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Combating Parkinson's Disease with Plant-Based Polyphenols: Tackling Oxidative Stress and Neuroinflammation

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Abstract

Parkinson's disease (PD) is a chronic neurodegenerative disorder that affects millions of individuals worldwide, leading to motor and cognitive impairments. Oxidative stress and neuroinflammation are central to the pathophysiology of PD, exacerbating neuronal damage and accelerating disease progression. Recent research suggests that plant-based polyphenols, natural compounds abundant in fruits, vegetables, and other plant sources, offer potential therapeutic benefits in mitigating these underlying mechanisms. These polyphenols, including flavonoids, resveratrol, and curcumin, exhibit powerful antioxidant and anti-inflammatory properties that can reduce oxidative damage, suppress neuroinflammation, and promote neuroprotection. This review examines the molecular mechanisms by which polyphenols exert their effects on oxidative stress and neuroinflammation in the context of PD, highlighting their promise as complementary interventions for managing and potentially modifying the course of Parkinson's disease.

Keywords: Parkinson's disease; Plant-based polyphenols; Oxidative stress; Neuroinflammatio; Neurodegeneration; Flavonoids; Resveratrol; Curcumin; Antioxidant properties; neuroprotection

Introduction

Parkinson's disease (PD) is a chronic and progressive neurological disorder that primarily affects motor function due to the degeneration of dopamine-producing neurons in the brain's substantia nigra. This neurodegenerative process is accompanied by a range of symptoms including tremors, rigidity, bradykinesia, and postural instability, as well as non-motor symptoms such as cognitive decline, mood disturbances, and autonomic dysfunction [1]. The complex pathophysiology of Parkinson's disease involves multiple mechanisms, with oxidative stress and neuroinflammation emerging as central contributors to neuronal damage and disease progression. Oxidative stress results from an imbalance between the production of reactive oxygen species (ROS) and the brain's capacity to neutralize them through endogenous antioxidant systems. In Parkinson's disease, excessive ROS lead to oxidative damage of cellular components, including lipids, proteins, and DNA, ultimately causing neuronal death and contributing to disease progression [2]. Concurrently, neuroinflammation, characterized by the activation of microglia and the release of pro-inflammatory cytokines, exacerbates neuronal injury and disrupts normal brain function. In light of these pathogenic processes, there is growing interest in exploring novel therapeutic approaches that can target both oxidative stress and neuroinflammation. Plant-based polyphenols have garnered attention for their potential neuroprotective properties due to their robust antioxidant and anti-inflammatory effects [3]. Polyphenols, such as curcumin, resveratrol, and epigallocatechin gallate (EGCG), are bioactive compounds found in various fruits, vegetables, and beverages, and have shown promise in preclinical studies and early clinical trials for their ability to mitigate oxidative stress and reduce neuroinflammation. Curcumin, derived from turmeric, is known for its potent antioxidant properties and its ability to modulate inflammatory pathways. Resveratrol, found in grapes and red wine, has been shown to suppress inflammatory responses and protect against neuronal damage [4]. EGCG, a major component of green tea, offers neuroprotection by scavenging free radicals and inhibiting neuroinflammatory processes. These plant-based polyphenols represent a promising adjunct or alternative to conventional therapies, potentially offering a multi-faceted approach to managing Parkinson's disease.

Parkinson's disease (PD) is a progressive neurodegenerative disorder characterized by the gradual loss of dopamine-producing neurons in the brain, leading to motor symptoms such as tremors, rigidity, and bradykinesia, as well as non-motor symptoms including cognitive impairment and mood disturbances. While the exact etiology of Parkinson's disease remains elusive, oxidative stress and neuroinflammation are recognized as central contributors to its pathogenesis [5]. In recent years, plant-derived polyphenols have emerged as promising therapeutic agents in combating these pathological processes due to their potent antioxidant and anti-inflammatory properties.

The role of oxidative stress and neuroinflammation in Parkinson's disease: Oxidative stress arises from an imbalance between reactive oxygen species (ROS) production and the brain's ability to counteract their harmful effects with antioxidants. In Parkinson's disease, elevated oxidative stress leads to the damage and death of dopaminergic neurons, contributing to the progression of the disease. Neuroinflammation, characterized by the activation of microglia and the release of pro-inflammatory cytokines, further exacerbates neuronal damage and disrupts normal brain function [6]. Addressing these two key factors—oxidative stress and neuroinflammation has become a focal point in developing therapeutic strategies for Parkinson's disease. Plant-based polyphenols, with their multifaceted mechanisms of action, offer a promising approach to mitigating these detrimental processes.

Plant-derived polyphenols: a brief overview: Polyphenols are a diverse group of naturally occurring compounds found in fruits,

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vegetables, grains, and beverages like tea and wine. They are known for their antioxidant, anti-inflammatory, and neuroprotective properties. Major classes of polyphenols include flavonoids, phenolic acids, and stilbenes. Notable examples include curcumin, resveratrol, and epigallocatechin gallate (EGCG), each of which has been studied for its potential therapeutic effects in neurodegenerative diseases.

Mechanisms of action: Antioxidant Activity: Polyphenols scavenge free radicals and reduce oxidative stress by enhancing the brain's endogenous antioxidant defenses [7]. For instance, curcumin, a polyphenol derived from turmeric, has been shown to increase the activity of antioxidant enzymes such as superoxide dismutase and catalase, thereby mitigating oxidative damage. Anti-Inflammatory Effects: Polyphenols modulate neuroinflammation by inhibiting the activation of microglia and reducing the production of pro-inflammatory cytokines. Resveratrol, a polyphenol found in red grapes, has been demonstrated to suppress the expression of inflammatory markers like TNF-alpha and IL-6, thus reducing neuroinflammation and protecting neuronal health [8]. Neuroprotective Properties: Polyphenols can exert direct neuroprotective effects by stabilizing neuronal membranes, promoting neuronal survival, and modulating cell signaling pathways involved in neurodegeneration. EGCG, a major component of green tea, has been shown to protect dopaminergic neurons from oxidative damage and apoptosis, contributing to its potential as a neuroprotective agent.

Clinical and preclinical evidence: Numerous studies have investigated the effects of plant-derived polyphenols in Parkinson's disease models and human trials. Preclinical studies using animal models of Parkinson's disease have demonstrated that polyphenols like curcumin and resveratrol can reduce motor deficits, protect dopaminergic neurons, and improve overall brain function. Clinical trials have also reported promising results, with polyphenol supplementation leading to improvements in motor symptoms and quality of life in patients with Parkinson's disease [9]. For example, a study on curcumin supplementation in Parkinson's patients showed a reduction in motor symptoms and improvements in cognitive function. Similarly, resveratrol has been associated with reduced neuroinflammation and enhanced cognitive performance in clinical settings [10]. However, while these findings are encouraging, further research is needed to confirm these effects, optimize dosing, and understand the long-term safety and efficacy of polyphenol-based interventions.

Conclusion

Plant-derived polyphenols represent a promising frontier in the fight against Parkinson's disease, offering multifaceted benefits through their antioxidant, anti-inflammatory, and neuroprotective properties. By addressing oxidative stress and neuroinflammation, these compounds have the potential to mitigate neuronal damage and improve clinical outcomes. Continued research is essential to validate their therapeutic efficacy and overcome existing challenges, paving the way for novel and effective treatments for Parkinson's disease. As our understanding of these natural compounds advances, they July become integral components of a comprehensive approach to managing and potentially altering the course of Parkinson's disease

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Conflict of Interest

None

References

1. Chin RL, Latov N (2005) Peripheral Neuropathy and Celiac Disease. Curr Treat Options Neurol 7: 43-48.
2. Lerman SE, Eskin E, Flower DJ, George EC, Gerson B, et al. (2012) Fatigue risk management in the workplace. J Occup Environ Med 54: 231-258.
3. Ibáñez, Silva v, Cauli j, Omar (2018) A survey on sleep assessment methods. PeerJ 6: 125-128.
4. Kushida CA, Littner MR, Morgenthaler TM (2005) Practice parameters for the indications for polysomnography and related procedures: An update for 2005. Sleep 28: 499-519.
5. Vinik AI, Nevoret ML, Casellini C, Parson H (2013) Diabetic neuropathy. Endocrinol Metab Clin North Am 42: 747-787.
6. Papanas N, Ziegler D (2014) Efficacy of α-lipoic acid in diabetic neuropathy. Expert Opin Pharmacother 15: 2721-2731.
7. Dewanjee S, Das S, Das AK, Bhattacharjee N, Dihingia A, et al. (2018) Molecular mechanism of diabetic neuropathy and its pharmacotherapeutic targets. Eur J Pharmacol 833: 472-523.
8. Qureshi Z, Ali MN (2021) Diabetic Neuropathy Pain Management: A Global Challenge. Curr Diabetes Rev 17: e031120187542- e031120187545.
9. Baka P, Escolano-Lozano F, Birklein F (2021) Systemic inflammatory biomarkers in painful diabetic neuropathy. J Diabetes Complications 35: 108017-108020.
10. Zhang X, Yang X, Sun B, Zhu C (2021) Perspectives of glycemic variability in diabetic neuropathy: a comprehensive review. Commun Biol 4: 1366-1369.