Short Communication
Volume 11:06, 2025

Journal of Pharmacognosy & Natural Products

ISSN: 2472-0992

Open Access

Antioxidants: Health, Disease Prevention, Diverse Applications

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Introduction

This review explores the fundamental roles of antioxidants in maintaining health and their therapeutic potential against various diseases. It highlights how antioxidants combat oxidative stress, a key factor in the pathogenesis of chronic conditions like cardiovascular diseases, neurodegenerative disorders, and cancer, by neutralizing free radicals and protecting cellular components from damage [1].

This review delves into the intricate relationship between oxidative stress, reactive oxygen species, and the protective mechanisms of endogenous and exogenous antioxidants. It emphasizes the therapeutic potential of natural compounds, particularly polyphenols, carotenoids, and vitamins, in counteracting oxidative damage and mitigating the progression of chronic diseases [2].

This article highlights the critical role of mitochondrial antioxidants in protecting cells from oxidative damage, particularly focusing on their therapeutic potential in diseases linked to mitochondrial dysfunction and oxidative stress. It discusses various endogenous mitochondrial antioxidant systems and how targeted exogenous antioxidants can be leveraged to restore mitochondrial health and alleviate disease symptoms [3].

This review focuses on the significant role of plant-derived antioxidants in food preservation. It details how natural extracts and their active compounds, such as polyphenols and flavonoids, can inhibit lipid oxidation and microbial growth, thereby extending the shelf life and enhancing the safety of food products, presenting a natural alternative to synthetic preservatives [4].

This comprehensive review examines the diverse array of dietary antioxidants, including vitamins, polyphenols, and carotenoids, and their profound health-promoting effects. It highlights their mechanisms in neutralizing free radicals, reducing inflammation, and modulating cellular pathways, thereby contributing to disease prevention and overall well-being [5].

This comprehensive review elucidates the multifaceted roles of antioxidants in combating oxidative stress, which is implicated in numerous chronic diseases. It provides an in-depth analysis of various classes of antioxidants, both endogenous and exogenous, discussing their mechanisms of action and therapeutic applications in mitigating cellular damage and restoring redox balance [6].

This review provides an updated perspective on the role of antioxidants in combating neurodegenerative diseases, where oxidative stress is a primary pathogenic factor. It discusses how various natural and synthetic antioxidants can protect neuronal cells from damage, modulate disease progression, and improve cognitive functions, offering insights into potential therapeutic strategies for conditions like Alzheimer's and Parkinson's [7].

This article explores the combined roles of antioxidant and anti-inflammatory pathways in the prevention of cardiovascular diseases (CVDs). It details how oxidative stress and chronic inflammation are critical drivers of atherosclerosis and other CVDs, and how various natural and pharmacological agents targeting these pathways can significantly reduce cardiovascular risk and improve cardiac health [8].

This mini-review highlights the profound antioxidant potential of polyphenols, a diverse group of plant-derived compounds, and their significant role in preventing various chronic diseases. It explains their mechanisms of action in scavenging free radicals, chelating metal ions, and modulating enzyme activities, underscoring their therapeutic relevance in health and disease management [9].

This review explores the emerging connection between dietary antioxidants and gut health, focusing on their ability to modulate the gut microbiota. It discusses how these compounds can influence the composition and function of gut bacteria, reduce gut inflammation, and strengthen the intestinal barrier, ultimately contributing to overall health and preventing various gut-related disorders [10].

Description

Antioxidants play a fundamental role in maintaining health and offer significant therapeutic potential against a variety of diseases [1]. They are essential for combating oxidative stress, a key contributor to the development of chronic conditions like cardiovascular diseases, neurodegenerative disorders, and cancer. By neutralizing free radicals and protecting cellular components from damage, antioxidants safeguard overall cellular integrity and function [1], [6].

The intricate relationship between oxidative stress, reactive oxygen species, and the protective mechanisms of both endogenous and exogenous antioxidants is well-documented [2]. Natural compounds, especially polyphenols, carotenoids, and various vitamins, demonstrate considerable therapeutic promise in counteracting oxidative damage and slowing the progression of chronic illnesses [2], [5]. Mitochondrial antioxidants, in particular, are vital for protecting cells from oxidative damage, with promising therapeutic applications in diseases linked to mitochondrial dysfunction and oxidative stress [3]. Targeted exogenous antioxidants can help restore mitochondrial health and alleviate disease symptoms [3].

Beyond general health, specific types of antioxidants show diverse applications. Plant-derived antioxidants, for instance, are crucial in food preservation. Natural extracts and their active compounds, like polyphenols and flavonoids, effectively inhibit lipid oxidation and microbial growth, extending food product shelf life and

enhancing safety, offering a natural alternative to synthetic preservatives [4]. Furthermore, polyphenols, a diverse group of plant-derived compounds, exhibit profound antioxidant potential, playing a significant role in preventing various chronic diseases by scavenging free radicals, chelating metal ions, and modulating enzyme activities [9].

Antioxidants are also critical in the context of specific health challenges. In neurodegenerative diseases, where oxidative stress is a primary pathogenic factor, both natural and synthetic antioxidants can protect neuronal cells, modulate disease progression, and improve cognitive functions, presenting potential therapeutic strategies for conditions such as Alzheimer's and Parkinson's [7]. For cardiovascular diseases, the combined roles of antioxidant and anti-inflammatory pathways are explored, showing how addressing oxidative stress and chronic inflammation with natural and pharmacological agents can reduce cardiovascular risk and improve cardiac health [8].

Dietary antioxidants, including vitamins, polyphenols, and carotenoids, offer profound health-promoting effects by neutralizing free radicals, reducing inflammation, and modulating cellular pathways, thus contributing significantly to disease prevention and overall well-being [5]. An emerging area of research connects dietary antioxidants to gut health, highlighting their ability to modulate the gut microbiota. These compounds can influence the composition and function of gut bacteria, reduce gut inflammation, and strengthen the intestinal barrier, ultimately contributing to overall systemic health and preventing various gut-related disorders [10]. The comprehensive understanding of antioxidant mechanisms, both endogenous and exogenous, is pivotal for developing therapeutic strategies aimed at mitigating cellular damage and restoring redox balance [6].

Conclusion

This collection of reviews underscores the critical and multifaceted roles of antioxidants in promoting health and combating disease. Antioxidants are vital for neutralizing oxidative stress, a primary factor in the pathogenesis of chronic conditions like cardiovascular diseases, neurodegenerative disorders, and cancer, by protecting cellular components from damage. Various types, including dietary, mitochondrial, and plant-derived antioxidants such as polyphenols, carotenoids, and vitamins, demonstrate therapeutic potential by scavenging free radicals, reducing inflammation, and modulating cellular pathways. Beyond their direct health benefits, plant-derived antioxidants are effective in food preservation, inhibiting oxidation and microbial growth. Emerging research also highlights their role in modulating gut microbiota and improving gut health, contributing to overall well-being. The collective evidence emphasizes antioxidants' significance in disease prevention, therapeutic strategies, and maintaining redox balance.

Acknowledgement

None.

Conflict of Interest

None.

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How to cite this article: Al-Khalidi, Noor. "Antioxidants: Health, Disease Prevention, Diverse Applications." *J Pharmacogn Nat Prod* 11 (2025):400.

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Received: 01-Dec-2025, Manuscript No. jpnp-25-178348; **Editor assigned:** 03-Dec-2025, PreQC No. P-178348; **Reviewed:** 17-Dec-2025, QC No. Q-178348; **Revised:** 22-Dec-2025, Manuscript No. R-178348; **Published:** 29-Dec-2025, DOI: 10.37421/2472-0992.2025.11.400