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ReviewArticle

Ethnomedicinal Study of Plants used for Neurodegenerative Diseases: A Review

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Abstract: Various diseases are correlated with the nervous system. These diseases are called Neurodegenerative Diseases (NDs) such as Alzheimer's disease (AD), Huntington's disease (HD), Parkinson's disease (PD), Epilepsy, Schizophrenia, and Depression. NDs can be cured by using various medicinal plants that have certain active chemical compounds that are effective against neurodegenerative diseases. In this study, forty plants are overviewed which are used to extract bio-chemicals for treating neurodegenerative diseases in Pakistan as well as in other countries of the world. Whole plants or parts of plants from roots to seeds are given directly to patients with neurodegenerative diseases or bio-chemicals are extracted from these plants and used for the cure of these diseases.

1. INTRODUCTION

The human body consists of the nervous system which contains the brain and sensory organs. The brain consists of nerve cells by which it regulates all the functions of the body [1]. The brain consists of 100 billion neurons. These neurons are involved in different functions like remembering, thinking, smelling, hearing, and seeing. By these neurons, all the organs are connected with the brain and work accordingly to the signal received by the brain [2]. Neurodegeneration is a progressive deterioration of the nervous system. It may be due to age or different environmental factors that result in damage to the motor, emotional, cognitive, and sensory functions. Acute neurodegenerative diseases can be cured while chronic diseases remain and progress with time. According to the Global Burden of Diseases, Neurodegenerative syndromes are the second major reason for deaths in the whole world [3]. About 6.8 million deaths occur every year due to these disorders [4].

Neuroprotection includes relative mechanisms and strategies by that we can fight against damaged neurons that are due to some neurodegenerative disorders. For this purpose, phytochemicals play an important role in neuroprotection. Researchers in the world are finding bioactive phytochemicals from plants that can be used for neuroprotection in traditional medicine like the Korean system of medicine, Chinese medicinal system, the Mediterranean system of medicine, Indian Ayurvedic medicine systematic.

2. NEURODEGENERATIVE DISEASES

Here are some of the important neurological diseases. Neurodegenerative disorders are the second major reason for death among old people by the 2040s.

2.1. Alzheimer's Disease

It is named after German physician Aloes Alzheimer. AD is a prolonged disease that causes degeneration of the brain. It is also a type of dementia [5]. It mostly affects old age people. This disease increases with time. Its increasing rate is estimated to about 3.0% in 65-74 age and 47.2% in people with the age of 85 years [6]. During AD there is the formation of neurofibrillary clots, astrogliosis, amyloid-beta plaques which results in chronic disease. The symptom of AD includes Memory impairment,

insomnia, disruptive behavior, memory loss, confusion, and decreased speaking function.

2.2. Parkinson's Disease

It is initiated by the malfunction of motor neurons. In this disease substantianigra (brain part) is affected. Motor neurons play an essential role in movement. Due to PD Body parts involved in movements are affected. Primary symptoms of PD involve trembling of legs, hands, face, arms, the rigidity of limbs, and impaired coordination [7]. It is estimated to about 15 people out of 100,000 becomes victims of this disease each year [8].

2.3. Huntington's Disease

It is a disease of the brain which is due to a chromosomal disorder. It is due to chromosome 4 which gets affected which leads to changes in nerve cells [9]. Symptoms of HD involve, involuntary movement of legs, arms, and heads, weakening of thinking, depression, and bad temper. Mostly it is found in people with the age of 30-40 years. About 12 people per 100,000 are affected by HD.

2.4. Depression

Depression represents an unhappy mood. It may vary from slight sadness to misery. This condition is determined by environmental as well as biological factors. Depression results from a reduction in the hippocampus and frontal cortex, 5-HT abnormalities, and dysfunctions of the HPA axis [10]. Approximately 450 million people are affected by depression according to World Health Organization (WHO).

2.5. Epilepsy

Epilepsy is characterized by the irregular occurrence of periodic epileptic seizures. Seizures result from the unnecessary release of cerebral neurons in gray matter. In epilepsy, damaged calcium and sodium channel having excessive glutamate-mediated neurotransmission may activate a flow of events which leads to cellular death. Epilepsy affects almost 50 million worldwide [11].

2.6. Schizophrenia

It is a disease in which the patient does not know about the present and what is around him. In this psychiatric disorder level of neurotransmitters such as acetylcholine, dopamine, 5-HT, and nor-epinephrine up-regulates in the nervous system [12]. This disease has two types of symptoms.

2.6.1. Positive symptoms

These symptoms include hallucination, misunderstandings, and abnormality in behavior and thinking disorders.

2.6.2. Negative symptoms

These include a lack of social contact and flattening of emotional responses.

3. PHYTOCHEMICALS EFFECTIVE FOR NEUROPROTECTION

3.1 Polyphenols

Polyphenols are secondary metabolites found in plants. The benzene ring is associated with more than one phenolic group. Studies show that flavanols have a positive effect on the brain. Catechin gives protection against brain damages due to Parkinson's disease. Catechin also suppresses inflammation of neurons [13].

3.2. Alkaloids

Alkaloids affect the autonomic nervous which regulates blood circulation breathing, and heartbeat. It also affects the Central Nervous System. Indole alkaloids containing indole carbon-nitrogen ring may hinder the action of serotonin in the brain [14]. Tropane alkaloids extracted from Datura effects Peripheral Nervous System (PNS) and Central Nervous System (CNS).

3.3. Isoprenoids

Plants contain isoprenoids which are effective for neuroprotection. For example, *Valerian officinalis* rhizome contains sesquiterpenes and valepotriates which affect GABA uptake inhibition and GABA (B) receptor binding property in rat synaptosomes. Similarly, *Centella asiatica* contains γ-terpinene, triterpenoid, and β-pinene which are effective for reinforcement and energizing of nervous functions.

3.4. Fatty acids

Fatty acid maintains the structural organization of neurons [15]. Unsaturated Fatty Acids slow down mental degeneration in humans and animals. Omega-6 and Omega-3 fatty acids have neuroprotective activity. During aging, the composition of fatty acid declines. Besides, Poly Unsaturated Fatty Acids directly contribute to signaling to stimulate the functioning of neurons and neuroprotection.

4. DIETARY SOURCES OF NEUROPROTECTIVE INGREDIENTS

4.1. Sulforaphane

Sulforaphane is found in brussels sprouts, broccoli, and other Cruciferaceae members. It is an isothiocyanate. It reduces brain edema and has a protective action against mitochondrial toxicity for a retinal pigment called dopaminergic neurons [16].

4.2. Curcumin

Curcumin is found in *Curcuma longa*. It is used for the prevention of age-related neurodegenerative ailments. It also reveres stress which is induced by damaged neurogenesis process of the hippocampus. It also increases neurotrophic factor (BDNF) [17]. It also prevents cortex cells of rodents from glutamate excitotoxicity.

4.3. Resveratrol

Resveratrol is found in red grapes exhibiting antioxidant activity. Resveratrol protects against ischemic injury. It also protects neurons against NO-mediated oxidative stress [18]. It is also effective for the protection of neuronal cells by amyloid β-peptide.

4.4. *Allium* and *Allicin*

These are Organosulfur compounds found in *Allium cepa* and *Allium sativum* (garlic). Allicin and Allium are effective for neuroprotection. These scavenge free radicals found in neuronal cells. Allyl-containing sulfides may stimulate the paths correlated with neuroprotection, causing the initiation of mitochondrial uncoupling proteins [19].
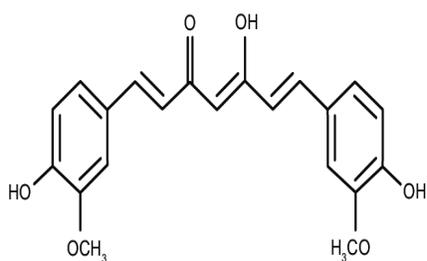
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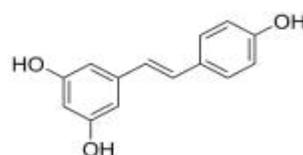
Resveratrol

Sulforaphane
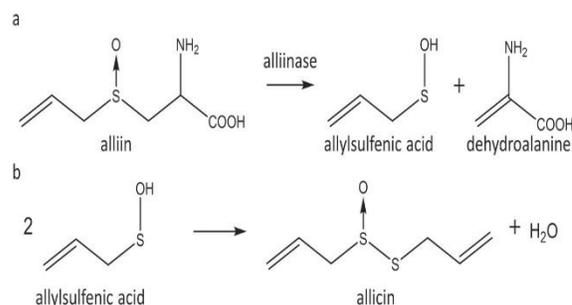
Allium and allicin

5. BIOCHEMICAL ACTION OF NEUROPROTECTIVE PLANTS

Many plants are used in neuroprotection. Chemicals can be extracted from different parts of plants and sometimes the whole plant is used for the extraction of biochemical used in the protection of the nervous system.

5.1. *Bacopa monniera*

The plant is commonly known as Brahmi. It is used for boosting memory, relieving stress during nervousness, and learning. It contains bacopa saponins, Stigmastanol, Betulinic acid, and bacosides active components that help in repairing impaired neurons, re-establishment of synaptic activity, nerve impulse conduction, and kinase activity [20]. It also inhibits cholinergic degeneration and has a cognition-enhancing effect in rats.

5.2. *Centella asiatica*

The plant contains brahmoside, isothankunoside, brahminoside, asiaticoside, thankunoside as active compounds [21]. The leaf is used for strengthening and revitalizing nervous function and memory enhancement. It is also used as a dementia preventer and restorative. It prevents the death of beta-amyloid, so used for the treatment of AD and the prevention of beta-amyloid toxicity. It is also used against depression, mental weakness, and epilepsy [22].

5.3. *Ginkgo biloba*

It is used for memory improvement by eliminating free radicals and by increasing oxygen supply. Hence used for treating Alzheimer's disease and neuroprotective agent against Aβ and toxicity caused by nitric oxide. It contains quercetin and isorhamnetin as flavonoids, stigmasterol, and sitosterol as steroids, diterpenic lactones, sesquiterpene lactones, and ginkgolides A, B, C, J, and M [23].

5.4. *Hypericum perforatum*

Plant flowering contains tannins, essential oils, choline, hayperciyn, and hayperpyron. It has positive effects on depression, anxiety, wound healing, and neurological diseases. Plant extract contains quercitrin and quercetin which is effective for scavenging free radicals. Pretreatment with Hypericum shows antioxidant activity before injecting scopolamine. It affects the activity of glutathione peroxidase, glutathione level, and MDA of the brain [24].

5.5. *Picrorhiza scrophulariiflora*

Plant roots contain phenolic glycosides, terpenoids, iridoid glycosides, and phenylethanoid glycosides. The rhizome is used as a neuroprotective agent in Southeast Asia. Picrosides I and II show neurite growth in PC12D cells by signaling pathway which is dependent on cellular Mitogen-Activated Protein Kinase [25].

5.6. *Cyperus rotundus*

It is commonly known as sedge. It contains essential oils such as terpenes, pinene, and cineole in little amount. Ethanolic extract of sedge has anti-AChE activity. After treating with two doses of C.rotundus extracts (100 & 200 mg per kg) improved spatial learning and memory in Rats with injured NBM [26].

5.7. *Zizyphus jujube*

The plant is edible having a sweet taste and medicinal values. It has anti-grouch and soothing properties. It is a customary medicinal plant of China and Korea. IT contains flavonoids, cerebrosides, saponins, phenolic acids, amino acids, and nucleosides as active constituents. It decreases nervousness and reinforces the spleen, gastrointestinal and stomach system [27]. It has been shown that herb comprises of compounds that have inhibitory action against histamine release, cyclooxygenase I and II, and AChE activity. Medicinal values of jujube are recognized as antioxidant properties due to these compounds. The plant extract has shown the maximum effect on acetylcholine transferase activity. This increase in the level of acetylcholine in the cholinergic terminals may cure Alzheimer's disease. Extract of the plant has healing effects on memory, behavioral disorders, learning, and motor coordination that are due to the Meynert nucleus lesion in the frontal lobe of the Rat brain.

5.8. *Lavandula officinalis*

Lavandula officinalis is also known as lavender. Plant oils are used in making fragrances and cosmetics. Lavender extract contains geraniol, linalyl acetate, ursolic acid, linalool, borneol, luteolin flavonoids cineol, aflapin, butyric acid, camphor, and valerianic acid [28]. These compounds enhance plant effects on the CNS area, triggering soothing and calming effects by GABA receptors. Lavender oil decreases neurologic deficit, level of MDA, stroke volume, carbonyl species, and ROS in rats that are subjected to reperfusion, ischemia. It showed a strong neuroprotective effect. It has an inhibitory effect on the AChE enzyme activity. Increased intake of antioxidants improves spatial learning in mice suffering from Alzheimer's disease [29].

5.9. *Curcuma longa*

The rhizome is known as turmeric. It is used for cooking purposes. It is used as a source of Curcumin which has anti-inflammatory and antioxidant potential; it also treats AD. It maintains mind balance. It has antidepressant action in mice [30].

5.10. *Rosmarinus officinalis*

Rosemary contains anti-inflammatory and antioxidants compounds. These antioxidants are ferulic acid and carnosic acid which have greater antioxidant capacity than butylated hydroxyl anisole (BHA) and butylated hydroxyl toluene (BHT) [31]. It also contains oleanolic acid, carvacrol, ursolic acid, and eugenol which are inhibitors of COX-2. These COX-2 inhibitors prevent Alzheimer's disease.

5.11. *Matricaria recutita*

According to the University of Maryland Medical Center; Chamomile calms the nerves, aid in digestion, aid the immune system, counteract insomnia, stimulate the brain, and dispel weariness. It can also relieve anxiety [32].

5.12. *Melissa officinalis* **L.**

Melissa officinalis is known as lemon balm. It contains luteolin-7-O-glucoside, rhamnocitrin, rosmarinic acid, methyl carnosoate, and ferulic acid. It sharps memory, improves the mood of Alzheimer's patients. It is very effective for treating Alzheimer's disease (AD) because it can prevent acetylcholinesterase and their antioxidant property [31].

5.13. *Glycyrrhiza glabra*

AD is due to loss of neurons and senile plaques' presence. These plaques contain Amyloid-β peptide as a basic constituent. Glycyrrhiza contains Glycyrrhizin, glycyrrhetinic acid, and glycyrrhizic as active compounds [33]. So it has a positive effect against apoptotic death of nerve cells caused by Aβ fragments. The root extract is effective for brain diseases like AD [34].

5.14. *Galanthus nivalis* **L.**

The major constituent of *Galanthus nivalis* is Galanthamine. Galanthamine is an isoquinoline alkaloid. It is a specific and long-acting AChEase inhibitor. It also stimulates cholinergic nicotinic neurotransmission by modulating nicotinic acetyl-choline receptors allosterically, which are effective for treating AD [35].

5.15. *Acorus calamus* **L.**

It is known as the sweet flag. Ethanolic and hydroethanolic rhizome extracts have sedative and neuroprotective properties [36]. It contains α-and β-asarone. The plant has memory enhancing, anti-inflammatory, cytoprotective, antidiarrheal, anthelmintic, and antispasmodic properties.

5.16. *Bertholettia excels*

It is known as Brazil Nuts. It is rich in lecithin containing choline [37]. Choline is the basic unit of acetylcholine. These basic units increase acetylcholine levels in AD patients.

5.17. *Urtica dioica*

It is commonly known as Stinging Nettle. It contains Acetylcholine, histamine, proteins, and 5-hydroxy tryptamine [37]. It is used for treating hay fever and other allergy symptoms. It has anti-inflammatory biological compounds. It contains

boron that enhances the estrogen level in the body which is beneficial for short term memory. It also elevates the mood in Alzheimer's patients.

5.18. *Tinospora cordifolia*

T. cordifolia is also known as Guduchi. It enhances memory and learning in memory-deficit animals. It enhances the level of acetylcholine, which improves cognitive function [38].

5.19. *Huperzia serrate*

It is commonly known as 'QianCeng Ta' in China. The plant is used in the Traditional Chinese Medicinal (TCM) system for enhancing memory. It contains 'Lycopodium alkaloids' which is a potent, reversible inhibitor of AChE. It is used for treating AD, by decreasing the level of free radicals in the brain. It also reverses the scopolamine-induced amnesia, in monkeys suggesting its value for cognitive problems in Alzheimer's diseases [39].

5.20. *Eclipta prostrate*

E. prostrate contains luteolin which improves memory and inhibits chronic neurodegenerative disorders such as Alzheimer's disease and Parkinson's disease [40]. To interpret the effect of the ethanolic extract on neuroprotection, Morris water maze, Y-maze, and passive avoidance tasks were made in mice. Results have shown that ethanolic extract (100 mg/kg) has protective action for memory injure and learning deficit caused by scopolamine. It also enhances hippocampal LTP which is caused by the Akt-GSK-3β pathway activation [41]. Butanol fraction of methanol extract improved acetylcholine formation and inhibited oxidative stress in serum and brain of cesarean derived rats, *E. prostrata* can increase memory and learning and have an anti-inflammatory effect, also resists free radicals damage in the brain.

5.21. *Cannabis sativa*

Cannabis sativa is also known as Indian hemp. It contains flavonoids, terpenoids, alkaloids, and cannabinoids as active compounds [42]. The plant has anxiolytic and anxiogenic effects. It also contains CBD and D9-THC: a low dose of D9-THC has anxiolytic effects, while a high dose has anxiogenic effects. CBD has anxiolytic effects in both humans and animals due to its action on paralimbic and limbic regions. Due to the anxiolytic effect of CBD patients with anxiety ailments use cannabis to gain relief from anxiety. CBD, Cannabidivarin, and the propyl alternative of CBD have anticonvulsant effects. So it has proved experimentally effective for Epilepsy. It has been approved by the Food and Drug Administration that EPIDIOLEX® a dug, effective for Dravet syndrome, epilepsy, and Lennox-Gastaut syndrome. Similarly; Cannabis sativa is also effective for age-related neurodegenerative diseases. Endocannabinoids are useful against Alzheimer´s diseases [43]. In adults, low doses of hemp have a valuable effect on preventing AD.

5.22. *Petasites japonicus*

Petasites japonicus is an herbaceous plant. It is found in Hubei, Shanxi, and Sichuan of China. *P. japonicus,* contains nineteen sesquiterpenoids [44] which are effective as anti-allergic, antioxidant, neuroprotective, and anti-inflammatory activities. Sesquiterpenoids promote neurite growth.

5.23. *Rhaponticum carthamoides*

The plant is distributed in China. It is used as medicine in China for treating hypertension, anepithymia, and treats nervous prostration. Ecdysterone extracted from the plant are abundantly used neurotrophic compounds [45]. These ecdysterone increase glutamate-induced neuronal damage.

5.24. *Sida cordifolia*

The plant contains asparagine, ephedrine as active compounds [46]. It is used for treating sciatica and facial paralysis. The plant extract has strong hypoglycemic, anti-inflammatory, and analgesic actions. Plant roots along with Milk are effective for treating Parkinson's disease [47].

5.25. *Cynodon dactylon*

It is cosmopolitan. It contains Flavonoids, saponins [48] which are effective for epilepsy, insanity, and hysteria [49].

5.26. *Evolvulus alsinoides*

It is found in India. The plant contains betaine, β-sitosterol which is effective for stress, epilepsy, nervous retarders, and senselessness [50].

5.27. *Celastrus paniculatus*

It is commonly known as black-oil tree and Malkangni in India. It contains Triacylglycerol, diacylglycerol, monoacylglycerol, and esterified sterols as active constituents [51]. Indians use it as an intelligence enhancer. The oil obtained from seeds is used as a memory enhancer [52]. This oil reduces noradrenaline, 5- hydroxytryptamine, and dopamine levels. It also improves the IQ levels in mentally retarded children. Methanol extract has an anti-inflammatory action that is related to Alzheimer's disease treatment.

5.28. *Clitoria ternatea*

It is common is also known as Butterfly-pea. It contains sitosterol, kaempferol-3-rutinoside [53]. The rhizome is used as a brain tonic in AM. It promotes intellect and memory [54]. Ethanolic extract of rhizome also enhances memory. This effect is due to increased levels of Ach and ChAT. The aqueous extract also enhances Ach level in the hippocampus of rats.

5.29. *Commiphora whighitti*

C. whighitti is also known as Guggulu. It contains guggulipid, a guggulsterone. It has a memory enhancing effect for scopolamine-induced memory deficits. It also decreases the level of acetyltransferase in the hippocampus. The plant is effective for memory and dementia [55].

5.30. *Convolvulus pluricaulis*

The plant is commonly known as Shahkpushpi. It contains convolidine, confoline, kaempferol & steroids [56]. It is used by Ayurvedic experts for treating neurodegenerative diseases. It is also used to cure the aging process. Plant extract along with milk is effective for treating memory loss, syphilis, scrofula, disability, and fever [57].

5.31. **Crocus sativus**

The plant is also called saffron. It contains Gallic acids, picrocrocin, lycopene, safranal, crocin, and α- and β-carotenes. It is used for treating nervous system disorders. An alcoholic extract *C. sativus* pistil is effective for impaired behavior and learning-induced by ethanol in mice. This can be attained by inhibiting the impairment of hippocampal synaptic plasticity [58]. Saffron inhibits the deposition and aggregation of amyloid β in the human brain and inhibits short-term memory diseases. It also decreases acetylcholinesterase (AChE) levels. It is used for treating AD.

5.32. *Terminalia chebula*

The plant contains Arjungenin, chebulinic acid, chebulosides I and II, gallic acid, and punicalagin. The ripened fruit enhances memory [54]. A methanol extract is found to bind GABA and NMDA receptors. But there is no proof of cholinesterase inhibitory action [59].

5.33. *Withania somnifera*

The plant contains withasomniferin A, B, C, and withanone. Roots are commonly known as Ashwagandha and are used in AM for the increment of intellect and memory [60]. The standardized root extract is effective for the improvement of cognitive dysfunction. The hydroalcoholic extract improved the neuroprotective effect in vivo. It also has antioxidant and anti-inflammatory functions [61].

5.34. *Panax ginseng*

Ginseng is a Chinese and Korean medicinal herb. Herb is effective against diseases such as neurodegenerative disorder, cancer, diabetes, and hypertension [62]. Ginsenosides (Rb3 and Rg1) have a neuroprotective influence so it can be used against neurodegenerative disorders. It inhibits the rise of nigral iron level, decreasing DMT1 (divalent metal transporter) expression and raising FP1 (ferroportin) expression in Parkinson's disease.

5.35. *Lycium barbarum*

Wolfberry is a Chinese medicinal plant. Wolfberry is used against glaucoma and diabetes. Yu et al examined the protective action of wolfberry extract for Alzheimer's diseases (AD). Pre-treatment of rat cortical neurons with wolfberry decreased the lactate dehydrogenase discharge before exposure to

Fig. 1. Neurodegenerative diseases of human beings.

Ab peptide. Plant extract is effective against optical hypertension. Chiu et al. demonstrated that plant is effective for preventing cell death induced by glutamate. It also inhibits secondary degeneration of retinal ganglion cells and inhibits the increase of p-JNK and p-ERK [63].

5.36. *Commiphora mukul*

The plant contains Terpenes, eugenol, cuminic aldehyde, sesquiterpenoids, and the ketone steroids guggulsterone I, II, & III, and Z- and E-guggulsterone, as active compounds. It helps to Decrease neuronal cholesterol levels in the brain and turn, inhibits the beta-amyloid-forming amyloidogenic pathway, probably by anti- acetylcholine esterase activity [64].

5.37. *Rheum glabricaule*

The plant contains n- hexacosnic acid, daucosterol, palmitic acid, chrysophanol-8-Me ether, chrysophanol 8-O-beta-D- glucopyranoside, and citreorosein as active compounds. These are used as neuroprotective agents. Rhapontigenin exerts a protective effect on the functioning of mitochondria against amyloid-beta (1-42) neurotoxicity [65].

5.38. *Salix alba*

The plant contains active compounds as Salicin, populin, salicortin, fragilin, Salicyl alcohol, tremulacin, saligenin, vanillin, salidroside, syringin, caffeic salicylic acid, and ferulic acids. Salicin is a nonselective inhibitor of COX-1 and COX-2 and acts as an anti-inflammatory by its action of

Table 1: Role Of Medicinal Plants Against Neurological Disorders

Scientific name	Common name	Family	Phytochemical constituents	Plant used For	Citations
Bacopa monniera	Brahmisak	Scrophulariaceae	Bacopasaponins, Stigmastanol, and bacosides	Boosts memory, Decreases nervousness,	[20]
Centella asiatica	Gotu kola	Apiaceae/ Umbelliferae	Asiatic acid, iso-thankunoside & asiaticoside	Depression and epilepsy	[22]
Ginkgo biloba	Maiden hair tree	Ginkgoaceae	Quercetin, sesquiterpenictrilactone, and ginkgolides A, B, C, J	Prevention of AD, Neuroprotective	[23]
Hypericum perforatum	Bulhsana	Hypericaceae	Quercitrin,hayperciyn, and quercetin	Alzheimer disease	[24]
Picrorhiza scrophulariiflora	Hu Huang Lian	Scrophulariaceae	phenolic glycosides and terpenoids,	Picrosides I and II shows neurite growth in PC12D cells	[25]
Cyperus rotundus	Sedge	Cyperaceae	essential oils such as terpenes and pinene	Improves spatial learning in Rats.	[26]
Zizyphus jujube	Red date, Chinese date,	Rhamnaceae	Flavonoids, cerebrosides, phenolic acids, amino acids and nucleosides	Lessens nervousness, behavioral disorders, in rats.	[27]
Lavandula officinalis	Lavender	Lamiaceae	Geraniol, ursolicacid, linalool and camphor	Decreases neurologic deficit and ROS	[28]
Curcuma longa	Turmeric	Zingiberaceae	Curcumin	Treats AD	[30]
Rosmarinus officinalis	Rosemary	Lamiaceae	ferulic acid , and eugenol	Alzheimer's disease	[31]
Matricaria recutita	Babonaj	Asteraceae	α-bisobolol, chamazulene, sesquiterpenes,	Insomnia and anxiety	[32]
Melissa officinalis L.	Lemon balm	Lamiaceae	luteolin-7-O-glucoside	Alzheimer's disease	[31]
Glycyrrhiza glabra	Liquorice	Fabaceae	Glycyrrhizin and glycyrrhetinic acid	Alzheimer's disease	[34]
Galanthus nivalis	Snowdrop	Amaryllidaceae	Galanthamine	Alzheimer's disease	[35]
Acorus calamus	Sweet flag,Vacha	Araceae	α-and β-asarone	Memory enhancer	[36]
Bertholettia excelsa	Brazil Nuts	Lecythidaceae	Lecithin	Alzheimer's disease	[37]
Urtica dioica	Stinging Nettle	Clusiaceae	Acetylcholine, and 5 hydroxytryptamine	Short term memory	[37]
Tinospora cordifolia	Guduchi	Menispermaceae	alkaloids, terpenoids	Improves cognitive function	[38]
Huperzia serrata	QianCeng Ta'	Lycopodiaceae	Lycopodium alkaloids'	Alzheimer's Disease	[39]
Eclipta prostrata	Bhangra	Asteraceae	Luteolin	Parkinson's disease.	[41]

Scientific name	Common name	Family	Phytochemical constituents	Plant used For	Citations
Cannabis sativa	Indian hemp, Bhang	Cannabaceae	terpenoids, Endocannabinoids, and cannabinoids	Alzheimer´s diseases	[43]
Petasites japonicas	butterbur, giant	Asteraceae	Sesquiterpenoids	Neuroprotection	[44]
Rhaponticum carthamoides	Maral root	Asteraceae	Ecdysterone	Treats Hypertension	[45]
Sida cordifolia	Beej band	Malvaceae	asparagine, ephedrine	Sciatica,Parkinson disease	[47]
Cynodon dactylon	Lawn grass	Poaceae	Flavonoids, saponins	Epilepsy and hysteria	[49]
Evolvulus alsinoides	Sankha-holi	Convolvulaceae	betaine, β-sitosterol	Anti-stress	[50]
Celastrus paniculatus	Black-oil tree	Celastraceae	Triacylglycerol and esterified sterols	Memory enhancer,	[52]
Clitoria ternatea	Butterfly-pea	Fabaceae	sitosterol, kaempferol-3-rutinoside	Treats AD.enhances memory	[54]
Commiphora whighitti	Guggul, Mukul	Burseraceae	Guggulipid and guggulsterone	dementia preventer	[55]
Convolvulus pluricaulis	Shahkpushpi	Convolvulaceae	convolidine, confoline, kaempferol	memory loss and syphilis	[57]
Crocus sativus	Saffron	Iridaceae	Gallic acids, safranal, crocin, and α- and β-carotenes	impaired behavior and learning	[58]
Terminalia chebula	Myrobalan	Combretaceae	Chebulinic acid, chebulosides I and II	Enhances memory	[54]
Withania somnifera	Ashwagandha	Solanaceae	withasomniferin A, B, C and withanone	Intellect and memory enhancer	[60]
Panax ginseng	Ginseng	Araliaceae	Ginsenosides	Neurodegenerative disorders	[62]
Lycium barbarum	Wolfberry	Solanaceae	Lyciumbarbarum polysaccharide	Inhibits degeneration of retinal ganglion cells	[63]
Commiphora mukul	Gugal,	Burseraceae,	Terpenes, eugenol, cuminic aldehyde, sesquiterpenoids	Decrease neuronal cholesterol level	[64]
Rheum glabricaule	Samuelsson	Polygonaceae	n-hexacosnic acid and citreorosein	Mitochondrial protection against amyloid-beta neurotoxicity	[65]
Salix alba	White willow	Salicaceae.	Salicin and saligenin	Inhibits COX-1 and COX-2	[66]
Cassia obtusifolia	Senna	Fabaceae.	Isorubrofusarin and Rubrofusarin	Reduces ROS generation	[67]
Coffea arabica	Arabian coffee,	Rubiaceae	Caffeine	Reverses motor deficit in PD mice,	[68]

blocking prostaglandin release [66].

5.39. *Cassia obtusifolia*

The plant has Isorubrofusarin, Rubrofusarin as active compounds. It protects against neuronal degeneration of dopaminergic in brain part (substantianigra) and striatum of MPTP-induced PD mice models. In 6-OHDA induced pc12 cells, CSE supplementation mitigates cell damage, mitochondrial membrane depolarization, and attenuates ROS generation [67].

5.40. *Coffea Arabica*

It contains Caffeine. This is effective for dopaminergic neuronal damage in MPTP- induced PD mice. It also reverses the motor deficit in PD mice; enhanced motor function and reduction in apomorphine-induced rotation [68].

6. CONCLUSIONS

Neurodegenerative diseases are very dangerous for human beings in which most of these diseases have no permanent cure. Ethnomedicinal plants are used for centuries to cure such kind of diseases. Forty plants are discussed in this study and it is concluded that biochemical extracted from these plants are very useful in remedies of these diseases. Various parts of plants including bark, root, shoot, leaves, flowers, seeds, and fruits depending on the plant or disease are used to extract biochemical or given intact to treat such diseases. However, in some cases, the whole plant is used for this purpose.

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