased acetylcholine levels and increased acetylcholinesterase activity. *Clitoria ternatea* extracts have demonstrated acetylcholinesterase inhibitory activity, leading to enhanced acetylcholine availability at synaptic junctions and improved cognitive function in experimental models.

Glutamatergic system: Glutamate is the primary excitatory neurotransmitter in the central nervous system. Excessive glutamatergic signaling contributes to excitotoxicity and neuronal damage in Alzheimer's disease through overactivation of NMDA receptors. Phytochemicals

with antioxidant and anti-inflammatory properties from *Clitoria ternatea* may help attenuate glutamate-induced oxidative stress and protect neurons from excitotoxic injury.

GABAergic system: The gamma-aminobutyric acid (GABA) system is responsible for inhibitory neurotransmission and maintenance of neuronal balance. Dysregulation of GABAergic signaling in Alzheimer's disease can contribute to cognitive deficits and behavioral disturbances. *Clitoria ternatea* has been traditionally associated with anxiolytic and sedative effects, suggesting a modulatory role on GABAergic neurotransmission that may help restore excitatory–inhibitory balance.

Dopaminergic system: Dopamine is involved in motivation, reward, and executive function. Alterations in dopaminergic signaling have been implicated in neuropsychiatric symptoms associated with Alzheimer's disease. Bioactive compounds in *Clitoria ternatea* may indirectly support dopaminergic function through antioxidant protection and anti-inflammatory actions, thereby contributing to behavioral stabilization.

Serotonergic system: Serotonin regulates mood, cognition, and sleep. Serotonergic dysfunction is linked to depression, anxiety, and sleep disturbances in Alzheimer's disease. The neuroprotective and neuromodulatory properties of *Clitoria ternatea* phytochemicals may help maintain serotonergic signaling, improving neuropsychiatric symptoms commonly observed in affected individuals.

Overall, modulation of multiple neurotransmitter systems underscores the multi-targeted neuroprotective potential of *Clitoria ternatea* phytochemicals. By restoring neurotransmitter balance and reducing neurotoxic signaling, these compounds may contribute to the preservation of cognitive function and neuronal integrity in Alzheimer's disease.

Medicinal Plants Used in AD :

Different kinds of medicinal plants and their formulations have been used since ancient times to enhance remembrance and cognitive abilities (Figure 6). These plants have therapeutic potential, the capacity to inhibit AChE activity, anti-inflammatory and antioxidant qualities, the capacity to prevent Aβ protein aggregation, and the capacity to hyperphosphorylate the tau proteins. They also have chelating activities for redox metals. Medicinal plants with bioactive

components have shown potential beneficial effects against dementia and AD.127 Additionally, natural chemicals differ in both their action and structure; it is not pretentious to discover anti-AD remedies from natural herbal products.128 Additionally, the FDA now only approves a few medicines for the treatment and diagnosis of AD.129 Here, we are more focused on mainly current studies on the prospective benefits of employing a variety of traditional medicinal plants and their phytoconstituents to treat AD.

Thus, the therapeutic value of the important Ayurvedic single medicinal plants is discussed and shown in Table 2 concerning their various mechanisms, such as anti-inflammatory properties, antioxidant properties, anti-ChEs properties, anti-Aβ aggregation, anti-tau aggregation, microtubule stabilizing, β-secretase inhibition, free radical scavenger neuroprotective properties, antiapoptotic properties, and nootropic and memory-enhancing properties.130

In addition, there are currently five FDA-approved medicinal plants that can be used against AD. Among them, rivastigmine, which is derived from the plant Physostigma venenensis (Leguminosae), was given the brand name Exelon by the FDA in 2000, and it is intended to inhibit AChE activity in the hippocampal and cortex regions

Figure 3 Phytoconstituents of Ayurvedic medicinal plants used for AD.

Herbal Drug Plant Collection for the Treatment of Impairments:

Clitoria ternatea commonly known as Butterfly pea belonging to the family Fabaceae and sub-family Papilionaceae is a perennial leguminous twiner, which originated from tropical Asia and later was distributed widely in South and Central America, East and West Indies, China and India, where it has become naturalised. Clitoria ternatea commonly also called Clitoria, blue-pea, kordofan pea (Sudan), cunha (Brazil or pokindong (Philippines) is a vigorous, summer growing, legume of old world origin. Clitoria L. comprises 60 species distrib- uted mostly within the tropical belt with a few species found in temperate areas. The mostly frequently reported species is Clitoria ternatea. It is characterised as a woody genus with showy, papilionaceous flowers, an in- fundibular calyx with persistent bracteoles, stipules and stalked ovaries. Fantz reported economic uses for 23 species of Clitoria as antihelmintic, diuretic, refrigerant etc.lThis plant is known as Aparajit (Hindi), Aparajita (Bengali), and Kokkattan (Tamil) in Indian traditional medicine." It has several synonyms in ayurvedic scriptures like: Sanskrit names: Aparajita, Girikarnu, Asphota and Vishnukranta. English names: Butter-fly pea, Mazerion and Winged leaved Clitoria. Local names: Aparajita (Hin), Aparajita (Beng), Gorani (Guj), Gokarna (Mar) and Buzrula The plant is mainly used as a forage as it is highly palatable for live-stock and it is well adapted to various climates.!"Native to the island of Ternate in the Molluca archipelago, this species is now widely grown as ornamental, fodder or medicinal plant. It is found commonly as an escape in hedges and thickets throughout India to an altitude of 15cm and in Andaman Islands. It can be grown as a forage legume either alone or with perennial fodder grasses in Punjab, Rajasthan, Uttar Pradesh, Gujarat, Maharashtra, Madhya-Pradesh, Andhra-Pradesh and Karnataka. The plant is also suitable as a green manure and cover crop. Besides suppressing many perennial weeds, it enriches the soil by fixing nitro- gen.!" Clitoria ternatea is now widely distributed throughout the humid, low- land tropics occurring both naturally and in cultivations although no improved pasturc cultivars have been developed, "" Clitoria ternatea is cultivated through- out India but is naturalized in the more tropical regions." The juice of flowers is reported to be used in insect bites and skin discases. The roots are useful in asthma, burning sensation, ascites, inflammation, leucoderma, leprosy, reported.

PLANT PROFILE:

Botanical Name: Clitoria ternatea Common Name: Butterfly pea, Blue pea and Cordofan pea **Synonyms**: Asphota, Girikarni, Visnukranta, Sankhapuspi, Sephanda, Sveta, Maha Family: Fabaceae whole plant

Figure 4 flower of Shankh-pushpi (Clitoria ternatea)

Clitoria ternatea a popular Ayurvedic drug, is used for a number of CNS effects, most notably memory enhancement. It is unclear where the term "shankhpushpi" originated because it is used to refer to a number of plants in different locations of India. Plants commonly referred to as Clitoria ternatea include Convolvulus pluricaulis Chois., Evolvulus alsinoides Linn., and Clitoria ternatea Linn. (Leguminosae).

Shankhpushpi (Clitoria ternatea) is an Ayurvedic cognitive enhancer (nootropic) that regulates neurotransmitters, shields brain cells, and enhances learning, memory, focus, and stress/anxiety. It is applied as a "brain tonic" to improve overall mental clarity and cognitive function.

Botanical Description:

Clitoria ternatea has twining fine stems 0.5-3 m long. The leaves are pinnate with 5-7 elliptic to lanceolate leaflets 3-5 cm long and shortly pubescent underneath. Flowers are solitary, deep blue to blue mauve; very short pedicellate and 4-5 cm long. Pods are flat, linear, beaked, 6- 12 cm long, 0.7-1.2 mm wide and slightly pubescent with upto 10 seeds. The seeds are olive, brown or black in colour, often mottled, 4.5-7 mm long and 3-4 mm wide.

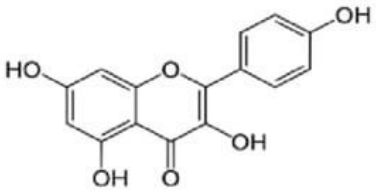
Table: Taxonomical Classification

Kingdom	Plantae
Order	Fabales
Family	Fabaceae
Genus	Clitoria
Species	ternatea

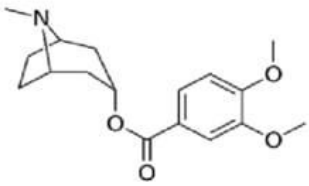
Chemical Constituents:

The mystical herbal remedy has a number of active substances, including alkaloids like convolvuline, convolidine, convolvine, convolamine, convoline, confoline, and convozine.

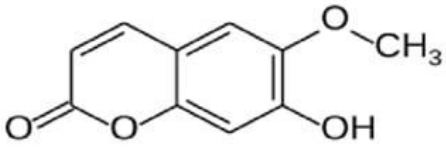
Additionally found are volatile oils, fatty acids, fatty alcohols, hydrocarbons, palmitic acids, linoleic acids, myristic acids, flavonoids, steroids-phytosterols, D-glucose, maltose, sucrose, starch, rhamnose, and other carbs, proteins, and amino acids.



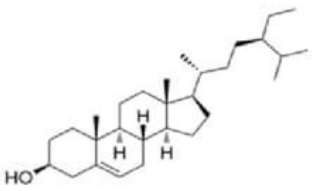
Kaempferol



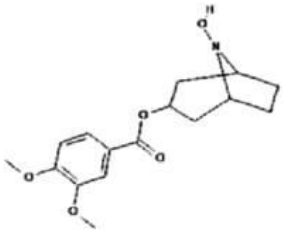
Convolamine



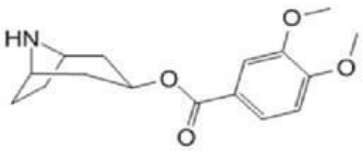
Scopoletin



β-sitosterol



Convoline



Convolvine

Alkaloids: Convolvine, convolamine, confoline, convoline, convosine, subhirsine, phyllabine, and convolvidine are among the most prominent tropane alkaloids. These substances are especially linked to the plant's anxiolytic and neuroprotective qualities. As potent antioxidants, flavonoids and phenolics help shield brain cells from oxidative damage.

Lipids and Steroids: Ceryl alcohol and β-sitosterol are important sterols. Along with hydrocarbons and waxy components, the plant also includes a variety of fatty acids, including linoleic acid, myristic acid, and palmitic acid.

Carbohydrates and Other Compounds: In addition to proteins and amino acids, Shankhpushpi is high in a variety of carbohydrates, including as D-glucose, rhamnose, maltose, sucrose, and starch.

Therapeutic Uses:

Cognitive & Nervous System Support

Memory enhancement & brain health:

- Traditionally used in Ayurveda as a nootropic, believed to enhance memory, learning, and intellect.
- Studies show extracts may influence neurotransmitter systems and improve cognitive function in experimental models.

Stress, anxiety & mood:

- Traditionally used as a calming, anxiolytic (anxiety-reducing), anti-stress, and sedative agent.
- Some research supports reduction in stress responses and potential antidepressant-like effects in preclinical tests.

Seizure control:

- Extracts have shown seizure-modulating effects in animal studies**.**

Antioxidant & Anti-Inflammatory

Rich in antioxidants:

- Flowers contain anthocyanins (ternatins), flavonoids (kaempferol, quercetin), and other phenolics which combat free radicals.

Anti-inflammatory & potential anti-aging:

- Extracts have demonstrated anti-inflammatory and anti-ageing activity, reducing inflammatory markers in experimental models.

Respiratory & Digestive Support

Respiratory uses:

• Traditionally used for cough, bronchitis, phlegm reduction, and asthma in combination with other herbs.

• Animal studies suggest antitussive (cough-suppressing) and bronchodilator activity.

Digestive benefits:

• Used as a mild laxative, anti-dysenteric, and digestive tonic in traditional systems.

Metabolic & Other Effects

Antidiabetic & metabolic health:

• Extracts exhibited antidiabetic activity in animal models, possibly aiding blood sugar control.

Antimicrobial & protective:

• Demonstrated antimicrobial, antimicrobial, hepatoprotective (liver-protective), and testicular protective effects in preliminary research.

Vision & Circulation Support

• Traditional belief suggests that proanthocyanidins in the plant may improve blood flow in capillaries (e.g., around the eyes), potentially supporting eye health.

Skin, Hair & Cosmetic Uses

• Antioxidant and anti-inflammatory compounds in the plant have led to use in cosmetics for skin rejuvenation and hair health.

• May help reduce oxidative stress in skin aging and support hair growth.

Pharmacological studies:

Neuroprotective & Antioxidant in Neurological Models

It is shown that the administration of ethanol extract of Clitoria ternatea has nephroprotective potential against APAP-induced nephrotoxicity. It provides experimental evidence that Clitoria ternatea augmented the myocardial antioxidant enzymes level, preserved histoarchitecture and improved cardiac performance following APAP administration reported in evaluation of phytoconstituents. nephro-protective and antioxidant activities of Clitoria ternatea by Sarumathy et al.

Anti-Alzheimer Potential: Combination extracts of flowers and roots have shown potent inhibitory effects on cholinesterase enzymes, suggesting a synergistic role in managing neurodegenerative conditions.

Antioxidant Activity: The plant exhibits powerful free-radical scavenging abilities. Blue flower varieties generally outperform white varieties due to higher **anthocyanin** content. It protects cells from oxidative damage, particularly in the liver, kidneys, and brain.

The ethanolic leaf extract demonstrated notable antioxidant capacity and **potential neuroprotective effects**, suggesting benefits against oxidative stress-linked neurological conditions such as Alzheimer disease in experimental models.

Conclusions:

There are currently no effective medications or treatments for AD, which is the most prevalent neurocognitive disease worldwide. With their wide variety and abundance of pharmacological principles, natural remedies may show significant functions in the development of novel chemical entities. Plants' secondary metabolites, like alkaloids, flavonoids, and phenolic acids, are essential in either encouraging regeneration or avoiding neurodegeneration. Several herbal medicines and particular herbal medicinal parts have exhibited substantial promise for the amelioration of AD. Furthermore, several medicinal herbs and plants have been available with identical taxonomic backgrounds that showed almost similar pharmacological characteristics. However, given the fact that research in neurocognitive diseases, like AD, presents significant scientific challenges, it is a highly important field for the investigation of traditional medicinal methods, and natural remedies could warrant a safe, reliable, and effective strategy for its treatment. The nootropic mixture made with Shankhpushpi, mint, and licorice has encouraging potential for enhancing cognitive abilities like learning, memory, and mental alertness. Mint helps to promote focus and mental clarity, while Shankhpushpi is well known for its neuroprotective and memory-boosting qualities. Licorice has antioxidant and adaptogenic properties that enhance general brain health and lessen mental stress. The combination formulation may work in concert to preserve normal neuronal function and improve cognitive performance. Compared

to synthetic nootropic drugs, this formulation is anticipated to provide superior safety and tolerability due to its herbal composition. However, additional pharmacological testing.

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