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Herbal Medicine in the Treatment of Alzheimer's Disease and Dementia: Phytoconstituent & Their Possible Pharmacological Activities

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Abstract

Alzheimer's Disease (AD) is a chronic, progressive neurological illness that is linked to ageing and is characterised by memory and cognition problems that progress to death. The pathogenicity is defined by tau protein hyperphosphorylation in neurons and the buildup of Amyloid-Beta Plaques (Aβ) and Neurofibrillary Tangles (NFT) in brain tissues, and the main cause is the oxidative stress-induced generation of Reactive Oxygen Species (ROS). There is no cure for Alzheimer's disease as of yet, while symptomatic treatment may have some potential for memory enhancement and other concerns associated with the disease, as well as being a preventative for some neurological disorders. Many natural products, such as medicinal plants and herbal remedies, have been used for the treatment of various memory disorders such as short-term memory loss, dementia, Alzheimer's, and Parkinson's disease for a long time, and a number of medicinal plants, either in their crude forms or as isolated compounds, have shown to reduce the pathological characteristics of the disease, and various studies have depicted the use of therapeutically derived medicinal plants. An attempt has been made in this review to clarify the molecular method of action of numerous plant extracts and phytochemicals that have been tested against AD.

Introduction

Alzheimer's Disease (AD) is a severe, chronic, and progressive neurological illness that causes memory and cognition problems and eventually death [1,2]. A side from that, the etiopathology of Alzheimer's disease was unknown, although neuronal malfunction and cell death were the main events in these illnesses. Dementia is defined as a malfunction in the acquisition/learning, retention, or recall processes. Around 40 million older people worldwide suffer from dementia [3,4]. Dementia affects an estimated 3.7 million senior citizens in India, and the prevalence is anticipated to double by 2030 and triple by 2050 [5]. Alzheimer's disease, Parkinson's disease, and epilepsy are all neurodegenerative illnesses that are linked to dementia. Excessive formation of Reactive Oxygen Species (ROS) is thought to play a crucial role in the pathogenesis of this disease, accord-

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ing to a growing body of research. Dementia affects 24 million people worldwide, and the number is expected to rise every 20 years until 2040 [6]. After the age of 65, it is thought that the risk of developing AD doubles every five years [7,8]. Due to the lack of a cure for dementia and Alzheimer's disease, the public health priority has recently shifted to the prevention of cognitive decline. Although it is still unclear which variables cause the molecular cascade of neurodegeneration in Alzheimer's disease, environmental factors, vascular pathology, and risk factors have recently been revealed to play a key part in the disease's pathogenesis [9]. As a result, lifestyle interventions that benefit neurodegeneration and vascularity, such as natural nutrition and nutritional supplements, cognitive and social activity, and physical activity, have been identified as potential target alternatives for AD prevention [9,10,11,12].

Furthermore, there is strong evidence that a diet rich in specific nutritional food groups (fruit, fish, and vegetables) can reduce the occurrence and prevalence of some of the most common clinical outcomes, including neurodegenerative disorders, cardiovascular diseases, diabetes, cancer, and a variety of other conditions [13,14,15]. These specialised nutritional food groups are high in micronutrients and vitamins, which De Felice described as nutraceuticals in 1989 because of their nutritional characteristics while also being beneficial to health (like medications) [16]. Preventive or protective agents, such as nutraceuticals derived from natural products or herbal prescriptions, are also being employed, and their market is rising, which is directly related to therapeutic efficacy in the prevention of AD.

Meanwhile, herbal plants such as *Centella asiatica, Ginkgo biloba, Withania somnifera, Bacopa monnieri, Salvia officinalis, Melissa officinalis, Tinospora cordifolia, Glycyrrhiza glabra, Panax Ginseng* Extract, and others contain active molecules that are responsible for the prevention of certain brain disorders and associated co-morbidities. The current state of Alzheimer's disease has necessitated a crucial need to improve our understanding of neurodegeneration causation and to develop novel techniques for preventing neuronal diseases [17]. Through the onset of progressive neuronal cell death and oxidative cellular degeneration, genetic and environmental variables played a major role in the pathophysiology of these illnesses.

Sign and symptoms

Alzheimer's disease is marked by memory loss, which manifests itself in behaviours such as forgetting appointments, being away from home, misplacing items, and asking the same questions over and over. Insomnia, anxiety, sadness, disruptive behaviour, and hallucinations are all symptoms of Alzheimer's disease, in addition to memory impairments [18]. Chronic dementia accounts for almost 60% to 70% of instances of Alzheimer's disease [19].

Several investigations have discovered evidence that AD is caused or exacerbated by decreased brain metabolic activity. Each stage of Alzheimer's disease has its own set of symptoms [20].

✓ **Stage One:** It lasts two to four years on average. Confusion, amnesia, disorientation, recent memory loss, and mood changes are all symptoms.

✓ **Stage Two:** This stage usually lasts two to 10 years. Reduced memory, reduced attention span, hallucinations, restlessness, muscle spasms, increased anger, and increased inability to organise thoughts are all common symptoms.

✓ **Stage Three:** It lasts one to three years and is characterised by incontinence, swallowing difficulties, the development of skin infections, and seizures.

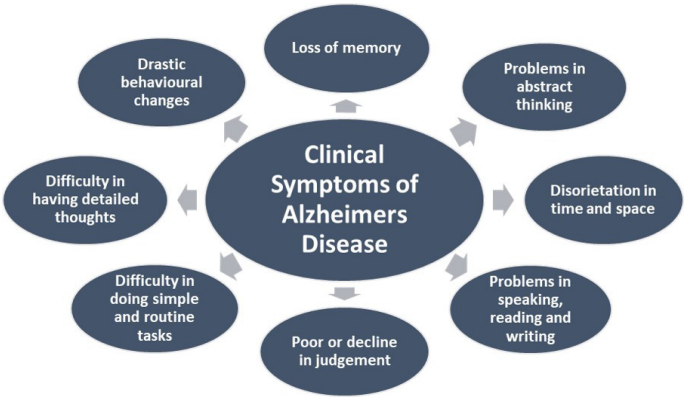


Figure 1: Clinical Symptoms of Alzheimer Disease.

Etiopathogenesis

In the progression of AD, synaptic loss or dysfunction, reduced neuronal metabolism, and the loss of numerous neurotransmitter systems are all seen [21]. Senile plaques made up of Amyloid-Beta (Aβ) deposits and Neurofibrillary Tangles (NFT) made up of aggregated tau proteins are the two neuropathological hallmarks of Alzheimer's disease. These plaques form as a result of abnormal processing of amyloid precursor protein, resulting in an overproduction of β-amyloid protein. The neuronal degeneration seen in Alzheimer's disease is caused by the formation of neurofibrillary tangles and amyloid plaques. Furthermore, oxidative stress, metal ion dyshomeostasis, mitochondrial dysfunction, neuroinflammation, autophagy, Endoplasmic Reticulum (ER) dysfunction, cell cycle dysregulation, and decreased levels of the neurotransmitter acetylcholine are thought to play a role in Alzheimer's disease progression which have been implicated in the aetiology of Alzheimer's disease [22,23,24].

Some recent research has revealed that epigenetic control may play a role in the progression and progression of Alzheimer's disease [25]. Although the pathophysiology of Alzheimer's disease is still unknown, it is clear that multiple factors are involved.

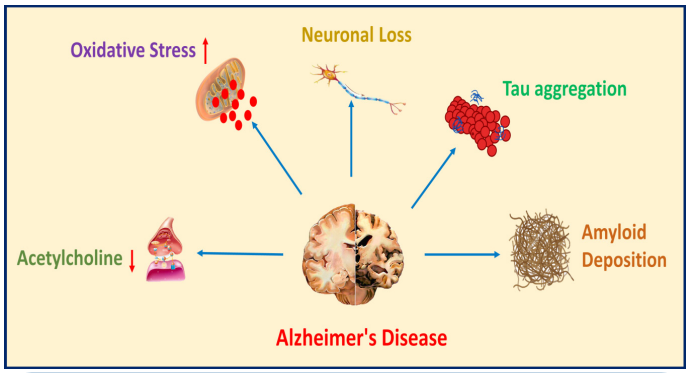


Figure 2: Pathophysiology of Alzheimer Disease (AD).

Herbal plants used in the treatment of alzheimer's disease and dementia

In a number of preclinical and human trials, medicinal plants such as *Salvia officinalis, Melissa officinalis, Rosmarinus officinalis,* and others have been cited for their cholinergic actions and memory-enhancing properties [26]. Ayurveda has already contributed a number of lead molecules to medicine devel-

opment, with many of them currently undergoing clinical trials [27]. Plants and their extracts have been found to protect against Parkinson's Disease (PD) [28], Huntington's Disease (HD) [29], ADHD [30], Multiple Sclerosis (MS) [31], schizophrenia [32], stroke [33], etc.

Recently, medicinal plants have gained wide acceptance because of their fewer side effects compared to synthetic medicines and the necessity to meet the requirements of medicine for an increasing human population suffering from various neurodegenerative disorders. Among all those, several investigations have reported that medicinal plants are utilised in Alzheimer's disease treatment, which includes *Serrate clubmoss, Centella asiatica, Ginkgo biloba, Withania somnifera, Bacopa monnieri, Salvia officinalis, Melissa officinalis, Tinospora cordifolia, Glycyrrhiza glabra,* and many more.

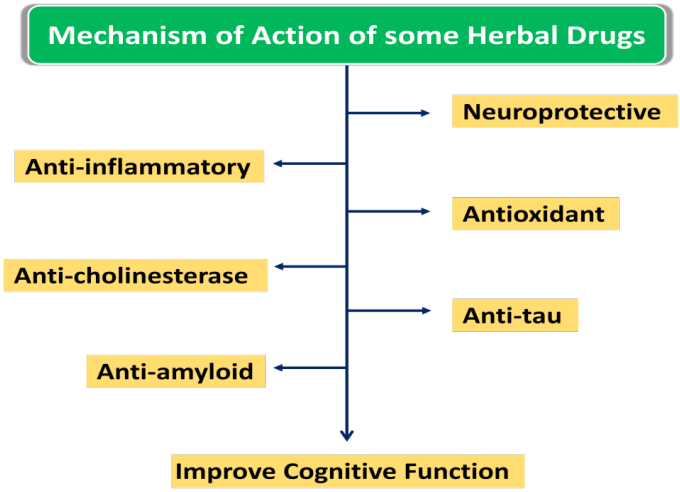


Figure 3: Possible mechanism of action of herbal drugs.

Ashwagandha (*Withania somnifera*)

It is a member of the Solanaceae family, and its root is commonly used for medicinal purposes. A prior study found that ashwagandha possesses cholinergic action [34]. The potential of ashwagandha to boost acetylcholine levels in the brain contributes to its memory-enhancing and cognition-improving properties. According to molecular modelling research, withanamides A and C bind to Aβ and prevent fibril formation [35]. It was also discovered that with anamides prevented amyloid plaques from damaging activated neuronal cells [35,36,37]. In human neuroblastoma cells, ashwagandha methanol extract stimulated the growth and development of the neural network [38]. In verified AD mice, per-oral administration of Withania root extract reversed behavioural deficits and prevented the formation of Aβ plaque [39]. The overexpression of the low-density lipoprotein receptor-related protein in the liver has been connected to Ashwagandha's effects [39]. The roots of ashwagandha help the body's defensive mechanism in cases of chronic disease by enhancing cellular immunity and neutralising the cytotoxic cascade's fatal mediators, such as cytokines and ROS [40,41].

Turmeric (*Curcuma longa*)

It is a member of the Zingiberaceae family. Because of its anti-amyloidogenic, antioxidant, and anti-inflammatory properties, it is used in the treatment of AD [42]. Turmeric plant extracts have been shown to reduce the production of fibrils and Aβ aggregation in experimental rats [43]. The results of the study also revealed a decrease in oxidative stress and an improvement in cognitive functions. It helps to prevent plaque buildup in the brain. Turmeric reduces oxidative stress and the formation of amyloid plaques [44]. In one study, low dosages of turmeric lowered Aβ levels by up to 40% in animals with AD when compared to a control medication [43].

Turmeric reduced the plaque formation in the brains of mice with Alzheimer's disease by 43% when given in low dosages [44]. According to a prior study, low doses of turmeric given over a lengthy period of time are more helpful than greater doses in the treatment of AD [45,46]. These effects, according to the researchers, aid in the treatment of Alzheimer's symptoms associated with inflammation and oxidation [47]. By accumulating cholesterol esters intracellularly, hypercholesterolemia and hyperlipidemia create amyloid plaques [48]. According to researchers, curcumin may have beneficial propery for Alzheimer's by blocking cholesterol production and lowering serum peroxides [49].

Shankhpushpi (*Convolvulus pluricaulis*)

It is a member of the Convolvulaceae family. A prior study found that extracts of *Convolvulus pluricaulis* in aqueous and ethyl acetate improved memory and learning capacities [50]. Shankhpushpiis used in India as a nervine stimulant to improve memory and cerebral function in various formulations [51,52,53,]. Another study found that a wide range of secondary metabolites, including steroids, anthocyanins, flavonol glycosides, and triterpenoids, are responsible for memory-improving and nootropic properties [52]. It is thought to relax nerves by controlling the body's stress hormone synthesis (cortisol and adrenaline) [54].

Ethanolic extract of shankhpushpi, as well as its aqueous and ethyl acetate fractions, dramatically improved memory retention and learning capacities in rats [55]. Similarly, giving aged mice shankhpushpi for a week improved their memory [56]. Shankhpushpi administration enhanced acetylcholinesterase activity in the hippocampus CA1 and CA3 areas, which are connected with memory function and learning capacities [57]. Shankhpushpi metabolites have nootropic and memory-enhancing properties, as well as boost pharmacological activity [58]. In rats, ethanol extract of shankhpushpi and its fractions (ethyl acetate and aqueous) significantly improve learning and memory [55]. Much research has shown that administering *Convolvulus pluricaulis* extracts improves memory in older mice and improves retention and spatial learning performance in newborn rat pups, suggesting memory-upgrading.

Ginkgo (*Ginkgo biloba*)

It is a member of the Ginkgoaceae family. This is a natural medicinal plant whose leaves are used to treat Alzheimer's patients with cognitive impairment [59]. It contains bilobalide, a neuroprotective compound [60]. It reduces free radicals and enhances memory in Alzheimer's patients [61]. It contains flavonoids, which are known to help with memory [62]. *Gingko biloba* protects against corticosteroid-induced neurodegeneration in the hippocampus and GABA inhibitory neurotransmission [63]. Administration of Ginkgo significantly improved memory and learning performance in albino rats [64]. Scientific research proved that *Ginkgo biboba* has the potential to improve cognitive function for the treatment of AD patients. *Ginkgo biboba* extract is extensively employed in treating patients with numerous forms of dementia in Europe [65,66].

Gotu kola (*centella asiatica*)

It is a member of the Apiaceae family. Saponins are the main components of Gotu Kola. It's widely used to cleanse the blood, improve memory, lower blood pressure, and extend life. It aids in the relaxation of the mind and the release of tension. Gotu kola aqueous extracts are used in ayurveda to rejuvenate and restore brain cells, as well as to alleviate sleeplessness [67].

Furthermore, in vitro data reveals that Gotu Kola is effective in inhibiting the β-amyloid cell, implying that it is useful in the treatment of β-amyloid poisoning in Alzheimer's patients [68]. [139] found that, in Wistar rat treatment with *Centella asiatica* (Linn) fresh leaf extract improved learning ability and memory retention capability. Depression, rheumatism, mental weakness, abdominal discomfort, and epilepsy are all treated with it [69]. It was also found that *Centella asiatica* decreased oxidative stress response and reversed Aβ pathology [70].

Jyotishmati (*Celastrus paniculatus*)

It belongs to the family Celastraceae. It prevented neuronal cell damage from hydrogen peroxide toxicity due to its antioxidant activity [71]. Administration of Jyotishmati prevents neuronal cell damage caused by glutamine-induced toxicity [72]. It increases cholinergic activity, which contributes to its ability to improve memory performance [73]. Jyotishmati aqueous extract has antioxidant and cognition-enhancing properties [74]. Jyotishmati extracts protect neuronal cells against hydrogen peroxide induced toxicity in part by virtue of their antioxidant and free radical scavenging activities [75]. The cholinergic activity of Jyotishmati seed aqueous extract was observed in a dose-dependent manner thereafter, refining memory activity [76].

Liquorice (*Glycyrrhiza glabra*)

It is a member of the Fabaceae family and contains coumarins, isoflavonoids, saponins, flavonoids, and stilbenoids, which are used to treat Alzheimer's disease [77]. Gastric ulcers, lung congestion, hoarseness, and throat difficulties are all treated by liquorice [78]. Liquorice has been shown to improve memory in scopolamine-induced dementia [79]. Liquorice has been shown to improve memory in mice by [80]. Another study found that giving a 1-month-old albino rat orally fed *Glycyrrhiza glabra* plant extract for 6 weeks increased memory and learning capacity [81]. Furthermore, a study found that Glycyrrhizainflata extract, a distinct species of glycyrrhiza, strongly reduced Aβ aggregation and radical-scavenging activities [82].

Spikenard (*Nardostachys jatamansi*)

It is a member of the Caprifoliaceae family. It is a medicinally important plant that is highly regarded in Ayurveda. The rhizome, or root, which has medicinal properties, is the most important portion of the spikenard. It contains coumarins and sesquiterpenes of various sorts. *Nardostachys jatamansi* was found to improve memory retention and learning in both old and young mice, as well as reverse scopolamine and diazepam-induced amnesia in research. It also helped to cure amnesia caused by ageing [83]. It was found that *Nardostachys jatamansi* to be effective in preventing stress-induced memory loss [84].

Ginseng (*Panax ginseng*)

It is a member of the Araliaceae family. A previous study discovered that ginseng consumption improves learning ability in mice. In vivo and in vitro research has demonstrated the efficacy of ginseng powder, extract, and different ginsedosides on AD [85,86,87]. Ginseng is an herb that has been used to treat Alzheimer's disease. It's a popular memory and energy-boosting plant in China, Japan, and Korea. Ginseng, also known as Chinese ginseng, contains phytochemicals such as ginsenosides (saponins), a triterpenoid dammarane derivative, and 20(S)-protopanaxadiol, which inhibits Amyloid-Beta (Aβ) aggregation, removes Aβ from neurons, increases neurotrophic factor secretion, and improves mitochondrial dysfunction [88].

According to a molecular enzyme study, ginsenosides contained in ginseng have significant AChE inhibitory activity, which is an efficient strategy for lowering AD symptoms [89]. Through the stimulation of phosphatidic acid receptors involved in hemolysis, Gintonin, a bioactive glycoprotein, lowers the production of Aβ and increases learning and memory capacity [90]. It also reduces the symptoms of Alzheimer's disease by stimulating autophagy, anti-inflammatory mechanisms, anti-apoptosis, and oxidative stress management, as evidenced by significant in vitro and in vivo research [91].

The significance of gintonin in the treatment of Alzheimer's disease has been scientifically demonstrated for many years; it modulates G protein-coupled lysophosphatidic acid receptors, altering the cholinergic system and neutrotrophic factors, resulting in a reduction in plaque formation. Gintonin treatment reduced memory impairment in mice by reducing Aβ plaque deposition and increasing the release of According to research, treatment with Gintonin reduced memory impairment in mice by reducing Aβ plaque deposition and increasing the release of AβPPα in the body [92].

In an Alzheimer's disease mice model, gintoninis believed to have the ability to boost choline acetyltransferase expression, prompting the release of Ach, and therefore attenuating Aβ caused cholinergic dysfunction [93]. Because of the presence of stigmasterol, β-sitosterol, and linoleic acid in red ginseng, it protects against Aβ 25–35-induced damage by suppressing NF-κB and MAPK pathway-mediated apoptosis and inflammationin the body [92]. The red oil and nonsaponin polysaccharide fractions worked together to decrease pro-inflammatory mediators by downregulating the p38/-JNK/-NF-κB pathway, as well as the caspase-3/PARP-1 signalling pathway, which inhibited mitochondria-mediated apoptosis and protected against Aβ-induced damage [88].

Nutmeg (*Myristica fragrans*)

It is a member of the Myristicaceae family. It's used to treat mental disorders, digestive problems, leukaemia, body aches, vomiting, tachycardia, dizziness, and memory problems [94]. It has antidepressant, antioxidant, and antibacterial properties [95]. Nutmeg N-hexane extract was given orally to young and old mice at three dose levels (5, 10 and 20 mg/kg p.o.) for three days. At 5 mg/kg, this medication was found to be helpful in reversing scopolamine and diazepam-induced learning and memory deficits. This study established the efficacy of *Myristicafragrans* in the treatment of AD and memory loss [96].

Guduchi (*Tinospora cordifolia*)

It is a member of the Menispermaceae family and has memory-enhancing qualities in both normal and memory-deficient animals. Choline supplementation improves cognitive performance by stimulating the immune system and enhancing acetylcholine production. It is known as a learning and memory booster in Ayurveda. The use of an aqueous extract of guduchi

roots improved verbal learning and logical memory [97].

Brahmi (*Bacopa monnieri*)

It is a member of the Scrophulariaceae family. It has multiple branches with oblong leaves that have decreased in size and purple flowers. Saponins and triterpenoid bacosaponins are the primary components [98]. Traditional healers combine Brahmi with *Centella astiatica* and *Evolulus alsinoides* to treat memory problems and Alzheimer's disease [99]. It improves memory in Alzheimer's patients. It has adaptogenic, neuroprotective, antibacterial, and memory-improving properties [100].

The efficacy of brahmi on cognitive performance, anxiety, and depression in the elderly has been recorded, and it has been found to be useful in improving cognitive functioning in the elderly. This research backs up the use of it as a memory booster. It has long been used to improve neuropharmacological and nootropic actions as well as memory and cognitive function [101,102,103]. They protect cortical, hippocampal, and striatal neurons in the brain from DNA-linked dysfunction and neurotoxicity in AD. In rats with AD-like symptoms, *Bacopamonnieri*has been shown to reduce cholinergic degeneration and improve cognition [104].

Maca (*Lepidium meyenii*)

It is a member of the Brassicaceae family, and it has been shown to increase memory and learning capacities [105]. In Alzheimer's sufferers, maca showed memory-boosting properties. It boosts acetylcholine levels, which improves memory [106]. Because of its acetylcholinesterase inhibitory and antioxidant properties, it improves experimental memory impairment caused by ovariectomy. The potential of *Lepidium meyenii* to improve memory retention and learning capacities in ovariectomized mice was discovered, and this activity may be attributed, at least in part, to its ability to lower lipid peroxidation and acetylcholinesterase in ovariectomized mice [107].

Drumstick tree (*Moringa oleifera*)

It is a member of the Moringaceae family. Its leaf extract contains antioxidant vitamins C and E, which help to improve cognition in Alzheimer's patients [108]. It contains nootropic properties and can help with stress in Alzheimer's patients (Mohan *et al.,* 2005). It affects monoamines, which have a role in memory [109]. According to a rat study, *Moringa oleifera* reduces the severity of colchicine-induced AD via altering monoamine levels such as norepinephrine, dopamine, and serotonin [110].

Amla (*Emblica officinalis*)

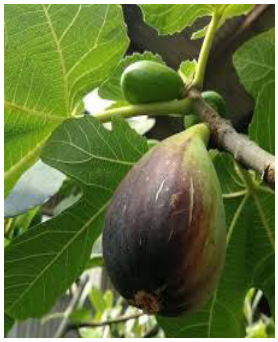
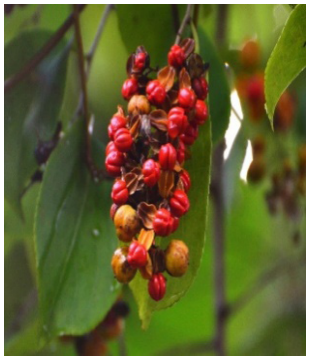
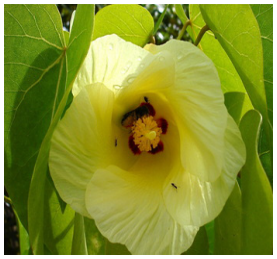
It is a member of the Euphorbiaceae family. In a dose-dependent manner, it showed a considerable improvement in memory retention in young and old rats. It has an important function in the treatment of memory deficits and AD as a memory enhancer and reversal of memory deficiencies [111].

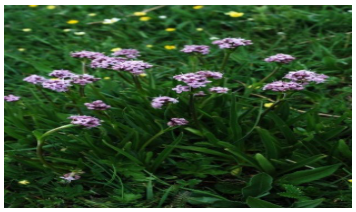
In a study, the memory-enhancing effect of piracetam when combined with amla and turmeric against aluminum-induced cognitive impairment and oxidative damage in rats was investigated. For six weeks, rats were administered 100 mg/kg of aluminium chloride orally. Rats were given amla (100 mg/kg, p.o.), curcumin (100 mg/kg, p.o.), and piracetam (200 mg/kg, i.p.) at the same time for 6 weeks. On days 21 and 42 of therapy, memory was assessed using elevated plus maze task paradigms and Morris water maze tests. Rats were slaughtered on day 43 of treatment to determine the amount of oxidative damage. In rats treated with *Emblica officinalis* (100 mg/kg, p.o.), curcumin (100 mg/kg, p.o.), and piracetam (200 mg/kg, i.p.), oxidative stress was greatly reduced and memory was significantly improved compared to rats treated solely with piracetam (200 mg/kg, i.p.). Amlacould be used to treat memory loss, it has an antioxidant and memory enhancer properties [112].

Table 1: Medicinal Plants Used in Alzheimer Disease and Dementia.

Plant name	Biological source	Phytoconstituents	Mechanism of action	References
Ashwagandha 	*Withania somnifera*	withanamides A and withanamides C	B-Site Amyloid Precursor Protein Cleaving Enzyme (BACE1) and Acetylcholinesterase are Effectively Inhibited (AChE).	[113].
Coriander 	*Coriandrum sativum*	Coumarin	Aβ42, glial cell proliferation, and extracellular signal-regulated kinase activation are all inhibited by this compound. Reduces oxidative stress in the rat hippocampus, which improves Aβ (1–42)-induced spatial memory impairment.	[114].

Ginseng 	*Panax ginseng*	Ginsenoside	Cholinergic and activates Rb1, Rg 1-3, Re, and Rh2 effective in the treatment of AD.	[115].
Coffea 	*Coffea arabica*	Caffeine and chlorogenic acids	Possesses neuroprotective effect in alleviating AD.	[61].
Liquorice 	*Glycyrrhiza glabra*	Glycyrrhizin	In mice, it alleviates the neuroinflammation and memory impairment caused by systemic lipopolysaccharide therapy.	[116]
Magnolia-bark 	*Magnolia officinalis*	Magnolol and honokiol	The ability of AChE inhibition may be connected to the ability to recover memory impairment caused by scopolamine. Reduces Aβ-induced cell death, is neuroprotective, reduces ROS production, inhibits caspase-3 activity, and suppresses intracellular calcium.	[117,118].
Ginger 	*Zingiber officinale*	Shogaol and gingerol	Significantly enhances rates of learning and memory.	[119].
Saffron 	*Crocus sativus*	Crocin	It reduces cognitive deterioration in Alzheimer's patients. Inhibits Aβ and improves cognitive function in Alzheimer's patients.	[120,121].
Maca  	*Lepidium meyenii*	Choline	In ovariectomized (OVX) mice, it improves learning and memory while lowering lipid peroxidation and acetylcholinesterase.	[107].

Ginkgo 	*Ginkgo biloba*	Bilobalideginkgolide	In mice, it promotes cell proliferation and neuroblast differentiation. Effective for the treatment and prevention of AD.	[61, 122].
Fig 	*Ficus carica*	Quercetin	Promotes neuronal bioactivity and protects against oxidative stress-related AD. Cognitive and behavioural deficiencies are improved.	[123,124].
Malkangani 	*Celastrus paniculatus*	Celapanin and celapanigin	Increasing ACh levels in the rat brain increases cholinergic activity and improves memory performance. Protects embryonic rat forebrain neuronal cells from glutamine-induced neurotoxicity.	[71,73].
Turmeric 	*Curcuma longa*	Curcumin	It inhibits the development of Aβ oligomer and fibril in the brains of Tg2576 mice. Reduces the astrocytic marker GFAP, Aβ, and plaque burden in Alzheimer transgenic mice.	[125,45].
Amur grape 	*Vitis amurensis*	Amurensis	In cultures of rat cortical neurons, it prevents neuronal death and has antioxidant properties. In AD mouse models, it improves learning and memory.	[126].
Indian tulip tree 	*Thespesia populnea*	Gossypol	It inhibits the activity of AChE. In diazepam and scopolamine AD mouse models, it improves learning and memory.	[127].

Pomegranate 	*Punica granatum*	Polyphenols	In transgenic mice, it reduces Aβ 42 accumulation and amyloid deposition in the hippocampus, protects PC12 cells from H_2O_2 generated oxidative stress, improves cognitive performance, and suppresses cell death caused by Aβ produced oxidative stress.	[128,129].
Brahmi 	*Bacopa monnieri*	brahmine, nicotinine, herpestine, bacosides A and B	Antioxidant, nootropic, rejuvenation, inhibits acetylcholinesterase	[100,130].
Shankhpushpi 	*Convolvulus pluricaulis*	alkaloids, glycosides, flavonoids, carbohydrates, proteins, sterols, gum and mucilages	Nootropic, anxiolytic, tranquillizing, antidepressant, anti-stress, anti-amnesic	[131].
Jatamansi 	*Nardostachys jatamansi*	sesquiterpenes and coumarins	AChE inhibitor, antioxidant, memory enhancer, anti-inflammatory properties	[132].
Mandookaparni 	*Centella asiatica*	madecassoside, asiaticoside, madecassic acid and asiatic acid	Modulates antioxidant and mitochondrial pathways and improves cognitive function	[133].
Guggul 	*Commiphora whighitti*	Z-guggulsterone, E-guggulsterone, Z-guggulsterol and guggulsterol I-V	Anti-inflammatory efficiency, learning and memory enhancer	[134].
Amla 	*Emblica officinalis*	Phenolic compounds, amino acids, tannins, alkaloids, and carbohydrates	Memory enhancer	[127].

Giloy 	*Tinospora cordifolia*	Choline, Tinosporin, Isocolumbin, Palmatine	Anti-amyloidogenic, anti-cholinesterase, antioxidant, neuroprotective effects, nootropic ameliorates cognitive deficits associated with glutamate-induced excitotoxicity	[135,136].
Lemon Balm 	*Melissa officinalis*	Citronellol, caryophyllene, neral, geraniol, geranyl acetate and citronellal	Nootropic, anxiolytic, antidepressant, anti-stress, anti-amyloid	[137,138].
Nutmeg 	*Myristica fragrans*	Myristicin	Acetylcholinesterase inhibitors, memory-enhancing effect, antioxidant, anti-inflammatory	[96].

Conclusion

In this study, we went over the management of AD in greater depth, as well as medicinal herbs with possible therapeutic benefit. Despite the vast amount of information available about this complex condition, there is no complete solution other than symptomatic treatment. As a result, herbal therapy is expected to slow the progression of Alzheimer's disease and alleviate its symptoms. Patients with Alzheimer's disease and memory problems may benefit from herbal therapy. There is a lot of research going on around the world to find an effective treatment for Alzheimer's disease. According to this study, herbal therapy appears to be a promising option for treating Alzheimer's disease. The majority of herbs and plants have been chemically analysed, and some are currently undergoing clinical trials. The end product is gorgeous and significant. The fundamental mechanisms of action, on the other hand, are still being discovered. Herbs may have a promising function in the early treatment of AD and other dementia-related disorders. One of the main advantages is that, as compared to pharmaceutical drugs, they have low toxicity. The use of various herbal products is becoming increasingly popular. Because multiple studies have shown that using synthetic medications has negative side effects, there is a need for an alternate source of drugs with minimal or no side effects. This article discusses the function of medicinal plants in the treatment of Alzheimer's disease. The mechanisms of action, on the other hand, are still unknown.

Future scope

Alternative medicine has been used since ancient times, and several extracts of medicinal plants and herbal combinations have shown promise in the treatment of Alzheimer's disease. Pharmacologically active phytoconstituents should be extracted, identified, and carefully tested. Multicenter clinical trials should be conducted to evaluate the effectiveness of these herbal drugs alone or in the form of formulations for the treatment of Alzheimer's disease. The use of herbal remedies in the treatment of AD should be compared to the present pharmacological treatment. In order to strengthen the clinical trial's validation, such research should include the identification of the active principle. More large-scale, multicenter research is needed to assess the usefulness of these drugs in the cognitive degeneration of AD. Until then, this review provides some information about the efficacy of a variety of herbs in the treatment of Alzheimer's disease.

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