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Herbal drugs used for the management of learning and memory disorders: A Review

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Abstract:

Memory is a vital mental process studied by neuroscientists through various methods. This symposium introduced two methods to understanding learning and memory. The first approach focuses on the function of synaptic plasticity in the regulating mechanism of motor learning, with a particular emphasis on long-term depression in the cerebellum. The second technique studies how neural populations interact during expansion to build significant behavioural neuronal circuits by using a chick-quail auxiliary system on particular brain regions. This method also helps clarify the neurobiological correlation of perceptual and motor predispositions. Cognitive disorders can result from brain trauma, neurodegenerative diseases, or aging. In humans aging is often accompanied by a decay in cognitive performance, particularly in learning and memory. However, there are various therapeutic approaches available to address cognitive impairments associated with age psychiatric disorders and neurodegenerative conditions. herbal medicine and several plants also as supplements and as part of the diet can enhance brain function, including memory and attention. Out of the hundreds of herbal remedies that have been used for many centuries for improving cognitive abilities and memory, very few have been the subject of controlled clinical investigations.

Keywords: Herbal plant, learning and memory disorders, nootropics.

Introduction

Learning is the process of achieving skills and knowledge through a series of experiences, and memory is how that information is stored and retrieved. Memory disorders can occur as a result of brain injury or neurodegenerative diseases, which can result in difficulties with learning, retention, and recall.[1] Memory problems can range in severity from minor to severe, with injury to the neuro-anatomical systems involved in memory storage and retrieval frequently being the cause.[2] The Botanical Survey of India in Kolkata reported that India is home to 18,386 flowering plant species, representing approximately 6.84% of the world's total. Out of these plants, over 3,000 species have been found to possess medicinal properties, and about 2,500 of them are traditionally used in medicine.[3] It has been demonstrated that more than 150 nootropic herbs improve memory and learning.[4] Because natural medicines are safer and more effective than synthetic pharmaceuticals, which are known to have unfavorable side effects, natural cures are recommended.[5] No single synthetic drug provides complete relief or management of cognitive impairment. Herbal medicines are gaining popularity as they provide a natural way to improve the superiority of life with little or no side effects. Emerging pharmaceuticals have been mostly created from natural materials of the 1,335 approved medications in the 1940s, 59 (4%) and 299 (22%) are derived from natural molecules that have undergone semi-synthetic modification.[6] Dementia is a neurodegenerative disorder that affects lots of people wide-reaching causing a loss of memory and learning abilities [7].

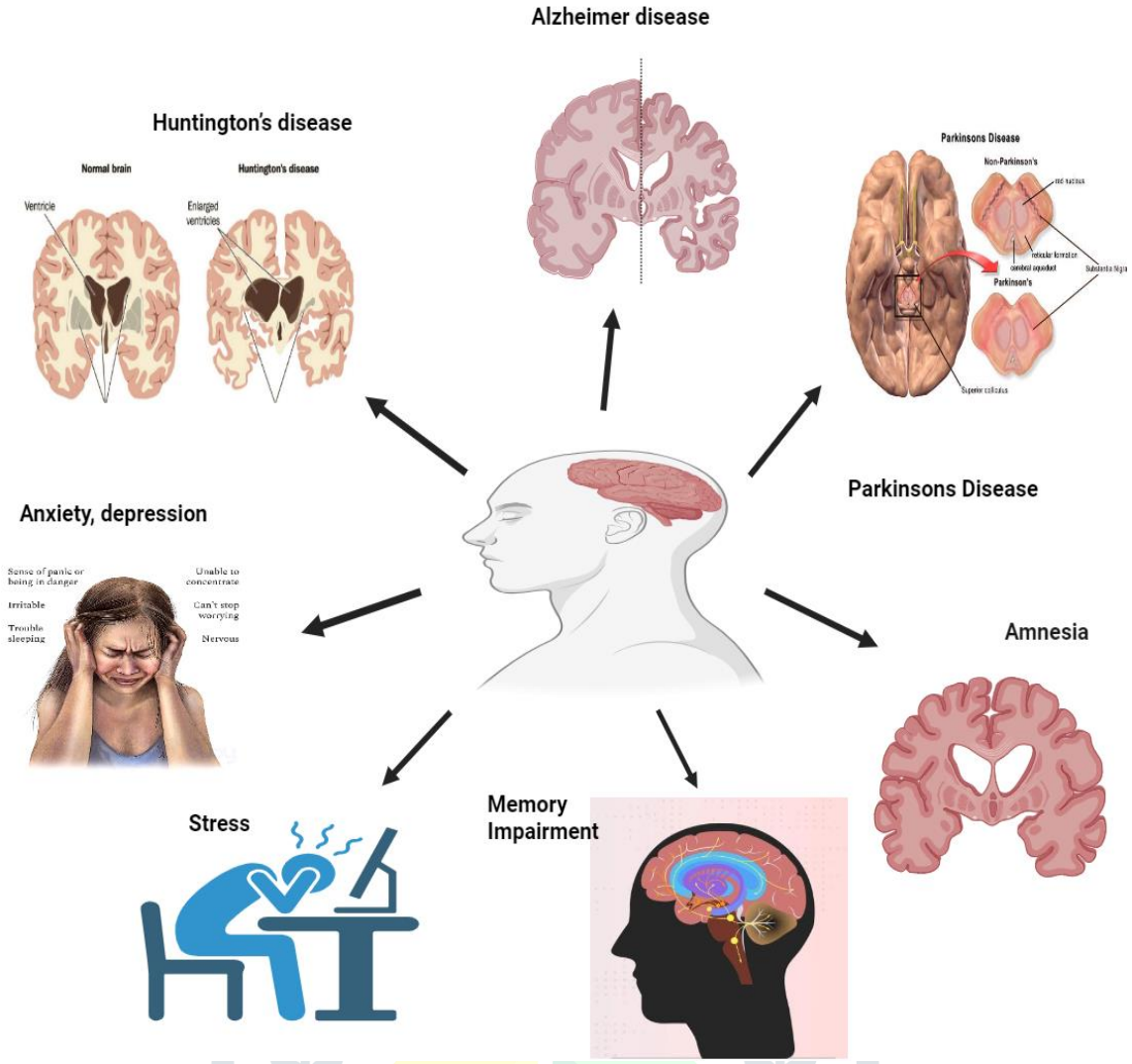

Fig.1 Learning and memory disorders

Sr. no.	Plant name	Scientific name	Phytochemical group	Active constituent	Medicinal use
1.	Ginkgo	Ginkgo Biloba	Terpenoid	Ginkgolide	Improve memory impairment [8]
2.	Brahmi	Bacopa monnieri	Terpenoids	Bacosides A, B, bacopaside.	Cognitive enhancer, nootropic, neuroprotective, sedative, and antiepileptic drug improve memory and repair damaged neurons in the brain.[9]
3.	Turmeric	Curcuma longa	Polyphenol	Curcumin, curcuminoids	Neuroprotective activity, oxidative stress, Parkinson's disease, epilepsy, traumatic brain injury, depression, and Alzheimer's.[10]
4.	Garlic	Allium Sativum	Carbohydrates, amino acids, vitamins,	Alliin, allicin, ajoenes, diallyl monosulfide	Visual memory, Alzheimer's disease.[11]
5.	Extra virgin olive oil	Olea europaea	Polyphenols	Oleic acid, linoleic acid, lutein,	decreased likelihood of developing Alzheimer's disease from moderate cognitive impairment.[12]
6.	Lavender	Lavandula angustifolia	phenolic acids, flavonoids, and benzofurans	cineole, camphor, linalool, linalyl acetate, and terpinene-4-ol	Prevent dementia, stress, depression, anxiety.[13]
7.	Guggul	Commiphora Mukul	steroids, sterols, terpenes, cembrenoids, flavones, tannins	Gallic acid guggulsterone E and Z	prevents the scopolamine-induced memory impairment.[14]
8.	Amla	Emblica Officinalis	flavonoids, isoflavonoids, and triterpenes	Vitamin C, apigenin, gallic acid, quercetin, ellagic acid, chebulinic acid, and chebulagic acid.	Alzheimer's disease, Amnesia, cognitive impairment.[15]
9.	Gotu Kola	Centella Asiatica	Polyphenolic, alkaloid, glycoside, triterpene.	asiatic acid, asiaticoside, madecassic acid, madecassoside, quercetin, glycerides of oleic, palmitic, asiaticoside A,B.	Neuroprotective activity, memory enhancer.[16]
10.	Ashwagandha	Withania somnifera	Alkaloids,	Withaferine A and withanilode D	Antistress agents, Parkinson's, and Huntington's disease help relieve stress and anxiety, improve memory and focus, and improve sleep.[17]

11.	Liquorice	Glycyrrhiza glabra	Flavonoids, triterpenes	glycycoumarin, glycerol, isoflavone, and glycine	neurological disorders such as Parkinson, Huntington's disease and cognitive impairment..[18]
12.	Damask rose	Rosa damascena	Anthocyanins, flavonoids, glycosides, and terpenes	vitamin C, kaempferol, quercetin, β citronellol, nonadecane, geraniol, anerol and kaempferol	Protective effects against dementia, antidepressant, anticonvulsant.[19]
13.	Guduchi	Tinospora cordifolia	alkaloids, glycosides, sesquiterpenoid, tannin, saponin, terpenoids, amino acid	berberine, aporphine tinosporine, atrorrhizine, columbin, tinocordiside, tinocordifolioside, cordifolioside A, B, C, D and E, syringin,	Reduced stress, calming the mind, improved memory.[20]
14.	Capsicum annuum	Capsicum annuum	Polyphenol, glycoside	capsaicinoids. Capsaicin, capsaicinoid	Antioxidant property, Alzheimer's disease, cognitive impairment.[21][22]
15.	Nutgrass	Cyperus rotundus	alkaloids, flavonoids, tannins, glycosides.	Isocyperol, Isokobusone, Kobusone, D-copadiene, Limonene, Camphene, Copaene, Cyperene, Cyperolone, and Linoleic acid	antioxidant, memory-enhancing, neuroprotective activities, antioxidants benefit for memory and neuroprotection.[23]
16.	Jujube	Ziziphus jujube	Flavonoids, alkaloids, saponins, and polysaccharides	Juzirine, juziphine, rutine, quercetin, ellagic acid, alpha-tocopherol.	Sedative and hypnotic effects, insomnia, anxiolytic effect.[24][25]
17	Fennel	Foeniculum vulgare	Phenol, phenolic glycoside, and volatile aroma compound	Fenchone, anethol	Memory enhancing effect, antistress, insomnia.[26]
18.	Lemon balm	Melissa officinalis	Flavonoids, alkaloids, phenolic acid and tannins	geranial, neral, citronellal and geraniol	Dementia, lowering excitability, cognitive dysfunction, stress, anxiety, antidepressant, neuroprotective.[27]

19.	Noni	Morinda Citrifolia	Phenolic compound	Damnacanthal, moridone, morindin, caprylic acid, aucubin,	mental depression, Alzheimer's disease, schizophrenia, Alzheimer's, dementia, seizure and Parkinsonism, antipsychotic, anxiolytic, Improving both long-term and short-term memory.[28]
20.	Devil's club	Oplopanax horridus	Glycosides, triterpenoids, sesquiterpenes, volatile compounds, polyacetylenes.	Phytol, pentacosadienoic acid, beta-sitosterol, maltol, acankoreagenin.	Memory enhancing activity, Alzheimer's disease.[29]
21.	Tulsi	Ocimum basilicum	Terpenoids, alkaloids, flavonoids	Linalool, geraniol and 1, 8-cineole	Numerous neurological disorders, including stress, headaches, nerve pain, epilepsy, depression, migraines, and dementia.[30]
22.	Rosemary	Rosmarinus officinalis	Terpenoids, alkaloids, flavonoids, and essential oils	rosmarinic acid, betulinic acid, ursolic acid, carnosic acid, rosmanol, and carnosol	Antidepressants, improve learning & memory process, epilepsy, stress, anxiety, Parkinson's disease.[31]
23.	Chia seed	Salvia hispanica	Flavonoid,	Alpha-linolic acid, quercetin, myricetin, chlorogenic acid, omega-3 acid	Memory enhancement, antidepressant.[32][33]
24.	Chicory	Cichorium intybus	Phenolic compounds, flavonoids	Artesin, Caffeic acid, Cyanidin Cichoriolide, Chlorogenic acid, epidiaside A.	Neuroprotective, antioxidant.[34][35]
25.	Pineapple	Ananas comosus	phenolic, flavonoids, steroids, tannins, saponins, alkaloids.	Quercitrin, harigenin,	Antidepressant [36]
26.	Vinca	Vinca Rosea	Alkaloids, saponins, tannins, flavonoid, steroids.	Vindoline, vinblastine, vincristine	Memory enhancing activity, Alzheimer's disease.[37]
27.	Ergot	Claviceps purpura	Alkaloid	ergotamine, ergotoxine, ergoxine, and ergoannines, lysergic acid, bromocriptine, nicergoline.	Migraine or cluster headache, Parkinson's disease, improvement in dysphagia, Raynaud's disease, vascular migraines.[38]

28.	Green tea	Cammelia sinesis	Polyphenol	epigallocatechin epicatechin, epicatechin-3-gallate, and epigallocatechin.	Reducing stress, anxiety, it improves the ability to recall information, Parkinson's disease.[39]
29.	Asafoetida	Ferula foetida	Terpinoids	Asafoetida A, Franesiferol A, Ferocaulicin, foetidin, umbelliferone, ferulic acid,	Relaxant effect, neuroprotective effect, memory enhancing effect.[40]
30.	Blue pea, shankhpushpi	Clitoria ternatea	Flavonoids, alkaloids	physostigmine, oleic acid, linolenic acid, palmitic acid, and stearic acid	Memory enhancement, anti-epileptic, anti-oxidative, anti-stress, CNS depressant.[41]
31.	Catuba	Trichilia catigua	Phenolic and flavonoids	Quercetin, isoquercitrin, gallic, chlorogenic, caffeic, rosmarinic, and ellagic acids.	Parkinson's, Huntington's, Alzheimer's, and neurostimulator disorders.[42]
32.	Tualang Honey	Apis dorsata	Flavonoid, phenolic acid	gallic acid, luteolin, kaempferol, naringenin, and apigenin	Improves memory, reduces neuronal damage, and anti-amnesia.[43]
33.	Saffron	Crocus sativa	Flavonoids	Crocin, picrocrocin,	Dementia, cognitive dysfunction, mental disease, neuroprotective function, gingival sedative, nerve sedative.[44]
34.	Coconut	Cocos nusifera	Phenol, tannins, steroids, flavonoids, alkaloids.	Vit.B, B1, B6, C, catechin, epicatechins nicotinic acid,	Depressant, anticonvulsant, antiseizure.[45]
35.	Ginger	Zingiber officinale	phenolic compounds, flavonoids, alkaloids, glycosides, steroids,	Gingerols, shogaol,	Enhancing learning and memory, neurodegenerative disorder.[46]
36.	Cubeb	Piper cubeba	phenylpropanoids, lignans, alkaloids	Ashantin, clusin, cubebinone, cubebin	Improve learning and memory, antidepressant.[47]
37.	Saint John's Wort	Hypericum perforatum	Flavonoids, tannins, phenolic compounds.	Hypericin, rutin quercetin, pseudohypericin, hyperforin, isoquercitin, spathulenol	Alzheimer's disease, Parkinson's disease, anticonvulsant.[48]
38.	Heal-all	Prunella vulgaris	Steroids, flavonoids,	hyperoside, rutoside,	sedative and hypnotic effects.[49]

			phenylpropanoids, triterpenoids.	quercetol, kaempferol, apigenin	
39.	Ginseng	Panax ginseng	Glycosides, carbohydrates, polyacetylenes, phytosterols,	Panaxadiol, panaxatriol,	Parkinson's, Alzheimer and Huntington's diseases, oxidative stress.[50]
40.	Garden sage	Salvia officinalis	cardiac glycosides, flavonoid glycosides, saponins	yunnaneic acids, apigenin, hispidulin, rosmarinic acid, salvianolic acids, sagecoumarin, and sagernic acid	Parkinson's, Alzheimer's disease, oxidative stress, mood enhancing, anxiolytic, antidepressant.[51]
41.	Milkworts	Polygala tenuifolia	Phenolics, triterpene saponins, glycoside.	tenuifolin, senegenin, polygalacic acid, tenuifolin,	Enhancing cognitive function, anti-Alzheimer disease, insomnia, memory dysfunction, neurasthenia.[52]
42.	Intellect plant	Celastrus paniculatus	Terpenoids, flavonoids,	Celastine, paniculatin, paniculatadiol, b-sitosterol, celastrol,	Dementia, Alzheimer's disease, schizophrenia, bipolar depression, Parkinsons disease, Huntington's disease, antidepressant, anticonvulsant.[53]
43.	Club moss	Lycopodium serratum	alkaloids	Huperzine-A, B, huperzinine, lycodoline, fmacleanine	Alzheimer's disease, schizophrenia, enhancing the learning and memory potential.[54]
44.	Nutmeg	Myristica Fragrances	Terpenes, phenols,	myristicin, elemicin, safrole	Antidepressant, memory enhancing activity.[55]
45.	Black seed	Nigella sativa	Flavonoids, alkaloids.	nigellicine, nigellidine, nielloing, carvacrol, nigellimine	prevent oxidative damage to cells, and dementia, improve memory, Parkinson's disease, Alzheimer's disease, and reduced anxiety.[56]
46.	Angel's trumpet	Brugmansia candida	alkaloids, terpenes, glycosides, triterpenes, saponins, glycosides	Anisodamine, Hyoscyamine, scopolamine	Hallucinogen.[57]
47.	Shrub verbena	Lantana Camara	Flavonoids, phenolic compounds, glycosides,	Santolina, elemene, germacrene, ketonic acid	Headache.[58]
48.	Alfalfa	Medicago sativa	Alkaloids, flavonoids,	asparagine, trigonelline, stachydrine, ferulic acid, salicylic acid	Improve the memory, neuroprotective.[59]
49.	Mexican tarragon	Tagetes lucida	Phenolic compound	Estragole, eugenol, methyl	Antidepressant.[60]

				eugenol	
50.	Cocoa	Theobroma cacao	Flavonoids, phenolic acids	Quercetin, ferulic acid, theobromine	Neuromodulator, neuroprotective, Alzheimer's disease.[61]
51.	Artemisia	Artemisia absinthium	Terpenoids, flavonoids, phenolic acids	artemetin, matricin, absinthin, anabsinthin	Improve thinking ability, memory, alertness, and Alzheimer's disease.[62]
52.	Carnation	Dianthus Caryophyllus	Flavonoids, alkaloids, cyanogenic glycosides,	Benzyl salicylate, hootkatone, m-cresyl phenyl acetate, hexyl benzoate, hexenyl benzoate, benzyl benzoate, benzoin, and eugenol	Improve memory, stress, and minor depression.[63]
53.	Lettuce	Lactuca sativa	Flavonoids, phenolic acid	Lectucin, acids ascorbic, citric, glutamic, pectin, vitamin-A, C, E, B1, B2, minerals	Anti-Alzheimer activity.[64]
54.	Coriander	Coriandrum sativum	alkaloids, phenolics, flavonoids,	Myrcene, citronellol, p-cymene, limonene,	anxiolytic, antidepressant, sedative-hypnotic, anticonvulsant, memory enhancement, Alzheimer's disease, neuroprotective,[65]
55.	Grapes	Vitis Vinifera	Flavonoids	resveratrol, vitisins A and B, and picaetannol, and miyabenol C	Alzheimer's disease, neuroprotective activity. [66]
56.	Galbanum	Ferula lutea	Terpenoids,	Umbelliferone, umbelliprenin, galbanic acid, farnesiferol A, diversin, diversolide D, and tschimgine	Alzheimer's disease, antidementia, improved learning abilities, memory enhancer, anticonvulsant, acetylcholinesterase inhibitors.[67]
57.	Lovage	Levisticum officinale	Flavonoids	palmitic acid, ligustilide, 3-butylidenephthalide, trans-β-farnesene, β-phellandrene, n-octanal, and γ-elemene.	Neuroprotective properties.[68]
58.	Chamomile	Matricaria recutita	Terpenoids, flavonoids,	Azulenes, apigenin, quercetin, patuletin, luteolin	Stress, depression, dementia, Parkinson's disease, and Huntington's disease.[69]
59.	Marjoram	Origanum majorana	flavonoids, tannins, glycosides, phenols,	Arbutin, quercetin, 2-carene, camphene,	Relieving insomnia, decreasing stress, and soothing anxiety, Minimising emotional responses,

			lkaloids.		ntianxiety, epilepsy nticonvulsant, headache, migraine.[70]
60.	arsley	Peroselinum vulgare	–	–	mprove the brain function nd memory.[71]
61.	Golden root, osenroot	Rhodiola Rosea	Glycosides, annins	Geraniol, osiridol, oxalic, citric, malic, gallic, succinic cid	rotects the nervous system, owers Alzheimer's risk, and mproves memory, anti-tress, anxiolytic, ntidepressant.[72]
62.	Milfoil, yarrow, housand leaf	Achillea millefolium	annins, erpenoids, flavonoids, lkaloids,	myricetin, hesperidin, quercetin, uteolin, apigenin,	Parkinson's syndrome, epilepsy, and Alzheimer's.[73]
63.	Maidenhair fern	Adiantum capillus-veneris	flavonoids, riterpenoids	utin, quercetin, haringin	nticonvulsant, Anti Alzheimer, Brain tonic
64.	Garden sparagus, hatavari	Asparagus racemosus	Flavonoids, olycyclic lkaloids,	sparagine, rginine, quercetin, kaempferol, rutin	Enhances memory, protects gainst amnesia, ntidepressant activity and ntistress.[74]
65.	Pomegranate	Punica granatum	Flavonoids, lkaloids, henolic compound	Gallic and ellagic cid, eduncula gin, unicalagin, and unicalin.	mprovement in verbal and visual memory, Alzheimer's disease, Parkinsons disease.[75]
66.	Almond	Prunus dulcis	Flavonoids, erpenoids	Amygdalin, runasin	nti-depressant, antioxidant, memory enhancing.[75]
67.	Cinnamon	Cinnamomum verum	Flavonoids, henolic compound	Eugenol, cinnamate, cinnamaldehyde, catechinproanthocyanidins	Alzheimer's disease, Parkinson's disease neuroprotective.[76]
68.	Guarana	Paullinia cupana	Polyphenols, flavonoids	Methylxanthine, caffeine, theobromine, catechin,	Improvement in cognitive function, mood, anxiety, antidepressant, and neuroprotective.[77][78]
69.	Cats claw	Uncaria tomentosa	Alkaloids, glycosides, riterpenes,	Ajmalicine, campesterol, rutin, sitosterols, akuammigine, catechin, carboxyl alkyl esters, and chlorogenic acid.	Anti-Alzheimer.[79]
70.	Woad	Isatis tinctoria	Alkaloids, flavonoids,	Isatin, indican Isatan A, isatan B	depression, anxiety, and stress resistance, neuroprotective.[80]
71.	Firmoss	Huperzia Serrata	Alkaloids,	Huperzine-A	Alzheimer's disease, schizophrenia.[81]
72.	Vacha	Acorus calamus	Alkaloids, riterpenoids, saponin, sesquiterpenoids	Alpha-asarone, eugenol, calamol Isoeugenol	Neuroprotective, anticonvulsant, antidepressant.[82]

73.	Chinese asparagus	Asparagus cochinchinensis	Steroidal saponins	diosgenin, Methyl protodioscin, and ferroic acid	Improve Alzheimer's disease, anti-depressant, neuroprotective.[83]
74.	Cinnamon	Cinnamomum cassia	Terpenoids, glycosides,	Cinnamaldehyde, cinnamic acid,	Neuroprotective effects such as anti-anxiety, cognitive improvement, antidepressants.[84]
75.	Japanese cornel	Cornus officinalis	Flavonoids	Oleanolic acid, ursolic acid,	Depression, insomnia, anxiety, post-traumatic stress disorder, loss of memory, Parkinson's disease, dementia, and cognitive impairment.[85]
76.	Sweet morin	Morinda Officinalis	Flavonoids, amino acid, oligosaccharides	Sucrose, 1-ketose, mannose	Alzheimer's disease, neuroprotective [86]
77.	Desert cistanche	Cistanche salsa	Glycosides	_	Anti-Alzheimer disease, antioxidative, improves learning and memory, antiparkinsons disease, dementia.[87]
78.	Drumstick	Moringa oleifera	Alkaloids, Glycosides	Vit A, C	Nootropics, and Alzheimer's disease, improve learning and memory.[88]
79.	Hazelnut	Corylus avellana	_	Palmitic acid, stearic acids, oleic acid, linolenic acid.	Alzheimer's disease, dementia, anxiety.[89]
80.	Walnut	Juglans regia	Flavonoids, glycosides, alkaloids.	Quercitin, palmitic acid.	Alzheimer's disease, cognitive impairment, dementia, anxiety.[90]

Some medicinal plants for the management of learning and memory

1] Ginkgo

Ginkgophyte. The term "living fossil" is frequently used to describe it because of the way that its shape and features have The maidenhair tree, or Ginkgo biloba (family Ginkgoaceae), is the only species that has not changed in over 100 million years.[91] The plant is used as a food source and is well renowned for its therapeutic qualities. Neuroprotective properties of ginkgo biloba have been shown in both human and animal models.[92] Ginkgolide A, Ginkgolide B, Ginkgolide C, Ginkgolide J, Ginkgolide K, Ginkgolide L, and Ginkgolide M (bilobalide and ginkgolide) are the terpenoid active chemicals present in Ginkgo biloba. G. biloba extract cures blood circulation issues, particularly in the brain, which cause depression, migraines, amnesia, and unconsciousness in the elderly.[93] When administered to mice continuously, G. biloba improved their ability to learn, remember, and store a two response sequence for food reward. Overexpressing β amyloid precursor protein did not alter the histopathological consequences of Intellectual function in an animal model of Alzheimer's disease.[94] G. biloba extract significantly reduces the brain's AChE activity. G. biloba extract's ability to ameliorate scopolamine-induced deficiencies in passive avoidance can be attributed to its reduction of AChE activity. The decrease in AChE activity suggests that acetylcholine levels are higher at baseline.[95]

Fig.1 Ginkgo biloba

2] Bramhi

Bacopa monnieri is belong to the Scrophulariaceae family, is a damp, marshy shrub that thrives over the Indian subcontinent.This plant has been utilised for several nervous system conditions, including as epilepsy, anxiety, and sleeplessness.[96] Bacosides A, B, and C are the active constituents of the dammarane-type triterpenoid saponins, which have been shown to have neuroprotective, nootropic, and memory-improving qualities.[97]. Furthermore, the bacosides A and B promote nerve impulse transmission, improve animal model-observed episodic memory, and mediate the 3 forms of learning function: declarative, procedural, and spontaneous.[98] Its nootropic function may possibly be explained by the fact that it reduced the amnesic effects of scopolamine, electroshock therapy, and immobilization stress, as well as increased hippocampal protein kinase activity.[99] The neurotoxic colchicines depleted acetylcholine, reduced acetylcholinesterase activity, and diminished muscarinic cholinergic receptor bind to the frontal brain and hippocampus. All these effects were reversed after administering bocopa monnieri for two weeks. (100). There is a suggestion that a decrease in noradrenergic function may mitigate the behavioral effects of cholinergic degeneration. (101). In the hippocampus, hypothalamus, and cerebral cortex, bacopa monerrrei is known to raise 5-hydroxytryptamine levels and decrease norepinephrine levels(102).

Fig. 2 Bacopa monnieri

3] Turmeric

Curcuma longa L. is a perennial parsley native to tropical and subtropical countries including India, Southeast Asia, and China.[103] The phenolic chemicals found in the rhizome of turmeric are 1-(4-hydroxy-3, 5-methoxyphenyl)-(6E)-6-heptene-3, 5-dione; 1-hydroxy-1, 7-bis (4-hydroxy-3-methoxyphenyl)1-(5-bis (4-hydroxy-3-methoxyphenyl)-(1E, 6E)-1, 6-heptadiene-3, 4-dione; 1, 5-bis1-dien3-one, -penta-(1E, 4E)-1 5-(4-hydroxyphenyl)-3-methoxyphenyl-14-dien3-one; 1-(4-hydroxy-3-methoxyphenyl); -penta-(1E, 4E)-13, 4-

dihydroxy phenyl -7-1, 7-bis (4-hydroxyphenyl)-1, 4, 6-heptatrien-3-one, and 6-heptane-3, 5-dione.[104] Curcumin and curcuminoids, the main chemical constituents, have a variety of pharmacological properties that include anti-cancer, anti-inflammatory, hypoglycemic, hypocholesterolemic, antithrombotic, liver-protective properties, carminative, diuretic, antirheumatic, hypertensive, antimicrobic, antiviral properties agent, antioxidant, predatory, insect repellent, antivenomous, and antityrosinase actions.[105] Curcumin exhibits potent neuroprotective properties.[106]. Controls hippocampal neurogenesis and defends dopaminergic neurons by activating nuclear factor erythroid 2-related factor, which is the master regulator of the antioxidant response.[107,108,109,110] Curcumin's mode of action includes copper binding, cholesterol reduction, microglial activity modulation, acetylcholinesterase inhibition, and insulin signalling pathway augmentation.[111]

Fig. 3 Curcuma longa

4] Saint john’s wort

The plant Hypericum perforatum belongs to the Hypericaceae family, which is a subfamily of the Malpighiales order and has over 1000 species spread across over 55 genera. Almost 450 species of plants in the Hypericum genus alone are found throughout the world in mild, temperate, subtropical, and mountainous tropical climates. It grows between 3000 and 10500 ends overhead sea level in the western Himalayas of India.[112] Compounds such as anthraquinone derivatives, prenylated phloroglucinols, tannins, flavonoids, and volatile chemicals like essential oils, tannins, hypericin, hyperpyron, choline, and flavonoids are found in the plant's flowering branches and leaves.[113] H. perforatum is used in popular medicine to treating a various conditions, such as rheumatism, hemorrhoids, neuralgia, sprains, snake bites, discomfort, and mood problems. In addition, it contains antimicrobial, hypotensive, stimulating, and spasmolytic qualities. Because H. perforatum works well in treating depression, it is currently utilized as an antidepressant in several countries.[112] Quercetin and quercitrin, two flavonoids found in hypericum extract, can scavenge free radicals. Quercetin's antioxidant properties were further demonstrated by its ability to suppress lipid peroxidation.[114] This healing herb is frequently used in homeopathic treatments to treat cancer, Alzheimer's illness, ear infections in youngsters, and to enhance memory and learning capacities.[115] Mice's passive avoidance memory was enhanced by repeated delivery of Hypericum and Hyperforin, the active ingredient, using a shuttle box.[116]

Fig. 4 Hypericum perforatum

5] Ginseng

Panax ginseng is a highly valued perpetual herb in the Araliaceae family. Its original homelands include China, Korea, and Japan, among other places. Given its numerous health benefits, ginseng is known as the "king of herbs" and it is used in traditional medicine for thousands of years.[117] Panax ginseng's active ingredients include oleanolic acid groups, panaxenosides, panaxadiol, and panaxatriol. It has been investigated whether the groups panaxadiol and panaxatriol can raise the brain's neurotransmitter levels.[118] It's well known that ginseng has adaptogenic properties, which aid the body in overcoming both mental and physical stress. It is similarly claimed to support the immune response, boost energy levels, and expand cognitive function.[119] Owing to its many advantages, ginseng has become well-known throughout the world and is currently among the most widely used herbal supplements. Utilizing ginseng extract can enhance hippocampal muscarinic receptor ligand binding activity and speed up acetylcholine turnover, both of which can enhance intellectual and psychomotor abilities. It may also aid Alzheimer's disease by restoring damaged neural networks and enhancing brain cholinergic function. In a study, red ginseng medicine significantly improved hippocampus lesion-related place-navigation deficiencies in both young and old rats during the place-learning test.[120]

Fig. 5 Panax ginseng

6] Lavender

The herbaceous plant Lavender officinalis, or lavender is belonging to the Lamiaceae family. Originating from the North Atlantic to the Middle East, it is indigenous to the Mediterranean basin.[121] There are roughly 47 different species of lavender, and they grow all throughout southern Europe and the Mediterranean region, especially in southern Italy, southern France, Greece, Yugoslavia, and northern Africa. Lavender extract is

widely used due to its therapeutic advantages. Aflatoxin, camphor, butyric acid, valerianic acid, ursolic acid, cineol, borneol, linalool, and luteolin flavonoids are among its active constituents. [122,123]. These substances contain a number of characteristics that may help to relax and soothe the GABA receptor. Lavender essential oil has been used for generations to treat sadness, anxiety, and sleeplessness. The established diminished effects of various doses of lavender extract on the AChE enzyme have been demonstrated by recent investigations. Acetylcholine is a neurotransmitter involved in learning and memory that is broken down by the enzyme AChE. The commencement of dementia disease and the impairment of spatial memory may be attributed to the increased activity of the AChE enzyme, decreased levels of acetylcholine, and impaired synaptic transmission. As a result, lavender extract might help stop or lessen the advancement of Alzheimer's disease. All things considered, Lavender officinalis is a useful and adaptable plant. [121,124,125]

Fig.6 Lavandula officinalis

7] Sage

In the Lamiaceae family, Salvia officinalis, or sage, is the largest genus. It includes numerous species that have historically been utilised as tonics to improve brain function. Sage has long been used medicinally and in the kitchen to improve memory. It has also been used for ages.[126] In one study, Salvia officinalis is used to treat slight to severe cognitive impairment by blocking the action of the enzyme acetylcholinesterase (AChE), which breaks down acetylcholine, a neurotransmitter that is lacking in Alzheimer's patients. It also has a big effect on concentration and conduct. [127]. For the investigation and therapy of a few illnesses of the central nervous system, including cocaine addiction, schizophrenia, bipolar disorder, and Alzheimer's disease, the active component salvinorin A is a key target. [128]. With approximately 160 recognised polyphenols, including a variety of phenolic acids and flavonoids, salvia plants are an excellent source of polyphenol chemicals. Coumarin, salvianolic acids, caffeic acid and its derivatives, rosmarinic acid, lithospermic acids, sagernic acids, and yunnaneic acids are a few of these phenolic compounds. The flavonoids quercetin, kaempferol, luteolin, apigenin, and hispidulin are the most widely distributed.[126]

Fig.7 Salvia officinalis

8] Ginger

Ginger, scientifically known as Zingiber officinale, is a widely used culinary and medicinal herb in Asian, Indian, and Arabian cultures. Belong to the family of Zingebaracea.
[129] The active components of Zingiber officinale are gingerol, shogaol, and zingerone. 6-gingerol is an active ingredient that raises acetylcholine (ACh) to block cholinesterase activity.[130] Ginger rhizome extract improved cognitive function and reduced oxidative stress in the Morris Water Maze test. [131]. It is used as an antibacterial, antineoplastic, Larvicidal, analgesic, anti-inflammatory, renal protective, liver-protective properties, anti-oxidants, and immune-modulation.[132]. When the effects of an alcoholic ginger extract were assessed in rats, it was found that the rats hippocampal neuron density and cognitive performance improved, but their brain infarct volume shrank. In fact, it lessened the localised cerebral ischemia-induced cognitive impairments.[133] Arabian folklore helps to fortify memory. increases the amounts of dopamine, serotonin, adrenaline, and norepinephrine in the cerebral cortex and hippocampus. [134,135]

Fig.8. Zingiber officinale

9] Guggul

Commiphora mukul secretes oleo gum resin, often known as gum guggul, an extensively used ayurvedic medication. Commiphora species are little, thorny bushes or trees belonging to the Burseraceae family that have short branches [136]. The active components of guggul include terpenes, sesquiterpenoids, cuminic aldehyde, eugenol, the ketone steroids Z- and E-guggulsterone, and guggulsterone I, II, and III.[137]. Superoxide radicals are nonetheless effectively scavenged by the phenols, ferulic acids, and other nonphenolic aromatic acids

present in guggul. These drugs are essential for the treatment of neurodegenerative diseases brought on by oxidative stress.[138,139] Z-guggulsterone has been found to improve behaviour in mice exhibiting abnormalities induced by neuroinflammation using tests such as forced swim and tail suspension.[140] Additionally, via activating the CREB-BDNF pathway, It has been shown to be protective against impairment of memory in scopolamine-induced loss of memory models.[141] In dementia models with memory deficits brought on by streptozotocin, guggulipids have been demonstrated to have beneficial effects due to their cholesterol-lowering, anti-oxidants, and acetylcholinesterase qualities.[142].

Fig.9 Commiphora Mukul

10) Drumstick

The plant known as Moringa oleifera belong to the Moringaceae family. It is a native of India and a widely spread species in its family. These trees can grow up to a height of ten metres. Their leaves are either tripinnate or bipinnate, and their branches are weak. The flowers are about 2 cm broad, 0.5-1 cm long, and yellowish-white. [143]. M. oleifera main chemical constituents include vitamins A and C, polyphenols (flavonoids, chlorogenic acid, and phenolic acids), alkaloids, glucosinolates, isothiocyanates, tannins, and saponins. [144]. The anti-convulsant qualities of moringa olifera have an impact on the central nervous system (CNS). This is explained by how it affects a key system that controls the release of GABA (γ-amino butyric acid). Because of this, it is frequently used to treat epilepsy. Moreover, it offers defence against chronic and degenerative brain illnesses like Alzheimer's. To improve memory, Additionally, moringa olifera affects hippocampus neurons. Furthermore, it promotes the variation of photo-receptors and myeloid cells, which helps to produce hippocampus neurons. [145] Impact of leaf extract from Moringa oleifera on markers of oxidative stress, AChE activity in the hippocampus, neurodegeneration, and spatial memory. The study findings show that the aforementioned extract significantly improves spatial memory and lowers the rate of neurodegeneration in the hippocampal areas known as the CA1, CA2, CA3, and dentate gyrus. It was discovered that the extract improved the actions of superoxide dismutase, catalase, and acetylcholinesterase while lowering malondialdehyde levels. These results imply that the leaf extract of Moringa oleifera may be useful in treating cognitive problems linked to oxidative stress and neuronal degeneration.[146]

Fig.10 Moringa oleifera

Conclusion

Alternative medicine has been practiced since antiquity, and a number of herbal remedies and plant extracts have demonstrated potential in the treatment of cognitive and memory impairments. Medicinal plants provide a rich field for the unearthing of novel medications since they can turn on a wide range of naturally occurring pathways and contain a variety of chemical components. To turn this promise into effective therapy, there is still more work to be done. There is a pressing demand for plant extract standardization in the study of herbal drugs. It is important to separate, identify, and thoroughly examine the phytoconstituents that are responsible for pharmacological actions. To confirm whether these herbal remedies, taken separately or combined in formulations, are effective in treating learning and memory disorders.

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