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Effective Phyto Therapeutic Agents for Parkinson's disease: Promising Medicinal Plants for Parkinson's Disease Management in Animal and Cellular Models

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Abstract: Parkinson's disease is a progressive neurodegenerative disorder predominantly affecting the elderly, characterized by symptoms such as muscle rigidity, tremors, and impaired motor function. Despite the absence of a definitive cure, various pharmacological agents, notably levodopa, are employed to manage symptoms and enhance quality of life. Within the realm of traditional Iranian medicine, which boasts a rich history spanning thousands of years, Parkinson's disease is often referred to as tremors. Scholars in this field have documented the underlying causes, clinical manifestations, and natural remedies associated with tremors in numerous texts. This review aims to elucidate the pathophysiological mechanisms of Parkinson's disease while exploring herbal therapies documented in traditional Iranian practices. Notable medicinal plants, including *Ferulago angulate*, *Curcuma longa*, *Foeniculum vulgare*, *Panax ginseng*, *Thymus vulgaris*, *Crocus sativus*, *Berberis vulgaris*, *Cinnamomum verum*, *Cuminum cyminum*, and *Gerbera jamesonii*, have demonstrated efficacy in combating the disorder. These plants exhibit mechanisms that may counteract neuronal degeneration and reduce movement-related disabilities, thereby offering a multi-faceted strategy for managing Parkinson's disease. Future research should focus on elucidating the specific biochemical pathways involved and conducting clinical trials to validate the efficacy and safety of these herbal interventions. By bridging the gap between traditional knowledge and modern pharmacotherapy, we may enhance therapeutic outcomes for individuals living with Parkinson's disease.

Keywords: Central nervous system, Nerve disease, Parkinson's disease, Medicinal plants

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Introduction

Parkinson's disease (PD) is a progressive neurodegenerative disorder that primarily affects dopamine-producing neurons in the substantia nigra, a region of the brain involved in motor control. The loss of these neurons leads to reduced dopamine levels, causing symptoms such as tremors, slowness, stiffness, and balance difficulties. These motor impairments become apparent when dopamine depletion reaches approximately 80 percentages. Parkinson's disease affects the basal ganglia and cerebellum, which are responsible for smooth coordination of movement. Diagnosis requires the presence of akinesia slowness of movement and at least one other symptom, such as muscular rigidity, rest tremor, or postural instability [1-3]. Nowadays, there is no effective treatment for Parkinson’s disease and medical treatment of this problem is mostly symptomatic. Furthermore, the side effects of the current medical treatments are not acceptable. Natural products, which have long been used as alternative or complementary medicines for Prkinson’s disease, have recently gained special attention. Parkinson's disease experimental model types may be classified into animal- and cell-culture-based model systems [27,29,37].

The disease model systems may use environmental or synthetic neurotoxins or a genetics-based approach to study the disease pathology. Each group comes with its own set of merits and demerits, and, therefore, learning about the existing variations and how they are used to study PD may enable researchers to decide correctly when selecting an appropriate model system for their specific experiments[30].

The traditional toxin-based animal models of PD which were developed via destroying the dopaminergic neurons assisted in treatment development for PD symptoms and investigating the adverse effects that might be related to therapies involving dopamine replacement[31]. The purpose of this study was to evaluate the effective phytotherapeutic agents for parkinson's disease, promising medicinal plants for Parkinson's disease management in animal and cellular models.

Pathophysiology of Parkinson's disease

The primary pathological feature of Parkinson's disease (PD) is the degeneration of dopaminergic neurons in the substantia nigra, leading to a loss of up to 70% of dopamine-producing neurons by the end of life [4]. A key mechanism in PD is the misfolding and aggregation of alpha-synuclein, which forms toxic clumps that damage brain cells and result in the formation of Lewy bodies [5].

This neuronal loss is accompanied by astrocyte death and an increase in microglia in the substantia nigra [6]. The progression of PD follows Braak staging, starting in the medulla oblongata and olfactory bulb before advancing to the substantia nigra and other brain regions. Motor symptoms appear when the disease affects the substantia nigra. Five major brain pathways connecting the basal ganglia to other regions are disrupted in PD, affecting motor control, attention, and learning [6].

Epidemiology

This is the second most common neurodegenerative disorder after Alzheimer's. The first case of Parkinson's disease was reported in 1817 [7]. The prevalence of Parkinson's disease in people over 50 years of age is two percent. The incidence of Parkinson's is fifteen per hundred thousand people in the general population and sixteen per one hundred thousand people over 65 years old. Parkinson's is more common in men than women, with a ratio of 1.8 to 1 [8, 9].

Clinical features and characteristics of Parkinson's disease

Parkinson's disease (PD) is a neurodegenerative and movement disorder characterized by the degeneration of dopamine-producing brain cells, leading to decreased dopamine levels and motor dysfunction [10]. While the exact cause remains unknown, both genetic and environmental factors are believed to contribute to its onset. PD symptoms vary among individuals and are classified into motor and non-motor groups. Motor symptoms include tremors, stiffness, muscle

rigidity, and impaired voluntary movements such as blinking, smiling, and swinging arms while walking. Non-motor symptoms may include pain, loss of smell, and dementia. As the disease progresses, patients may experience freezing when walking, difficulty rising from a chair, and slower, monotone speech [11, 12]. Although supportive treatments can alleviate symptoms, there is no cure, and in some cases, PD leads to dementia.

Risk factors for Parkinson's disease

Loss of dopamine in Parkinson's disease results from a combination of genetic and environmental factors. Parkinson's disease risk factors include age, heredity, infectious agents, gender, toxins, metals, solvents, drugs, narcotics, and head trauma [13].

Parkinson's prevention

Proper nutrition and intake of omega-3 fatty acids, aerobic exercise, caffeine consumption, stress avoidance, consumption of fruits and vegetables, intake of vitamins B and D_3, and strengthening the immune system can be helpful [14, 15].

Parkinson's treatment

Treatment options for Parkinson's disease include drug therapies such as levodopa, dopamine agonists (pramipexole, ropinirole, rotigotine), MAO-B inhibitors (selegiline, rasagiline, safinamide), anticholinergics (benztropine, trihexyphenidyl), and COMT inhibitors (tolcapone, entacapone). Additionally, deep brain stimulation (DBS) surgery, along with emerging treatments like stem cells and dopamine-generating cells, are also utilized [16,17]

Parkinson's disease and traditional medicine

Parkinson's disease currently has no definitive cure in modern medicine, with chemical drugs primarily addressing its symptoms. In contrast, Islamic medicine proposes a definitive cure for the disease [18]. Traditional medicine often attributes conditions like Parkinson's to body "coldness," and thus recommends hot-tempered plants like black seed to help manage symptoms. Additionally, plant-based products that enhance dopamine levels in the brain, such as beans, fennel, passion flower, ginseng, marigold, saffron, cinnamon, walnuts, green tea, turmeric, and whole grains, are commonly suggested for treating Parkinson's disease [19].

Methodology

In this study, a comprehensive search of reputable databases was conducted to identify sources related to medicinal plants effective in the treatment of Parkinson’s

disease. Keywords such as “Iranian medicinal plants,” “Parkinson’s disease,” “Traditional Iranian Medicine,” and “antioxidant effects of plants” were employed. The scientific databases consulted included PubMed, Scopus, Web of Science, Google Scholar, SID (Scientific Information Database of Iran), and Magiran. Additionally, authoritative texts in the field of traditional Iranian medicine, such as Books of Iranian Traditional Medicine and Islamic Traditional Medicine Texts, were thoroughly reviewed. Inclusion criteria for this study consisted of articles and sources that specifically addressed the efficacy of indigenous Iranian medicinal plants in alleviating or reducing the symptoms of Parkinson’s disease.

Studies focusing on treatments other than medicinal plants, those with low scientific quality or incomplete/unreliable data, and articles unrelated to Parkinson’s were excluded. Initially, a preliminary review was conducted by examining the titles, abstracts, and keywords of the articles. Subsequently, the full texts of the selected articles were assessed to verify their relevance and the quality of the data.

Herbal antioxidants for Parkinson's disease

Various chemical drugs and treatments have been proposed for this disease; however, each of these chemical drugs has side effects, and their duration and effectiveness also vary.

Another method of treating Parkinson's disease that lacks the harms of chemical drugs is the use of herbal remedies.

Herbs traditionally used to treat Parkinson's include black seed, ginger, licorice,aragan cinnamon, olive, red clover, soy, ashwagandha, horehound, cumin, thyme, maoluang, and St John's wort, which have been traditional used.

These plantsmostly have antioxidant activity [20].

There are a lot of other plants such as Sargassumwightii, which reduce the symptoms of Parkinson’s disease in table 1, complete botanical information and the traditional effects, as well as the potential anti-Parkinsonian mechanisms of medicinal plants, are provided.

Table 1. Botanical and Traditional Insights into Anti-Parkinsonian Medicinal Plants

Common Name	**Scientific Name**	Family	**Traditional Uses**	**Main Compounds**	**Mechanism of Action**	**Effects on Parkinson's Disease**
Black Seed	*Nigella sativa*	Ranunculaceae	Used in traditional medicine for various ailments	Thymoquinone, carvacrol, and other volatile oils	Reduces oxidative stress and inflammation in neuronal cells.	Reduces symptoms and improves motor function in Parkinson's disease [21].
Ginger	*Zingiber officinale*	Zingiberaceae	Digestive aid, anti-nausea, anti-inflammatory	Gingerol, shogaol	Decreases inflammation and provides neuroprotection.	May alleviate motor symptoms in Parkinson's disease [22].
Licorice	*Glycyrrhiza glabra*	Fabaceae	Used for digestive issues and respiratory conditions	Glycyrrhizin, flavonoids	Mitigates oxidative stress and protects brain cells.	May provide neuroprotection in neurodegenerative diseases [23].
Argan Cinnamon	*Cinnamomum argenteum*	Lauraceae	Used in cooking and traditional medicine	Essential oils, flavonoids	Reduces inflammation and supports neuronal cell function.	May reduce oxidative stress in neurological disorders [24].
Olive	*Olea europaea*	Oleaceae	Used as a food source and for medicinal purposes	Oleuropein, hydroxytyrosol	Exhibits antioxidant and anti-inflammatory properties to protect	May protect against neurodegenerative diseases [25].

					the brain.	
Red Clover	*Trifolium pratense*	Fabaceae	Used for women's health and as a blood purifier	Isoflavones, flavonoids	Protects dopaminergic cells and reduces inflammation.	May improve cognitive function and reduce symptoms in neurodegenerative diseases [26].
Soy	*Glycine max*	Fabaceae	Used for protein source and women's health	Isoflavones (genistein, daidzein)	Reduces oxidative stress and supports dopamine production.	May help in preventing cognitive decline in Parkinson's disease [27].
Ashwagandha	*Withaniasomnifera*	Solanaceae	Adaptogen, used for stress and anxiety	Withanolides, alkaloids	Reduces oxidative stress and offers neuroprotective benefits.	May improve motor functions and cognitive abilities [28].
Horehound	*Marrubiumvulgare*	Lamiaceae	Used for respiratory issues and digestive health	Marrubiin, flavonoids	Reduces inflammation and provides neuroprotection.	May provide neuroprotective effects [29].
Cumin	*Cuminum cyminum*	Apiaceae	Used in cooking and traditional medicine	Cuminaldehyde, p-cymene	Supports brain cells and reduces inflammation.	Improves motor and cognitive deficits in Parkinson's models [30].
Thyme	*Thymus vulgaris*	Lamiaceae	Used for culinary and medicinal	Thymol, carvacrol	Exhibits anti-inflammatory and antioxidant effects	May reduce oxidative stress in neurodegenerative

			purposes		to support brain health.	diseases [31].
Mao Luang	*Lysimachiafoenum-graecum*	Primulaceae	Used for digestive and respiratory health	Flavonoids, saponins	Protects neural cells and reduces inflammation.	Potential neuroprotective effects [32].
St John's Wort	*Hypericum perforatum*	Hypericaceae	Used for depression and anxiety	Hypericin, hyperforin, flavonoids	Reduces oxidative stress and protects brain cells.	May enhance neuroprotection and improve motor function [33].
Japanese Loquat	*Eriobotrya japonica*	Rosaceae	Used for respiratory and digestive issues	Caffeic acid, chlorogenic acid, oleanolic acid	Possesses antioxidant and anti-inflammatory properties to support brain health.	Reduces oxidative stress and symptoms of Parkinson's disease [34].
Turmeric	*Curcuma longa*	Zingiberaceae	Used for anti-inflammatory and digestive health	Curcumin	Reduces inflammation and oxidative stress in the brain.	Improves motor symptoms in Parkinson's models [35].
Fennel	*Foeniculum vulgare*	Apiaceae	Used for digestive issues and respiratory conditions	Estragole, fenchone, caffeic acid	Protects dopaminergic cells and reduces inflammation.	Increases motor activities and muscle strength in Parkinson's models [36].

Milk Thistle	*Silybum marianum*	Asteraceae	Used for liver health and detoxification	Silymarin, silybin, silydianin	Provides neuroprotection and reduces inflammation.	Reduces oxidative stress and lipid peroxidation in Parkinson's disease [37].
Saffron	*Crocus sativus*	Iridaceae	Used for digestive aid, mood enhancement	Crocin, picrocrocin, safranal	Protects brain cells and reduces oxidative stress.	Stops cellular degradation in the substantia nigra and improves cognitive function [38].
Barberry	*Berberis vulgaris*	Berberidaceae	Used for digestive health and as a blood purifier	Berberine, berbamine, phenolic compounds	Supports dopamine secretion and reduces inflammation.	Improves symptoms of Parkinson's disease in models [39].
Cinnamon	*Cinnamomum verum*	Lauraceae	Used for digestive health and blood sugar regulation	Cinnamaldehyde, coumarin, eugenol	Reduces inflammation and supports dopamine function.	Protects against dopaminergic cell death in Parkinson's models [40].

The effects of different plants and their compounds on Parkinson's disease are outlined in Table 2, covering both animal and cellular models. These findings highlight the potential of various plants in mitigating Parkinson's symptoms through mechanisms such as reducing oxidative stress and inflammation.

Table 2. Neuroprotective Effects of Various medicinal Plants and Their Compounds in Parkinson's disease Experimental Models (Animal and cell models)

Scientific Name	Animal models	Ref.
Nigella sativa	Reduces oxidative stress and inflammation in neuronal cells.	[21]
Zingiber officinale	MEZO treatment in symptomatic mice reduced sensorimotor and neuromuscular deficits by increasing TH protein expression, dopamine release, and AChE activity, while inhibiting α-Syn aggregation and reducing oxidative stress and inflammation	[22]
Glycyrrhiza glabra	Mitigates oxidative stress and protects brain cells.	[23]
Cinnamomum argenteum	Yashtimadhu treatment restored rotenone-induced dysregulation in nucleic acid, amino acid, lipid metabolism, and the citric acid cycle, preventing energetic stress and cell death	[24]
Olea europaea	OLE treatment improved balance and muscle strength, prevented increases in MDA levels, enhanced SOD, CAT, and GPx levels in the midbrain, and prevented the depletion of TH-positive in rat neurons	[25]
Trifolium pratense	The results showed that exposure of HCN 1-A cell cultures to hydrogen peroxide led to a concentration-dependent decrease in neuron viability. Pretreatment with isoflavones extract significantly improved cell line survival and prevented morphological disruption caused by H2O2, suggesting its neuroprotective effect is linked to antioxidant activity	[26]
Glycine max	The neuroprotective effects of Glycine max against glutamate-induced toxicity in primary cortical cultured neurons were examined. Compound 2, isolated from triterpene	[27]

	glycosides, exhibited significant neuroprotective activity, suggesting that the neuroprotective effect of Glycine max may be due to the inhibition of glutamate-induced toxicity (Rat model)	
Withaniasomnifera	Mice treated with MPTP showed reduced levels of DA, DOPAC, HVA, GSH, and GPx, and increased TBARS levels. Treatment with Ws root extract (100 mg/kg) for 7 or 28 days increased DA, DOPAC, and HVA levels, normalized TBARS levels, and improved motor function in PD mice. Additionally, 28 days of treatment increased GSH and GPx levels in the striatum.	[28]
Marrubiumvulgare	Marrubiin treatment significantly restored cognitive performance, motor tests, body weight, neurotransmitter levels, oxidative stress, antioxidant enzymes, and histological architecture in MPTP-induced rats. These preliminary results highlight marrubiin'sneuroprotective potential, though its cellular and biochemical mechanisms require further investigation	[29]
Cuminum cyminum	MPTP treatment significantly impaired locomotor behavior and cognitive functions in mice. Administration of CCY extract (100, 200, and 300 mg/kg) for three weeks significantly and dose-dependently improved these deficits and inhibited the MPTP-induced decrease in antioxidant enzyme levels and lipid peroxides in brain tissues. CCY extract shows strong neuroprotective potential and may serve as a therapeutic strategy for PD-related neurodegeneration	[30]
Thymus vulgaris	Exhibits anti-inflammatory and antioxidant effects to support brain rat model.	[31]
Lysimachiafoenum-graecum	Protects neural cells and reduces inflammation.	[32]
Hypericum perforatum	Reduces oxidative stress and protects brain cells.	[33]
Eriobotrya japonica	Possesses antioxidant and anti-inflammatory properties to support brain health.	[34]
Curcuma longa	Oral administration of C. longa significantly protected against deterioration in motor activity, learning-related memory, and anxiety- and depression-like behaviors in PD model	[35]

	rats. These effects were associated with decreased brain levels of LPO, TNFα, α-synuclein, and increased levels of cognition-related proteins SNAP-25 and BDNF	
Foeniculum vulgare	Protects dopaminergic cells and reduces inflammation.	[36]
Silybum marianum	Provides neuroprotection and reduces inflammation in brain rat mode;l	[37]
Crocus sativus	Intracerebral injection of 6-hydroxydopamine increased the time latency required to find the hidden platform and impaired spatial memory ($P<0.05$). Pretreatment with saffron extract (5 and 10 µg/rat, 5 days) improved the reduced spatial memory in Parkinson's rats	[38]
Berberis vulgaris	Supports dopamine secretion and reduces inflammation in SH-SY5Y cells	[39]
Cinnamomum verum	Administration of AuNPs reduced the oxidative stress and motor abnormalities induced by MPTP in PD rats. ELISA analysis showed that AuNPs significantly decreased the expression levels of TNF-α, IL-1β, and IL-6, and suppressed alterations in the TLR/NF-κB signaling pathway. These results suggest that AuNPs alleviate PD symptoms by inhibiting the TLR/NF-κB pathway and offer a promising approach for treating neurodegenerative diseases like PD	[40]

Japanese loquat (*Eriobotrya japonica*)

Japanese loquat is a fruit from the rose family whose antioxidant effect has been proven in various studies, and it has been shown that this plant due to its high flavonoid content can reduce free radicals and prevent various diseases [21]. The flower extract of Japanese loquat contains various compounds that exhibit high antioxidant activity, including caffeic acid, chlorogenic acid, oleanolic acid, ursolic acid, and amygdalin [22, 23].

Turmeric (*Curcuma longa*)

Turmeric is a plant from the ginger family native to South Asia. Studies have shown that turmeric has high antioxidant property, which is related to its yellow oil pigments called curcumin [24]. In a study, researchers investigated the antioxidant effect of curcumin supplementation on a Parkinson's model induced by 6-hydroxydopamine in mice. Administration of curcumin improved motor symptoms and performance in the rotarod test in mice made Parkinsonian by 6-hydroxydopamine [25].

Fennel (*Vulgarefoeniculum*)

Fennel is an aromatic and fragrant herbaceous plant belonging to the Apiaceae family. This plant has been used in traditional medicine in Eastern Asian countries, India and China for the treatment of various diseases for thousands of years [26]. This plant contains essential oils, sugars, mucilage, flavonoids, mineral compounds including (calcium, potassium, iron), vitamin A and C and is rich in phytoestrogens including lignans. The main compounds of this plant include estragole, fenchone, coumarin (bergapten), caffeic acid, chlorogenic acid, cinnamic acid and gallic acid [27].

In a study, the effect of fennel extract on the Parkinson's model induced in mice was investigated and it was found that gavage with doses of 100 and 200 mg/kg fennel extract per body weight increased motor activities and muscle strength in mice [28]. Since oxidative stress as well as inflammation play a role in the pathogenesis of this disease, and there are numerous reports indicating that oxidative stress by weakening the antioxidant system and producing free radicals may be involved in the pathogenesis of Parkinson's disease. Therefore, it can be concluded that the flavonoid and antioxidant compounds present in fennel have been effective in improving this disease [29].

Ginseng (*Panax ginseng*)

Ginseng is an aromatic and perennial plant from the Araliaceae family whose medicinal properties are due to the presence

of various compounds in the root of this plant [30]. Studies have shown that the root of the ginseng plant contains triterpene saponins, essential oils, polysaccharides, fatty acids, and phenolic compounds. Studies have shown that this plant acts as an antioxidant by increasing the body's resistance [31]. It can also inhibit lipid peroxidation in cell membranes by inhibiting the activity of hydroxyl radicals and anions. It has been reported that oral consumption of ginseng extract stops cellular degradation in the substantia nigra and reduces motor impairments in Parkinson's animal models [32].

Milk Thistle (*Silybum marianum* L.)

Milk thistle is a biennial plant with a thick root that grows wildly. The most important active ingredients of this plant are silymarin, silybin, and silydianin. Milk thistle is used to treat liver toxicity and liver cirrhosis. It is also a free radical scavenger, cell protector against chemical damage, and reduces lipid peroxidation [33, 34].

Saffron (*Crocus sativus* L.)

Saffron is a plant from the Iridaceae family that grows up to 10-30 cm in height. In traditional medicine, this plant is used as a digestive aid, appetite enhancer, sedative, expectorant, and for relieving menstrual pain [35]. The most important compounds present in saffron include picrocrocin, picosalvin, crocin, crocetin and safranal. The antioxidant effect of these compounds has been proven in research [36, 37].

Several studies have reported that saffron extract and its two main components, crocin, and crocetin improve memory and learning behaviors in models whose learning behavior is impaired by ethanol induction [38]. These findings suggest that the oral administration of saffron may be beneficial in the treatment of neurodegenerative disorders and associated memory impairments. According to the conducted research, oral consumption of saffron extract stops cellular degradation in the substantia nigra and reduces the emergence of functional disorders in Parkinson's animal models [39].In another study, it was found that the leaf extract of the saffron plant reduces behavioral disorders caused by 6-hydroxydopamine-induced damage in Parkinson's [40, 41].

Barberry (*Berberis vulgaris* L.)

Barberry is a plant whose root, bark, stem, leaf, flower, and fruit are used for various food, medicinal and industrial purposes [43]. This plant exists in different regions of the world and has a long history in traditional medicine. The root, bark, stem, leaf, flower, and fruit of barberry are used

for various medicinal purposes [44, 45]. This plant contains alkaloids like berberine, berbamine, palmatine, oxyacanthine, and jatrorrhizine. Berberine is the most important alkaloid isolated from this plant. Barberry also contains high amounts of phenolic and terpenoid compounds. Researchers have reported that aqueous extract of barberry improves Parkinson's disease in male mice [46].

Cinnamon (*Cinnamomum verum*)

Cinnamon is a fragrant and flavorful spice obtained from the bark of the cinnamon tree. This spice has numerous health benefits such as lowering blood sugar, improving brain function, boosting the immune system, reducing inflammation and reducing the risk of heart disease, improving digestion, relieving muscle pain and bloating, having antimicrobial and antifungal effects,as well as being effective against acne and eczema [47].

The chemical compounds of cinnamon include cinnamaldehyde, camphor, cinnamyl-acetate, caryophyllene, trans α-bergamotene, caryophillene oxide, linalool, geraniol, bornyl acetate, α-cubebene, γ-elemene, α-copaene, guaiol, and eugenol [48]. Cinnamomum species essential oils, primarily containing cinnamaldehyde and sodium benzoate, are protective against cell death induced by oxidative stress, reactive oxygen species generation, and autophagy disturbances. Oral administration of cinnamon powder and sodium benzoate may protect against dopaminergic cell death, striatal neurotransmitter transporter dysfunction, and motor deficiency in 1-methyl-4-phenyl-1,2,3,6-tetrahydropyridine (MPTP) mouse models of PD and have anti-Parkinsonian effects [49]. Experiments in animal models revealed that cinnamon leaf extract, nanoemulsion and hydrosol increased dopamine content from 17.08% to 49.39% and tyrosine hydroxylase level from 17.07% to 25.59%, while decreasing α-synuclein level from 17.59% to 17.59%. Besides, in mice midbrain, increasing activities of superoxide dismutase (6.69–16.82%), catalase (8.56–16.94%), and glutathione peroxidase (2.09–16.94%) were exhibited, while malondialdehyde content 4.7–15 decreased thus cinnamon exerted anti-Parkinsonian effect [50].

Cumin (*Cuminum cyminum*)

Cumin is a medicinal plant with small leaves, purple flowers, and pleasant aroma. Cumin has anti-inflammatory, antibacterial, antioxidant, respiratory and gastrointestinal problems, antispasmodic, digestive, bloating and colitis, bone and

teeth strengthening, muscle activity, heart health and blood sugar control, and sedative properties [51]. The chemical compounds of cumin include cuminaldehyde, p-cymene, β-pinene, α-terpinen-7-al, γ- terpinene (6.1%), p-cymen-7-ol and thymol [52]. Administration of 200 and 300 mg/kg doses of *Cuminum cyminum* Linn extract for three weeks significantly and dose-dependently improved motor and cognitive deficits in MPTP-treated mice. *Cuminum cyminum* Linn treatment also significantly ($P < 0.001$ at 300 mg/kg) attenuated MPTP-induced decreases in antioxidant enzyme (superoxide dismutase and catalase) and lipid peroxide levels in mouse brain tissue. Thus, Cuminum cyminum may represent a therapeutic strategy for the treatment of the neurodegeneration seen in Parkinson's disease [53].

St John's Wort (*Hypericum perforatum*)

St. John's wort is used to treat kidney stones and sore throat, as an anti-inflammatory for urinary tract health, anti-cancer, and skin health, anti-depressant, and weight loss. St. John's wort contains compounds like hypericin, pseudohypericin, hyperforin, proanthocyanins, flavonoids, biflavonoids, xanthones, phenylpropanes, and phenolic acids [54]. Doses of 100, 200, or 400 mg/kg, p.o. of the extract of *Hypericum perforatum* significantly decreased the number of contralateral rotations on all evaluation days indicating a neuroprotective effect. However, they were unable to prevent the decrease in tyrosine hydroxylase expression induced by 6-OHDA in the injured striatum. It is conceivable that *H. perforatum* may counteract through overexpression of dopamine receptors in the injured striatum as a possible mechanism for this effect and provide novel evidence that H. perforatum may be a promising therapeutic tool for Parkinson's disease [55].The results of one study showed the effects of 6-OHDA on intrastriatallesioned mice treated with the hydroalcoholic extract of *H. perforatum* at a dose of 200 mg/kg/day. The extract decreased striatal malondialdehyde, increased striatal catalase activity, and decreased glutathione content [56]. α-Factor significantly decreased nigral DNA fragmentation and blackened neigral dopaminergic neurons with higher tyrosine hydroxylase striatal reactivity. These findings demonstrated the beneficial effect of *H. perforatum* through attenuating DNA fragmentation, astrogliosis, inflammation, and oxidative stress [57]. Based on this analysis, the families Fabaceae, Lamiaceae, and Apiaceae have the highest

representation, each comprising three species. Conversely, the families with the least representation include Ranunculaceae, Oleaceae, Primulaceae, Hypericaceae, Iridaceae, and Berberidaceae, each consisting of only one species. Most of the medicinal plants in this study share common mechanisms such as antioxidant and anti-inflammatory properties. A smaller segment is identified with specific mechanisms like neuroprotection and adaptogenic effects, underscoring their potential impact on nervous health and the treatment of Parkinson's disease.

Discussion

Parkinson's disease is a chronic neurological disorder that affects the body's motor system. The reduction of dopamine levels in the brain causes symptoms of this disease such as tremors, rigidity and muscle stiffness, reduced mobility, balance problems, and also problems controlling hand and foot movements. Parkinson's medications are the most important treatment method to control Parkinson's symptoms. Usually, medications are used to control dopamine levels in the brain and they can cause significant improvement in Parkinson's symptoms. However, each individual needs a specific medication regimen prescribed by a doctor.

It is important to carefully follow the doctor's instructions and consult with him/her if dose changes or treatments are needed. Warm-natured herbal medicines with high penetration and delicacy are among the assisting drugs in this disease. Most diseases and disorders related to the brain and nervous system are caused by the accumulation of phlegm in the body, especially in the head area. For this reason, most phlegm-expelling and body-cooling medicines in traditional medicine are effective in helping treat and slow the progression of Parkinson's disease. Phenolic and flavonoid compounds of plants are one of the best antioxidants and protective sources that have therapeutic effects in relation to diseases produced by oxidative stress. Given the effects of flavonoids as strong antioxidants, by neutralizing free radicals they can have a protective role on body cells.

Therefore, medicinal plants and compounds in them can be introduced as an effective factor in human health and used as a natural antioxidant for the prevention and treatment of Parkinson's disease. Overall, it seems that herbal compounds through multiple effects can have a protective role against memory-related diseases, motor disorders and neuronal degradation caused

by free radicals. It is hoped that in the future these plants can be used to treat Parkinson's disease.Inflammation has also been linked to Parkinson’s disease.

Some patients with Parkinson’s disease have shown inflammatory markers, including some proteins associated with inflammation in their serum or cerebrospinal fluid. Furthermore, in animal models of Parkinson’s disease, the manipulation of inflammatoryparameters has resulted in changes in the brain and disease progress [58].

Hence, medicinal plants with anti-inflammatory activities such as Mangifera indica and Magnolia kobusmay have positive effects of Parkinson’s disease [59, 60].

Conclusion

Japanese parsnip, turmeric, fennel, ginseng, martigall, saffron, barberry, cinnamon, cumin and gerbera are among the most important plants effective in the treatment of Parkinson's disease. These medicinal plants can be effective as effective herbal medicines to control Parkinson's disease in traditional medicine.

Authors’ contribution

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