Introduction

Memory is the ability of an individual to record sensory stimuli, events, information etc., retain them over a short or long period of time and recall the same at a later date when needed. Learning is the process of acquiring knowledge about the world and memory could be considered as the retention of the acquired knowledge, which can be retrieved as and when, required. Memory function is perhaps the most vital of all aspects that differentiates human beings from other animals. However, memory can become faulty due to several reasons, and in that case the person is not able to make full use of his or her potentials. Cognitive enhancers are drugs, supplements, nutraceuticals and functional foods that are purported to improve mental functions such as cognition, memory, intelligence, motivation, attention and concentration. Drugs considered cognitive enhancers include dietary products, racetams, stimulants, dopaminergics, cholinergics, GABA blockers, glutamate activators, serotonergics and hormones etc. Not all of them are healthy or safe to use but they can still have mental benefits. In recent years research on medicinal plants has been studied for nootropic activity. Bacopa monnieri (Brahmi), Ginkgo biloba, Euphorus alsinoides (Shankpushpi), Tinospora cordofolia (Guduchi), Acorus calamus (Bach) etc., are used as memory enhancer drugs. The abstract refers to several plants with their activity. The main aim of this article is to give up the data reviews on plants with nootropic properties.

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2. SCIENTIFIC DOCUMENTATION OF HERBS

In traditional practices of medicine, numerous plants have been used to treat cognitive disorders, including neurodegenerative diseases such as Alzheimer’s disease (AD) and other memory related disorders. Various studies been undergone to identifying potential new drugs from plant sources, e.g. alkaloids from plant sources have been isolated from plants, e.g. alkaloids from plant sources have been investigated for their potential in AD therapy, and are now in clinical use. Usually herbal preparations are well tolerated but they may have harmful side-effects, including interactions with pharmaceuticals. Herbal medicines, such as, Ginkgo Biloba, Bacopa monniera (Bramhi), Shankhpushpi etc. has been found to increase memory power.
2.1. GLYCRRHIZA GLABRA (FABACEAE)
The roots and rhizomes of Glycrrhiza Glabra (Fabaceae) is an efficient brain tonic, it increases the circulation into the CNS system and balances the sugar levels in the blood\(^1\). Significant action on memory enhancing activity in dementia disorder\(^2\). Liquorice shows significantly improved learning and memory on scopolamine induced dementia. The main constituent of Glycrrhiza Glabra is glycyrrhizin. The roots have anti ulcer, expectorant, diuretic, laxative, sedative, antipretic\(^3\), anti microbial and anxiolytic activities\(^4\). Oxygen free radicals and other products of oxidative metabolism have been shown to neurotoxic\(^5\). The protective effect of liquorice extract may be attributed to its antioxidant property by virtue of which susceptible brain cells get to less oxidative stress resulting in reduced brain damage and improved neuronal function thereby enhancing the memory\(^6\).

2.2. CAESALPINIA CRISTA LINN. (CAESALPINIACEAE)
Caesalpinia crista (Lin.) synonym: Caesalpinia bonduc (L.) Roxb., Caesalpinia bonduca belong to family Caesalpinaceae and is commonly known as kat-takaranja in Hindi and sagargota in Marathi. It is prickly shrub found throughout the hotter regions of India and Sri Lanka\(^7\). The seeds of the plant contain bonducin, proteins, saponin, starch, sucrose, an enzyme, two phytosterols namely sitosterol and heptasane, fattyacids such as palmitic acid, stearic acid, lognecoric, oleic, linolenic acid. The seed kernels of the plant contain furanoterprenes- δ-caesalpin, β-caesalpin, γ-caesalpin, δ-caesalpin, ε-caesalpin and F-caesalpin\(^8\). In India, various parts of this plant has been used in various therapeutic uses like adapticogenic\(^9\), antimalrarial, antiproliferative, antidiabetic\(^10\), anti-filarial, contractility on uterus, hepatoprotective, antitumor, and antioxidant activities\(^11\). Ethanolic extract of dried seed kernel of Caesalpinia crista Lin. enhances learning and memory activity, impairment induced by scopolamine and these effects are mediated in part by inhibition of AChE activity in the brain.

2.3. GINKGO BILOBA (GINKGOACEAE)
Ginkgo Biloba (Ginkgoaceae) is also known as maiden hair tree, kew tree, ginkgo, yinhsing. The herb shows memory enhancing action by increase the supply of oxygen, and helps the body to eliminate free radicals thereby improving memory\(^12\). More recently, an in vitro study indicated that Ginkgo extract had an anti amyloid aggregation effect\(^13\). G. biloba extract has also been reported to increase transthyretin RNA levels in mouse hippocampus; transthyretin is part of the mechanism for beta amyloid transport and this mechanism may also protect against amyloid deposition in brain\(^14\). The main medicinal constituents are found in the ginkgo leaf. These include flavonoids and several terpene trilactones unique to ginkgo (ginkgolides and bilobalide). The 3 major flavonoids of ginkgo are querce tin, kaempferol, and isorhamnetin. About 40 minor flavonoids also have been identified and include catechins, dehydrodectachins (proanthocyandins), and flavones (eg. ginkgetin, amentoflavone, bilobetin, sciadopitysin). The major terpine molecules unique to ginkgo are ginkgolides A, B, C, J, and M and bilobalide\(^15\).

Ginkgo biloba can improve behavioral adaptation despite adverse environmental events, as shown in rats taught reward versus punishment (stress) testing to obtain drinking water. This supports clinical use of ginkgo to treat cognitive impairment in the elderly Population\(^16\).

2.4. CENTELLA ASIATICA (UMBELLIFERAE)
Centella asiatica (L) Urban (Umbelliferae/Apiaiceae family) is commonly known as Mandukparni. It is a perennial creeping herb, widely cultivated as a vegetable or spice in India. Since ancient times, it has been used as a memory enhancing, strength promoting, wound healing, immune booster, anti-anxiety, anti-epilepsy and anti-stress substance. This plant is also found to improve short-term memory and learning. Centella asiatica has also shown a protective effect against oxidative damage caused by lead acetate induced neurotoxicity\(^17\). Centella asiatica is also known as a brain tonic, cognition, recalling of thoughts and as an antioxidant capable of treating amnesia and having property for improving memory\(^18\). Treatment with C. asiatica extract during the early postnatal developmental stages, when the higher brain centers are maturing, can produce long lasting beneficial effects on the mouse brain. Beneficial effects on cognitive functions are probably mediated through their effect on cholinergic system and by influencing the neuronal morphology. Extract of C. asiatica (whole plant) has also been reported to increase the endogenous antioxidant enzymes in the rat brain\(^19\).

2.5. TINOSPORA CORDIFOLIA (MENISPERMACEAE)
Tinospora cordifolia (Wild.) Miers ex Hook.F. & Thoms. (family: Menispermaceae) commonly known, as “Amrita” or “Guduchi” is an important drug of Indian System of Medicines (ISM) and used in medicines since times immemorial\(^20\). It is distributed throughout the tropical Indian subcontinent and China, ascending to an altitude of 300 m. In Hindi, the plant is commonly known as Giloe\(^21\). A large number of chemicals have been isolated from T. cordifolia, belonging to different classes such as alkaloids, diterpenoid lactones, glycosides, steroids, sesquiterpenoid, phenolics, aliphatic compounds and polysaccharides. Leaves of this plant are rich in protein (11.2%), calcium and phosphorus\(^22\). Four new clerodane furanoterpene glycosides (amritosides A, B, C and D) have been isolated as their acetates from stems. Tinospora cordifolia has been extensively studied and reported to have potent immunomodulatory action. T. cordifolia is claimed to be useful in treating leprosy, fever, asthma, anorexia, jaundice, gout, skin infections, diabetes, chronic diarrhoea, dysentery, etc.\(^23\). Alcoholic and aqueous extracts of Tinospora cordifolia have been shown to produce a decrease in learning scores in Hebb William maze and retention memory, indicating enhancement of learning and memory\(^24\).

2.6. ZINGIBER OFFICINALE (ZINGIBERACEAE)
Ginger, or Zingiber officinale, a plant in the family of Zingiberaceae, has long been used as both a spice and as a medicine in Asian, Indian, and Arabian folklore. The rhizomes of Zingiber officinale exhibit a wide range of pharmacological properties including antilipidemia, antiematic, anti-inflammation, and antiarthrit. According to Arabian folklore, ginger has been claimed to improve memory. Moreover, it has also been traditionally used as an ingredient for cognitive improvement\(^25\).

Zingiber Officinale significantly improves learning and memory\(^26\). Its major active constituents are gingerin, gingerol, shogaol and zingerone. A scientific study has demonstrated beneficial effect of ginger rhizome to protect against focal cerebral ischemia. The cognitive enhancing effect and neuroprotective effect of Ginger is partly due to its antioxidant activity\(^27\).

Zingiber officinale was previously reported to enhance the level of norepinephrine, epinephrine, dopamine and serotonin contents in the cerebral cortex and hippocampus. Moreover, this plant extract and its active component, 6-gingerol, also inhibited the cholinesterase activity which in turn increased acetylcholine (ACh)\(^28\).

2.7. BACOPA MONNIERA (SCROPHULARIACEAE)
Bacopa monniera, a member of the Scrophulariaceae family\(^29\). It is known as Brahmi, Nīr-bṛhati in Sanskrit, Bhrmī-sak, Jalanimbra in Bangali, Brahmī in Hindi\(^30\).

The Bacopa monniera (BM) is a creeping, glabrous, succulent herb, rooting at nodes whose habitats include wetlands and muddy shores. Stem 10-30 cm long, 1-2 mm thick, soft, glabrous; branches ascending. Leaves 0.6-2.5 cm long and 3-8 mm broad, sessile. The compounds responsible for the memory enhancing effects of Bacopa monniera are triterpenoid saponins called “Bacosides”\(^31\). The major chemical entity should be responsible for the memory-facilitating action of Bacopa monniera. Bacosides A, was assigned as 3- (α-Larabinopyranosyl)-(β-D-glucopyranoside-10, 20 dihydroxy-16-keto-dammar-24-ene. Three new saponin have been isolated from the Bacopa monniera designated as bacosides III, IV, V with structures 3-O-α-L-arabinofuranosyl (1→2)-β-D-glucopyranosyl jujubogenin, 3-O-β-D-glucopyranosyl (1→3)-α-Larabinopyranosyl jujubogenin, 3-0-D-glucopyranosyl (1→3)-α-Larabinopyranosyl jujubogenin. Bacopa monniera is used in falling conditions Memory enhancing activity, Antisapmodic activity, Anticholinesterase activity, Neuroprotective role, Antioxidant activity, Antidepressant properties, Bronchovasodilator activity, Anticancerogenic activity, Antibacterial activity, Anticancer activity, Antileishmanial properties\(^32\).
2.8. ILEX PARAGUARIENSIS (AQUIFOLIACEAE)

Ilex Paraguariensis (Yerba mate tea) leaves (AQUIFOLIACEAE) is a dioecious evergreen tree, which can grow to an elevation of up to 8–15 m. The 8 cm long olive-green leaves are perennial, alternate, coriaceous, obovate with slightly crenate dentate margins and obtuse apex, and have a wedge shaped base. The petioles are up to 1.5 mm long. The flowering stage occurs during spring season, producing small, unisexual flowers which have 4 white petals. In some tropical or subtropical species, the number of petals may be 5, 6 or 7[1]. Ilex paraguariensis green (non-roasted) extracts contain purine alkaloids (methyl xanthines), flavonoids, vitamins such as vitamin A, B complex, C and E, tannins, chlorogenic acid and its Derivatives, numerous triterpene saponins derived from ursoic acid, known as matesapinols[43, 44, 45]. The ilexes leaves are reported memory enhancing activity on dementia on different models are spontaneous locomotor activity, social recognition task and inhibitory avoidance task methods[46].

2.9. HUPERZIA SQUARUS (LYCOPODIACEAE)

Huperzia squarosa (Lam) Trevis. (=Lycopodium squarum Lam., =Urostachis squarosa Lam.) (LYCOPODIACEAE) is known in Argentina under the names of “cola de quirquincho”; “piyiyay" or “piyiyay”, “quironcho”. Huperzia squarosa is used as an aphrodisiac[47]. Its habitat spreads from the northwest region of the country to the sierras of the center (Cordoba) and south of Buenos Aires. It has also been found in other South American and African countries[48]. Huperzia squarusa mainly contain two major constituents hyperzine A and B and are lycopodium alkaloids among the compounds with known activity on memory and learning[49]. Huperzine A has been investigated for memory improvement and for the treatment of Alzheimer’s disease and myasthenia gravis[50].

2.10. EVOLVULUS ALSINOIDES (CONVOLVULACEAE)

Evolvulus alsinoides (EA) is an important plant that has been well documented in Ayurveda for its therapeutic values. EA (Linn) (Family:Convolvulaceae) commonly known as Shankhpushpi is found throughout India ascending to 6000 ft in the Himalayas. It is well known for its therapeutic effect on brain disorders like insanity, epilepsy, memory enhancement and nervous debility in Indian Ayurvedic system of medicine[51]. Evolvolus alsinoides (Convolvulaceae) is used as nootropics or brain tonic in traditional systems of medicine. In the Ayurvedic system of medicine, the whole herb of Shankhpushpi has been employed clinically for centuries for its memory potentiating, anxiolytic and tranquilizing properties[52]. Ethanol, aqueous and ethyl acetate extracts of Evolvolus alsinoides have been shown to improve learning and memory in rats[53].

Evolvolus Alsinoidecs L contains alkaloids betaine, sakhaphispine and evolvine, scopoletis, scopolin, umbelliferone, 6-methoxy-7-0-β-glucopyranoside coumarin quertine-3-0-β glucopyranoside are reported[54]. Evolvolus Alsinoidecs L possesses antibacterial and anthelmintic[55].

2.11. ACORUS CALAMUS (ARACEAE)

Acorus calamus, commonly known as Sweet Flag or Calamus and erroneously as ‘rush’ or ‘sedges’, is a plant from the Acoraceae family, in the genus Acorus. It is a tall perennial wetland monocot, with scented leaves and more strongly scented rhizomes[56]. Acorus Calamus contains majorly α and β-asarone. The rhizomes of Acorus Calamus are used in loss of memory given in combination with other drugs like Centella Asiatica, Bacopa Monniera and Rauwolfa Serpentine[57]. Acorus Calamus also shows anti inflammatory, antioxidant, anti spasmodic, hypolipidemic, immunosuppressive, cytoprotective, anti diarrheal, antimicrobial and antihemilic properties[58].

2.12. COMMPHORA WHIGHTII (BURSERACEAE)

Commiphora wightii (Guggal, Guggul or Mukul myrrh tree) is a flowering plant in the family Burseraceae. It is a shrub or small tree, reaching a maximum height of 4 m, with thin papery bark. The active ingredient in the extract is the steroid guggulsterone, which acts as an antagonist of the farnesoid X receptor[59]. The guggul lipid shows potential cognitive enhancer for improvement memory in scopolamine induced memory deficits[60]. The commiphora whightii acting on impairment in learning and memory and decreased choline acetyltransferase levels in hippocampus[59].

2.13. EMBILICA OFFICINALIS (EUPHORBIACEAE)

Emblica officinalis, The Indian gooseberry, or amla, is known for its edible fruit of the same name[61]. Emblica Officinalis (Euphorbiaceae) possesses memory enhancing action on improvement in memory in scopolamine and diazepam induced memory deficits. Emblica Officinalis inhibits the AChE activity. Amla may prove to be a useful remedy for the management of Alzheimer’s disease due to its multifarious beneficial effects such as memory improvement and reversal of memory deficits[62].

2.14. SALVIA LAVANDULAEFOLIA (LAMINACEAE)

Salvia Lavandulaefolia (Spanish sage) (Laminaceae) and other salvia special are prominent for their reputed beneficial effects on memory disorders, depression and cerebral ischemia, anti cholineresterase activity[63]. Salvia majorly contains essential oils, 1, 8-cineole, linalool, α and β-pinene, carvacrol, luteolin. Salvia Lavandulaefolia has been reported to be antioxidan[64]. Salvia Lavandulaefolia inhibit the acetylcholinesterase and improvement of memory in dementia[65].

2.15. FOeniculum vulgare (UMBELLIFERAE)

Foeniculum vulgare Linn. Extract used as a nootropic and anticholinesterase agent in mice. F. vulgare extract increased step down latency and acetylcholinesterase inhibition in mice significantly. F. vulgare is employed in treatment of cognitive disorders such as dementia and Alzheimer’s disease[66].

2.16. MAGNOLIA OFFICINALIS (MAGNOLIACEAE)

Magnolia officinalis (commonly called Houpu Magnolia or Magnolia bark) is a species of Magnolia native to the mountains and valleys of China at altitudes of 300-1500 m. It is a deciduous tree growing to 20m in height. The bark is thick and brown but does not fissure. Magnolol and honokiol exhibit an AChE inhibitory property, in rat spleen microsomes and human polymorph nuclear leukocytes[67]. Magnolol, and honokiol has shown anti inflammatory, anti allergy and anti allergic activity by using water maze and step down avoidance methods[68].

2.17. LEPIDUM MEYENII (BRASSICACEAE)

Lepidum meyenii (Brassicaceae) known commonly as mace, is an herbaceous annual biennial plant native to the high Andes of Peru and Bolivia. It has shown beneficial improvement on memory and learning. Aqueous and hydroalcoholic extracts of Black Maca have significantly ameliorated the scopolamine-induced memory impairment in mice[69]. Lepidum Meyani acting on cholinergic dysfunction mainly neurotransmitter (ACH) related to memory and learning[70]. Black maca (0.5 and 2.0 g/kg) decreased brain malondialdehyde (MDA) levels marker of oxidative stress and acetylcholinesterase (Ache) levels in ovarioctomized mice whereas no differences were observe in monoamine oxidase (MAO) levels[71].

2.18. ROSA ALBA (ROSACEAE)

Rosa Alba (Rosaceae) possess memory enhancing property. Rosa alba produces symptomatic improvement in learning and memory. Rosa Alba might proven to be a useful memory restorative agent in the treatment of cognitive disorders. Rosa alba reported the effects on cognitive functions learning and memory by using elevated plus maze and passive-avoidance test. Rosa alba inhibits cholinesterase and improves the memory power[72]. Rosa Alba also used in leprosy, biliousness burning sensation, appetite, cold, headache, bronchitis, ophthalmia, rheumatism and its perfume is a tonic for the brain and the heart[73].

2.19. THESPESIA POPULNE (MALVACEAE)

Thespesia populnea (Malvaceae) is a large tree found in the tropical regions and coastal forests of India. Various parts of T. populnea are used as nootropic useful medicinal properties, such as antiarrhythmic, antibacterial, and anti inflammatory. The learning and memory parameters were assessed using elevated plus maze and
passive avoidance paradigm. It showed significant improvement in memory of young and aged mice. T. populnea bark possessed a powerful memory enhancing activity in mice. Since diminished cholinergic transmission and increased cholesterol levels appear to be responsible for development of amyloid plaques and dementia in Alzheimer patients17.

2.20. SESAMUM INDICUM (PEDALICAE) 

Sesamum indicum is annual herb family (Pedaliaceae). It is widely naturalized in tropical regions around the world and is cultivated for its edible seeds, which grow in pods. Sesaminol glycosides are one of the most abundant lignan glycosides found in sesame seeds. Dietary sesame has showed a protective effect against Abeta-induced learning and memory deficits in passive avoidance and the Morris water maze test17. Sesamum indicum contains major active constituent’s protein, carbohydrates, vitamins, (Thiamine, Nicacin), riboflavin, nicotinic acid, pantothenic acid and ascorbic acid. Sesame oil is rich in oleic and linolic acids. The main sesame lignans are sesamin and sesamolin which are found in sesame oil18. Sesamum oil having the antioxidant activity20. Sesamum seeds are considered emollient, diuretic, lactagogue and nourishing tonic, emmenagogue and cough. Powdered seeds are used in amenorrhea and dysmenorrhea24.

3. CONCLUSION 

The review focuses on several natural memory enhancing agents acting on dementia. Dementia is a syndrome usually occurs with impairment in memory, thinking, orientation and judgment. In majority of the studies, the underlying mechanism was found to be anti acetylcholinesterase activity and free radical scavenging activity with the facilitation of the cholinergic transmission. The typical scientific approach for selecting plants to investigate for the treatment of these disorders is relatively rational method to develop more acceptable and better substitute to the present pharmacotherapy. The collection of herbal plants showing the nootropic activity were tabulated from the various journals and were reported above as we can conclude that herbal plants are very rich source of substance which are responsible of increasing nootropic activity.

REFERENCES 


