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2**Medicinal plants with Memory enhancing activity: review****Omkar A. Devade\*, Rohan D. Londhe**

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**ABSTRACT:**

Alzheimer's disease progressive neurodegenerative disease characterized by severe memory loss, personality changes and unusual behavior, a decline in cognitive function. Indian traditional health care system (*Ayurveda*) named *Rasayana* is well known for its effective herbal treatments. Many plants affected the central nervous system and exerted many pharmacological effects including Hepatoprotective, Anti-spermatogenic, Antiepileptic, Antidiabetic, antidepressant, antipsychotic, Anxiolytic. Several Pharmacological studies have described the use of various Ayurvedic medicinal plants and their constituents play the important role in memory-enhancing for the treatment of Alzheimer's disease. Phytochemical studies of the different parts of the plants have shown the presence of many valuable compounds, such as saponin, flavonoids, tannins, polyphenols, triterpenes, sterols, and alkaloids that show a wide role in memory loss. The present review highlights the pharmacological activity of memory-enhancing effects medicinal plants being used in traditional Ayurvedic medicine.

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**INTRODUCTION:**

The brain is the organ that is responsible for what we call the mind. It is the basis for thinking, feeling, wanting, perceiving, learning, and memory <sup>[1]</sup>. Connections between the thalamus, hippocampus, striatum, and amygdale All of those regions are important for different types of memory <sup>[2,3]</sup>. Memory is one of the most complex functions of the brain and ultimately involves multiple neuronal pathways and neurotransmitter systems <sup>[4]</sup>. The most important function of the brain is Memory <sup>[5]</sup>. Age, stress, and emotion are conditions that may lead to memory loss, amnesia, anxiety, dementia, to more ominous threats like schizophrenia and Alzheimer's diseases (AD). Dementia

**Keywords:** Medicinal plants, Memory, Amnesia, Alzheimer's disease, Parkins Disease.

is a serious mood mental disorder that afflicts several millions of the world population, characterized by loss of intellectual ability. According to WHO Approximately 12 million people the dementia is occurring worldwide and this is likely to increase by 2040 up to 25 million <sup>[6-8]</sup>. Alzheimer's disease is a progressive neurodegenerative brain disorder that is slow in onset but leads to dementia <sup>[9,10]</sup> unusual behaviour <sup>[11]</sup>, personality changes <sup>[12]</sup> ultimately death <sup>[13,14]</sup>. AD is characterized by the presence of excessive amounts of neurotic plaques containing amyloid  $\beta$  protein loss of cholinergic markers in the brain. The central cholinergic system plays an important role in the learning and memory process <sup>[15,16]</sup> Acetylcholine (Ach) is one of the brain neurotransmitters involved in learning, memory, and attention processes <sup>[17]</sup>. A decrease in acetylcholine in the brain of patients with AD appears to be a critical element in producing dementia <sup>[18]</sup>. There are so many memory-enhancing medicines that are used in the treatment of AD, called nootropic drugs to belong to the class of psychotropic Agents <sup>[18]</sup>. Synthetic medicines like tacrine, donepezil <sup>[19]</sup> aniracetam, piracetam, rivastigmine are used for the treatment of cognitive dysfunction and memory loss associated with AD <sup>[20]</sup>. But these compounds have been reported to have adverse effects including gastrointestinal disturbances and problems associated with bioavailability <sup>[21]</sup>. So, to overcome the side effects of Synthetic medicines through the review we are looking for herbal plants which can overcome the adverse effect of synthetic drugs. Nootropics offer a range of cognitive benefits, including faster reaction time, increased alertness, improved memory, and decreased mental fatigue and fog. In the light, we tried to compile medicinal plants with Memory enhancing activity from literature.

#### WOOD APPLE:

*Limonia acidissima* Ayurvedic plant is one of the richest sources of Alkaloids <sup>[22]</sup>, Flavonoids which are essential anti-oxidant <sup>[23]</sup>, glycosides <sup>[24]</sup>, carbohydrates <sup>[25]</sup>, and saponin <sup>[26]</sup> which is involved in learning memory and cognition. Epidemiological studies have almost confirmed that non-steroidal anti-inflammatory drugs reduce the incidence of AD <sup>[27]</sup>. *Limonia acidissima* has been reported to produce anti-inflammatory action in rodents <sup>[28]</sup>. This anti-inflammatory property of *Limonia acidissima* certainly helps to treat Alzheimer's patients. *Limonia acidissima* inhibits acetylcholine

esterase enzyme, thereby elevating acetylcholine concentration in the brain, it seems that *Limonia acidissima* proved to be a useful anti-Alzheimer agent. Methanolic extract of *Limonia acidissima* possesses nootropic activity by scopolamine-induced amnesia <sup>[29,30]</sup>.

#### LION'S MANE MUSHROOM:

*Hericum erinaceous*, is an edible fungus, with a long history of use in Traditional Chinese Medicine, has become a well-established candidate in promoting positive brain and nerve health-related activities by inducing the nerve growth factor from its bioactive ingredient <sup>[31]</sup>. Historical record Lion's Mane Mushroom in the traditional use is safe and has important potential as a neuroprotective and neurotrophic therapeutic agent in neurological conditions <sup>[32]</sup>. *H. erinaceus* bioactive compounds present  $\beta$ -glucan polysaccharides; isoindolinones; hericenones and erinaceterpenoids; and myconutrients, which potentially have neuroprotective and neurodegenerative properties <sup>[33]</sup>. *H. erinaceus* helps in neuronal disorder. In a few of the studies, it is seen that those patients who are suffering from Alzheimer's disease have shown a reduction in symptoms of AD by the use of anti-inflammatory drugs <sup>[34]</sup>.

#### LEBBECK TREE:

*Albizialebeck(L.) Benth.* (Family: *Fabaceae*) is commonly known as Siris, Traditionally, it is used as anti-asthmatic, anti-inflammatory, anti-fertility, anti-diarrhoeal, antiseptic, anti-dysenteric, and antitubercular. It is also used in the treatment of ringworms and wounds by washing the affected areas, gonorrhoea, leucorrhoea, bronchitis, leprosy, paralysis, helminth infection, and other genital diseases <sup>[35]</sup>. Nerve tonic effect of saponin containing n-butanol fraction (BF) extracted from dried leaves of *Albizzia lebeck* on learning and memory was studied in albino mice using passive shock avoidance paradigm and the elevated plus-maze. Significant improvement was observed in the retention ability of the normal and amnesic mice as compared to their respective controls. Leaves of *A. lebeck*, which contain saponins, possessed nootropic activity in view of its facilitatory effect on retention of acquired learning in mice <sup>[18]</sup>.

#### GARLIC:

*Allium sativum* (Family: *Amaryllidaceae*) medicinal use of garlic has a long history<sup>[36]</sup>. Studies have shown that

*Allium sativum* L has an active role in health benefits on Central nervous system disorders like Alzheimer's disease<sup>[37]</sup>. Garlic helps in preventing the risk of stroke; it protects amyloid-beta peptide-induced apoptosis, prevents oxidative insults to neurons and synapses. Several studies have demonstrated the antioxidant properties of garlic and its different preparations including Aged Garlic Extract (AGE). AGE and S-allyl-cysteines (SAC), a bioactive and bioavailable component in garlic preparations have been shown in several in vitro studies to protect neuronal cells against beta-amyloid toxicity and apoptosis. Thus the broad range of anti-atherogenic, antioxidant, and anti-apoptotic protection afforded by garlic may extend to its neuroprotective action, helping to reduce the risk of dementia, including vascular dementia and AD<sup>[38]</sup>.

#### APPLE CIDER VINEGAR:

Apple cider vinegar has a long history as a home remedy; it is natural health-promoting food that includes various potential health benefits. Due to the existence of various polyphenolic compounds, it has a high anti-inflammatory, the antioxidant mechanism defined essential suggestions for a protective effect of Apple cider vinegar not only cancer but also cardiovascular diseases, asthma, and potentially diabetes. Oxidative stress and mutation in gene coding amyloid precursor protein and aging are the main origins of Alzheimer's disease<sup>[39]</sup>. Confirmatory studies suggest that a healthy diet of fruits and green vegetables containing phenolic compounds cures  $\beta$  amyloid and tau protein correlated problems associated with Alzheimer's disease. Apple cider vinegar contains phenolic compounds having high antioxidant potential. Phenolic compounds are not essential for survival but they can protect against various chronic diseases<sup>[40, 41]</sup>.

#### REISHI:

*Ganoderma lingzhi*, also known as reishi, is a polypore fungus belonging to the genus *Ganoderma*. In traditional Chinese medicine, *Ganoderma lucidum* is famous for its beneficial effect on the nervous system. It was traditionally used to manage different neurological disorders<sup>[42]</sup>. Ethanolic extract of *Ganoderma lucidum* (150 and 300 mg/kg) exerts reversal action on scopolamine-induced impaired memory and can be used as an agent for enhancing the cognition pattern. *Ganoderma lucidum* extract has significantly increased the time spent in the target quadrant (TSTQ)

and decreased the escape latency (EL) in the Morris water maze model<sup>[43]</sup>.

#### MACA:

*Lepidium meyenii* (maca) has been used as food and traditional medicine in the Andean region for over 2,000 years<sup>[44]</sup>. Maca has been shown to have antioxidant, neuroprotective effects. Improves memory, facilitates concentration, and alleviates the symptoms of menopause<sup>[45, 46]</sup>. Five weeks of maca supplementation improved cognitive function in middle-aged mice. Besides, maca increased the protein levels of subunits of OXPHOS complexes and autophagy-related proteins in the mouse cortex<sup>[47]</sup>. Aqueous extract of black maca has been reported to improve experimental memory impairment induced by ovariectomy via downregulation of oxidative stress<sup>[48]</sup>.

#### GINGER:

*Zingiber officinale* (*Z. officinale*) Roscoe (*Zingiberaceae*), commonly known as 'Ginger', has been used since times immemorial as Neuroprotective and Nerve tonic. Ginger is one of the most frequently used in traditional medicine to treat cold, fever, headache, nausea, and digestive problems<sup>[49, 50]</sup>. Anti-inflammatory effects of *Zingiber officinale* related to its ability to inhibit leukotriene biosynthesis and prostaglandin, Gingerols actively inhibit arachidonate 5-lipoxygenase, an enzyme of leukotriene biosynthesis. The 8-Gingerol, was shown to inhibit COX-2 expression, which is induced during inflammation to increase the formation of prostaglandins<sup>[51, 52]</sup>.

#### ASHWAGANDHA:

Ashwagandha (*Withania somnifera*, family. *Solanaceae*) is commonly known as "Indian Winter cherry" or "Indian Ginseng". Ashwagandha has been used for thousands of years by Ayurvedic doctors to relieve stress, increase energy levels, and improve concentration. It is used for various kinds of disease processes and especially as a nervine tonic. In experimental models, it increases the stamina of rats during swimming endurance tests and prevented adrenal gland changes of ascorbic acid and cortisol content produced by swimming stress. Ashwagandha have has an anti-tumor effect on Chinese Hamster Ovary (CHO) cell carcinoma. It was also found effective against urethane-induced lung-adenoma in mice. It has a Cognition Promoting Effect and was useful in children with memory deficit and in old age people loss of

memory. It was also found useful in neurodegenerative diseases such as Parkinson's, Huntington's, and Alzheimer's diseases <sup>[53, 54]</sup>.

#### **GINKGO TREE:**

*Ginkgo biloba* from the traditional Chinese system of medicine has been found to possess neurocognitive enhancing effects. *Ginkgo biloba* is a Memory booster that has been found to promote cerebral-enhancing properties. Ginkgo improves cognitive function because it promotes good blood circulation in the brain and protects the brain and other parts from neuronal damage. The mechanism of action of *Ginkgo* seems to be related to its antioxidant properties <sup>[55]</sup>. *In vivo* and *in vitro* preclinical studies support the notion that *Ginkgo biloba* extract may be effective in the treatment and prevention of AD and other age-related, neurodegenerative disorders <sup>[56]</sup>. *Ginkgo biloba* in combination with conventional medicine was superior in improving Mini-Mental State Examination scores at 24 weeks for patients with Alzheimer's disease and mild cognitive impairment <sup>[57]</sup>.

#### **GOTU KOLA:**

*Centella Asiatica* is a traditional herb that has been used widely in Ayurvedic medicine, has the ability to enhance memory and nerve function, which gives it potential in treating Alzheimer's disease, *In vivo* studies have shown that the aqueous extract of the leaves of the *Centella asiatica* revitalizes the brain and nervous system thus exhibit a significant effect on learning and memory process by increasing the level of norepinephrine, dopamine, and 5-HT in the brain <sup>[58,59]</sup>. Memory enhancement effects of *C. asiatica* have been documented in Ayurvedic medicine since ancient times <sup>[60]</sup>. Effects of *Centella asiatica* on Neurotoxicity and Brain Injury in study rats with middle cerebral artery occlusion showed that *Centella Asiatica* improves neurobehavioral activity and reduces tissue death due to lack of oxygen <sup>[61]</sup>.

#### **SHANKHPUSHPI:**

Shankhpushpi (botanical name, *Convolvulus pluricaulis*; also known as Sankhaphuli, Shankhini, Samkhaphushpi, Sadaphuli, and Shankhaphushpi) is a plant used in Ayurvedic medicine. The powerful antioxidants and flavonoids present in it improve the memory capacity, focus, concentration, calmness, alertness of an individual, act as brain tonic <sup>[62-63]</sup>. Shankhpushpi is also used for stress, anxiety, anti-amnesic mental fatigue,

neuroprotection, insomnia, diabetes, tranquilizing, antidepressant, antistress, neurodegenerative, antioxidant, hypolipidemic, immunomodulatory, antibacterial, analgesic, anti-fungal, anti-diabetic, anti-ulcer, anti-catatonic, and cardiovascular activity infections <sup>[64]</sup>. In a rat model of cognitive impairment (induced by scopolamine injection), oral treatment of shankhpushpi extract (150 mg/kg) prevented the increase in tau and A $\beta$  peptides as well as histopathological changes in the cerebral cortex, In a related study in rats, pre-treatment with an aqueous extract of shankhpushpi (150 mg/kg) significantly reduced scopolamine-induced cognitive deficits, as measured by transfer latency in the elevated plus-maze and improved spatial memory performance on the Morris water maze model <sup>[65]</sup>.

#### **GUDUCHI:**

*Tinospora cordifolia*, also known as Guduchi or amrita, is a highly valued herb in Ayurveda. Guduchi, a plant with distinctive heart-shaped leaves, is an adaptogen and thus illness. Scientists to the National Institutes of Health that Guduchi have had a significant response in children with a moderate degree of behavior disorders and mental deficit, along with improvement in IQ levels. The neuroprotective activity of ethanol extract of *Tinospora cordifolia* aerial parts has been shown in a study involving the 6-hydroxy dopamine (6-OHDA) lesion rat model of Parkinson's disease (PD) <sup>[66]</sup>. Evidence also exists for aqueous ethanolic extract of *Tinospora cordifolia* playing a role in differentiation-based therapy of glioblastomas. Involvement of Monoaminergic and GABAergic Systems in Antidepressant-like Activity of *Tinospora cordifolia* is shown in a study involving a mouse model of depression using tail suspension test and forced swim test. *Tinospora cordifolia* may also play an effective role against ischemic brain damage as it attenuates oxidative stress-mediated cell injury during oxygen-glucose deprivation (OGD) in rat hippocampal slices <sup>[67,68]</sup>.

#### **ROSEMARY:**

*Rosmarinus officinalis* L. (rosemary) -Brain-Boosting Herbs to Support Cognitive Health is an aromatic evergreen shrub that belongs to the *Lamiaceae* family. It is an ancient herb that originated from the Mediterranean and Asia and is cultivated worldwide. This common household plant is widely used in the improvement of memory, dysmenorrhea, epilepsy, rheumatic pain, spasms, nervous agitation, hysteria, depression <sup>[69]</sup>. Rosemary as a traditional herb contains carnosic acid

and carnosol, abietane-type phenolic diterpenes, which account for most of its biological and pharmacological actions; carnosic acid exerts antioxidant, anti-inflammatory, and neuroprotective effects via phase 2 enzyme induction initiated by activation of the KEAP1/NRF2 transcriptional pathway, which in turn attenuates NLRP3 activation<sup>[70]</sup>. A safe dose of rosemary could be used to boost prospective and retrospective memory, reduce anxiety and depression, and improve sleep quality.

#### GREEN TEA:

Green tea is a natural source of L-theanine, a common and powerful nootropic herb. Multiple studies have shown L-theanine increases attention performance, improves sleep, boosts reaction time, and promotes relaxation<sup>[71,72]</sup>. Methanolic extract of green tea also proved to be superior to the marketed product, Medharasayana as a memory enhancer. It has been demonstrated that green tea has a beneficial role in cognitive functions, specifically in alertness, attention, and memory retention<sup>[73-75]</sup>. Consumption of green tea was reduced cognitive impairments in Alzheimer's disease green tea influences psychopathological symptoms such as reduction of anxiety, cognition, benefits in memory and attention<sup>[76,77]</sup>.

#### CONCLUSION:

The pharmaceutical industry is facing serious challenges as the drug discovery process for neurodegenerative diseases is becoming extremely expensive, riskier, and critically inefficient. The ayurvedic system has described a large number of such herbal medicines to provide a better understanding of their active principles and mode of action. It is evident from the products shown above that they are working as Ayurveda carries importance in today's medicinal research.

There are so many herbal medicines are currently under research this will make medicine much safer, affordable, and more accessible. By using a synthetic medication, it leads to toxic effects on the body, so as to overcome side effects we are looking for an herbal formulation that can overcome the adverse effect of synthetic drugs. Hence this review is an initiation to provide a wide option of herbal sources for curing neurodegenerative disorders, such as learning and memory disorders, Alzheimer's disease Parkinson's disease, dementia, stress, cognitive dysfunction, mental dysfunction.

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