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Review

Review Article on Investigating the use of Medicinal Plants in Protecting Against Neurodegenerative Disease and Mental Disorder

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Abstract:
Neurodegeneration, the word describing the condition of neuronal death brought on by a chronic, degenerative disease, is one of the most significant health concerns of the twenty-first century. Parkinson's, Alzheimer's, epilepsy, and other neurodegenerative illnesses (NDs) and Huntington's, which affect millions of people globally, represent a serious danger to global health. The potential therapeutic effects of traditional herbal therapy in controlling and preventing certain disorders have drawn attention. Six herbal plants, including Curcuma longa (turmeric), Lavandula angustifolia (lavender), Rosmarinus officinalis (rosemary), Cardiospermum halicacabum (balloon vine), Careya arborea (wild guava), and Withania somnifera (ashwagandha), are highlighted in this review for their neuroprotective qualities. These plants have anti-inflammatory, anti-apoptotic, and antioxidant properties that prevent neurodegeneration and increase neuronal survival. Their bioactive substances, including linalool, curcumin, and Withanolides show promise in reducing oxidative stress, neuroinflammation, and cognitive loss. An overview of various well-known neuroprotective plants and their therapeutic applications in the treatment of NDs is given in this review, which also highlights the pharmacological characteristics, modes of action, and current knowledge of their effectiveness.

Keywords: *Alzheimer's disease, neurodegenerative, curcuma longa, neuronal*

Introduction

The progressive deterioration of the nervous system's structure and function is the hallmark of a group of diseases known as neurodegenerative disorders (NDs). These As the world's population ages, ailments are growing more common, which presents serious problems for healthcare systems everywhere. Alternative medicines, especially those derived from natural materials via the lens of pharmacognosy, are gaining popularity. Conventional treatments typically focus on symptomatic relief and halting the progression of the disease1. disease that mostly affects neurons and causes them to die. Certain subgroups of neurons in particular functional anatomic systems are impacted by neurodegenerative disorders[1].

Neurodegenerative disorders are linked to basic processes including oxidative stress and excitotoxicity in addition to neuronal malfunction and death. Alzheimer's disease, Parkinson's disease, and amyotrophic lateral sclerosis are the most common neurodegenerative illnesses, affecting approximately one billion people worldwide[2].

Pharmacological medications are used to treat these conditions, but they are costly and have mild to severe adverse effects[1].

What Neurodegenerative Disorders Are Neurons, the fundamental units of the brain, gradually

deteriorate in neurodegenerative diseases. and neural system, which results in functional, motor, and cognitive deficits. Alzheimer's disease (AD), Parkinson's disease (PD), amyotrophic lateral sclerosis (ALS), and Huntington's disease (HD) are examples of frequent neurodegenerative illnesses[1].

This disorder may cause the neurological system to cease working. It is a chronic condition that damages the brain.

Parkinson's and Alzheimer's Neurodegenerative illnesses include Huntington's disease, epilepsy, spinocerebellar ataxia, myasthenia gravis disease, and stroke[3].

Medicinal plants have been used to treat a wide range of ailments since ancient times, and there is growing interest in their potential for neuroprotection. These plants contain bioactive compounds known as phytochemicals, which have demonstrated significant promise in the treatment of neurological diseases such Parkinson's, Alzheimer's, and brain damage from strokes. These compounds, which include alkaloids, flavonoids, terpenoids, and phenolic acids, have neuroprotective benefits through a range of mechanisms, including antioxidant activity, anti-inflammatory properties, modulation of neurotrophic factors, and regulation of apoptotic pathways[2].

Recent research has shown that plant-derived bioactive chemicals can lower oxidative stress, enhance mitochondrial function, and make them attractive candidates for neuroprotective therapies. enhance the survival of neurons. Additionally, preclinical research has shown promise for several medicinal herbs, including as Ginkgo biloba, Withania somnifera, Panax ginseng, and Curcuma longa[1]. The word "nootropic" describes medications or dietary supplements that enhance brain activity. By altering the ratio of particular molecules (neurotransmitters) involved in brain function, a number of pharmacological medicines on the market have been employed for their neuroprotective properties[4].

Certain drugs increase cerebral blood flow, the metabolic rate of cerebral oxygen intake, and the metabolic rate of cerebral glucose in situations of chronic brain damage, including stroke, inadequate brain blood flow, dementia, and pseudodementia. Due of their potent phytochemical components, several drugs derived from medicinal herbs have shown promise in improving memory[4]. Neurodegeneration, the progressive loss of neurons, is the cause of a neurodegenerative illness. They may eventually die as a result of neuronal injury. Amyotrophic lateral sclerosis, multiple sclerosis, Parkinson's disease, Alzheimer's disease, Huntington's disease, multiple system atrophy, tauopathies, and prion disorders are examples of neurodegenerative diseases[4].

Neurons in the central or peripheral nervous systems gradually degenerate and die in neurodegenerative diseases (NDDs), a broad category of incurable and crippling conditions. These disorders mostly impact neurons, which are the fundamental units of the nervous system. Once injured, neurons often do not proliferate or regenerate.

The brain exhibits neurodegeneration at a variety of neural circuitry levels, from molecular to systemic. These conditions are thought to be incurable because there is no known mechanism to stop the neurons' ongoing destruction; however, studies have revealed that oxidative stress and inflammation are the two main causes of neurodegeneration.

Numerous subcellular commonalities between these disorders have been found by biomedical research, including triggered cell death and abnormal protein assemblages (such as proteinopathy).

These parallels imply that improvements in treatment for one neurodegenerative illness may also improve other illnesses.

According to estimates, 55 million individuals worldwide suffered from dementia in 2019; by 2050, that number is expected to rise to 139 million[2].

Important Features and Mechanisms

Even if every illness is different, they all have a number of cellular and molecular pathogenic characteristics in common:

- **Protein Misfolding and Aggregation:** The accumulation of aberrant protein clumps that impair cell function and cause toxicity, such as alpha-synuclein in Parkinson's disease or amyloid-beta plaques in Alzheimer's disease.
- **Oxidative stress:** An imbalance between free radicals and antioxidants that harms cellular lipids, proteins, and DNA and eventually results in cell death is known as oxidative stress.
- **Neuroinflammation:** Neuroinflammation is the long-term activation of immune cells (microglia and astrocytes) in the brain that exacerbate neuronal damage by releasing inflammatory chemicals.

- **Mitochondrial dysfunction:** Deficits in calcium homeostasis and cellular energy production that make neurons susceptible to degeneration5. **An overview of neurodegenerative illness Huntington's disease:**

Huntington's disease is a progressive neurodegenerative condition characterized by oxidative stress and the death of basal ganglia neurons. It's an autosomal dominant syndrome associated with muscular weakness, emotional instability, and dementia[3]. These include difficulty concentrating, depression, short-term memory loss, and problems with speech, language, and movement. Involuntary motions, mental symptoms, and cognitive deterioration are the hallmarks of HD, a hereditary condition. It is resulting from a huntingtin gene mutation.

Amyotrophic lateral sclerosis (ALS):

Amyotrophic lateral sclerosis (ALS), the most basic type of motor neuron disease, is a clinical disorder that is easy to diagnose. A fast-moving degeneration of upper and lower motor neurons results in muscle weakness and atrophy in the arms, legs, trunk, and bulbar region. The arm, leg, and bulbar regions are also spastic. Clinical symptoms include breathlessness, trouble eating and speaking, loss of hand and arm function, and difficulties walking. Aspiration pneumonia and respiratory insufficiency are common causes of death within five years of the onset of symptoms. Usually starting in one place, symptoms and indicators spread to nearby places, often leading to death within three to four days[5].

Alzheimer's disease:

At least 27 million people suffer with Alzheimer's disease (AD), the most prevalent form of dementia, which accounts for 60–70% of dementia cases. instances. Memory problems or inadequacies, personality changes, and cognitive loss are all progressive and irreversible. Early on in the illness, memory issues first appear, and as it progresses, motor and sensory function are also affected. After the age of 65, AD symptoms begin to manifest. The neuropathological features of AD include the formation and build-up of extracellular amyloid plaques from amyloid β precursor protein (APP) and intracellular neurofibrillary tangles (NFTs) with an aberrantly phosphorylated tau protein[4]. Severe cognitive impairment results from the loss of synapses and pyramidal neurons. deterioration as well as behavioral problems such wandering, sadness, and violence. The phosphorylation of several protein kinases regulates tau, a protein associated with microtubules in neurons. Choline acetyltransferase (ChAT) is the primary enzyme in charge of acetylcholine production. Significant neocortical deficits in ChAT have been demonstrated to cause loss of cholinergic perikarya from the nucleus basalis of Meynert, decreased choline absorption, and Ach release. It also affects Ach functioning including memory and learning[6]. The "cholinergic hypothesis of AD" resulted from this.

Parkinson's disease :

Parkinson's disease (PD), the most frequent and second most common movement disorder, affects about 6.5 million individuals globally. 2-3% of people over 65 suffer from neurological disease. Movement control is the main symptom of Parkinson's disease (PD), a neurodegenerative condition that worsens over time. It happens when brain nerve cells, especially those in the substantia nigra, sustain injury or die[7]. Dopamine, a neurotransmitter necessary for coordinating fluid and regulated motions, is produced by these nerve cells. People with Parkinson's disease have a variety of motor and non-motor symptoms when their dopamine levels drop. Parkinson's disease (PD) is a clinical disorder characterized by motor impairments such as muscle rigidity, bradykinesia, rest tremor, loss of postural reflexes, frozen phenomena, and flexed posture. In addition to movement deficiencies, non-motor symptoms like dementia, sleep issues, anxiety, depression, and fatigue have also been reported[6].

Myasthenia gravis disease:

The nerve-muscle link is harmed by myasthenia gravis (MG), a chronic autoimmune disease. MG is a traditional autoimmune condition that has been associated with a variety of autoantibodies (abs) directed against certain neuromuscular endplate proteins[8]. Using the current techniques, MG can be categorized as seropositive if antibodies against the nicotinergic acetylcholine receptor (AChR), muscle tyrosine kinase (MuSK), or low density lipoprotein receptor type 4 (LRP4) are detected. Antibodies against agrin, cortactin, collQ, acetylcholinesterase (AChE), titin, and ryanodine receptor are among the several muscle antibodies that certain MG patients may have, but their pathophysiological importance is still unknown[7].7–9 Abs against the nicotinergic type of AChR are found in up to 80% of patients with

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generalized MG, but abs directed against MuSK or LRP4 are found in around 6% and 2% of individuals with generalized MG alone, depending on demographic variation[8].

Pharmacognosy's Function in Neurodegenerative Research

In order to find new therapies for neurodegenerative diseases, pharmacognosy—the study of pharmaceuticals made from plants and other natural sources—is essential. illnesses. The discovery, extraction, and study of bioactive chemicals with potential neuroprotective effects from medicinal plants, fungi, and marine creatures are becoming more and more important in the field of pharmacognosy[9].

Plants which works in neuronal disorder

Curcuma longa (Turmeric)

Curcuma longa, commonly referred to as Haridra, Haldi, or turmeric in India, is a member of the Zingiberaceae family. It has active phytochemicals such Curcumin, an alkaloid, has several pharmacological characteristics, including anti-inflammatory, antioxidant, antibacterial, anticarcinogenic, anti-diabetic, and neuroprotective effects[7]. Additionally, recent research combining the TST and FST showed antidepressant efficacy in rats that was more potent than fluox[4].

Kingdom: Plantae
Phylum: Magnoliophyta
Class: Liliopsida
Order: Zingiberales
Family: Zingiberaceae
Genus: Curcuma
Species: Curcuma longa

Table no. 1

Bacopa monniera

Parkinsonism can be treated using an ethanolic extract of the whole Bacopa monniera plant. It works by lowering SOD activity. greatly inhibits the development of lipofuscin, a rise in TBARS, and ultrastructural alterations[10]. It restores GSH, dopamine, cytosolic antioxidant enzyme activity, neurotransmitter function, and oxidative marker levels (ROS, malondialdehyde, and hydroperoxides)[2].

Kingdom: Plantae (Plants)
Phylum: Tracheophyta (Vascular Plants)
Class: Magnoliopsida (Dicotyledons)
Order: Lamiales
Family: Plantaginaceae (Plantain Family)
Genus: *Bacopa*
Species: *B. monnieri*

Table no. 2

Ginko biloba

With few unfavorable side effects, its activity is comparable to that of donepezil or Tactrin. Its cholinergic and neuroprotective qualities (which resemble the impact of of the neurotransmitter acetylcholine), it aids in the treatment of NDDs, including AD[10]. It offers defense against oxidative damage caused by Aβ protein (degrading H2O2, stopping lipid oxidation, and trapping ROS)[2]. Gingko biloba extract taken orally greatly reduces the abnormalities in motor function. The loss of anterior motor horn neurons in the spinal cord is considerably reduced by gingko biloba extract. Patients with ALS may benefit from using gingko biloba extract as a therapy[1].

Kingdom: Plantae (Plants)
Phylum: Ginkgophyta
Class: Ginkgoopsida
Order: Ginkgoales
Family: Ginkgoaceae
Genus: Ginkgo
Species: *Ginkgo biloba*

Table.no 3

Important Medicinal Plants and Their Uses

Bacopa monnieri, also known as brahmi, has been extensively researched for Alzheimer's and cognitive decline. Its active chemicals, known as bacosides, protect against amyloid-beta toxicity,

repair damaged neurons, and improve cerebral blood flow.

Withania somnifera, also known as ashwagandha, is well-known for its adaptogenic qualities. It acts as a GABA mimic to stimulate dendritic formation and show neuroprotective effects against Parkinson's, Alzheimer's, and Huntington's illnesses.

Crocus sativus, sometimes known as saffron, has emerged as a powerful mental health remedy. Recent clinical trials indicate that its effectiveness in treating major depressive illness is on par with certain conventional SSRIs.

Ginkgo biloba: Regularly used to help dementia sufferers' cognitive function and cerebral circulation. Its potential to cure attention-deficit problems is further highlighted by recent research from 2024.

Centella asiatica, often known as gotu kola, has been studied for its potential to improve memory and neuroplasticity through the activation of antioxidant signaling pathways such as Nrf2 and HO-1.

Neuroprotective Therapeutic Mechanisms

Medicinal herbs work via a number of recently identified 2026 pathways:

Neurotransmitter Modulation: Serotonin, dopamine, and GABA levels are influenced by a variety of plants. For instance, the GABAergic system is modulated by Valeriana officinalis (Valerian) and Lavandula angustifolia (Lavender) to relieve anxiety.

Brain-Derived Neurotrophic Factor (BDNF), which is critical for neuronal survival and synaptic plasticity, is upregulated by phytochemicals such as quercetin and apigenin.

Blood-Brain Barrier (BBB) Integrity: It has been demonstrated that compounds like resveratrol and EGCG (found in green tea) shield the BBB from oxidative damage and stop harmful chemicals from entering.

Enzyme Inhibition: Plants often act as natural inhibitors of acetylcholinesterase (AChE) and monoamine oxidase (MAO), common targets in Alzheimer's and depression treatments.

As of 2026, translation to human clinical practice is still a challenge despite the strength of preclinical research (in vitro and animal models). Among the main obstacles are:

Bioavailability: The human body has trouble absorbing many powerful phytochemicals, like curcumin.

Standardization: Clinical outcomes are complicated by regional variations in plant extract quality and exact dosage.

Clinical Validation: To verify long-term safety and efficacy, more extensive, superior human clinical trials are desperately needed.

Present Therapeutic Difficulties

There are still few therapeutic choices and no cure for the majority of neurodegenerative diseases, despite advances in our knowledge of their molecular underpinnings. circumstances. Instead than treating the underlying causes, the main goals of current therapy are to control symptoms and halt the course of the disease.

Limitations of traditional treatment

The incapacity of treatment approaches for neurodegenerative disorders to stop neural degradation. For example, Alzheimer's medications like NMDA receptor antagonists and acetylcholinesterase inhibitors very slightly enhance cognition and do not change the course of the illness[6]. Levodopa, the main medication used to treat Parkinson's disease, also has side effects such dyskinesias and gradually loses its efficacy. These drawbacks emphasize the need for innovative treatment strategies that go beyond symptom alleviation[3].

Conclusion

Innovative and successful treatment strategies are required due to the rising incidence of neurodegenerative illnesses. Conventional herbal remedies has the potential to be neuroprotective, Strong anti-inflammatory, anti-apoptotic, and antioxidant properties of these herbs aid in lowering oxidative Although more investigation is required to completely understand the mechanisms and maximize the clinical applicability, According to available data, using these herbal medicines may enhance traditional treatments and provide a supplementary approach to the treatment of neurodegenerative illnesses. Future research should concentrate on standardizing herbal extracts, optimizing dosages, and conducting thorough clinical trials to confirm their safety and efficacy. Almost all bodily functions are influenced by neurotransmitters. The pathophysiology of a variety of diseases, including schizophrenia, epilepsy, multiple sclerosis, amyotrophic lateral sclerosis, Parkinson's disease, and Alzheimer's disease, has been linked to altered levels of neurotransmitters

like glutamate, GAB, dopamine, serotonin, norepinephrine, histamine, and acetylcholine. In order to better understand and treat these mental diseases, it is crucial to keep an eye on the levels of different transmitters.

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