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ROLE AND IMPORTANCE OF ANTİOXİDANTS İN SCİENTİFİC RESEARCH

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Introduction

Antioxidants are compounds that are increasingly important in modern medicine and health sciences. These molecules play a critical role in protecting cells and tissues by preventing oxidative stress caused by free radicals. Oxidative stress occurs when free radicals, such as reactive oxygen species (ROS) and reactive nitrogen species (RNS), interact with cellular components, damaging DNA, proteins, and lipids. This process is closely associated with many pathological conditions such as cancer, cardiovascular diseases, neurodegenerative disorders (Alzheimer's, Parkinson's, etc.), and even aging. Antioxidants help prevent cellular damage by neutralizing these harmful molecules.

Antioxidants are divided into two main groups: endogenous (produced by the body) and exogenous (taken from outside).Endogenous antioxidants include enzymes such as superoxide dismutase (SOD), glutathione peroxidase (GPx), and catalase, while exogenous antioxidants consist of compounds such as vitamin C, vitamin E, carotenoids, and polyphenols. These compounds can be taken into the body through foods, supplements, and herbal sources.

Recent scientific research has allowed us to better understand the effects of antioxidants on health. The role of antioxidants in the prevention of chronic diseases such as cancer, heart diseases, and neurodegenerative disorders has attracted great interest. However, there are still unanswered questions and challenges to be investigated regarding the effects of antioxidants. This article will examine in detail the mechanisms of antioxidants, their effects on health, their place in scientific research, and their potential applications in the future.

1.Definition and Types of Antioxidants

Antioxidants are divided into two main groups: endogenous (produced by the body) and exogenous (taken from outside). Endogenous antioxidants include enzymes such as superoxide dismutase (SOD), glutathione peroxidase (GPx), and catalase. Exogenous antioxidants are compounds such as vitamin C, vitamin E, carotenoids, and polyphenols (Halliwell & Gutteridge, 2015).

Table 1: Antioxidant Types and Sources

Antioxidant Type	Examples	Sources
Endogenous Antioxidants	Superoxide dismutase, Glutathione	Produced by the body
Exogenous Antioxidants	Vitamin C, Vitamin E, Polyphenols	Fruits, vegetables, nuts

2. Mechanism of Action of Antioxidants

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Antioxidants react with free radicals and stabilize them. This process protects cellular components from oxidative damage. Especially reactive oxygen species (ROS) and reactive nitrogen species (RNS) are the target molecules of antioxidants (Sies et al., 2017).

Mechanism of Neutralizing Free Radicals by Antioxidants

(Can be created with a simple reaction like the following:)

Free Radical (e.g., ROS) → Antioxidant (e.g., Vitamin C) → Stable Molecule

3. Effects of Antioxidants on Health

The effects of antioxidants on health have been studied in many scientific studies:

3.1. Cancer: Antioxidants can reduce the risk of cancer by preventing DNA damage. Many studies have been conducted on the anticancer effects of vitamin C and vitamin E (Valko et al., 2007).

3.2. Cardiovascular Diseases: Reduces the risk of atherosclerosis by inhibiting the oxidation of LDL cholesterol.For example, vitamin E has been shown to be effective in preventing cardiovascular diseases (Stampfer et al., 1993).

3.3. Neurodegenerative Diseases: Helps reduce oxidative stress in diseases such as Alzheimer's and Parkinson's.Studies on the neuroprotective effects of polyphenols are ongoing (Butterfield et al., 2002).

3.4. Aging: Can slow down the cellular aging process. Antioxidants can delay the aging process by improving mitochondrial functions (Harman, 1956).

Table 2: Effects of Antioxidants on Health

Disease Type	Antioxidant Type	Effects
Cancer	Vitamin C, Vitamin E	Prevention of DNA damage
Cardiovascular Diseases	Vitamin E, Polyphenols	Inhibition of LDL oxidation
Neurodegenerative Diseases	Polyphenols	Reduction of oxidative stress
Aging	Carotenoids, Polyphenols	Improvement of mitochondrial functions

4. Methods and Challenges in Antioxidant Studies

In vitro, in vivo, and clinical studies are conducted to evaluate the effectiveness of antioxidants. However, the ability of antioxidants to exhibit pro-oxidant effects at high doses and genetic differences between individuals increase the complexity of research (Bast & Haenen, 2013).

In Vitro Studies → Cell Cultures

In Vivo Studies → Animal Models

Clinical Studies → Human Experiments

5. Future Perspective

Antioxidant research has great potential in the fields of personalized medicine and nutrigenomics. The discovery of natural antioxidant sources and the pharmacological applications of these compounds will be the focus of future studies (Lobo et al., 2010).

Personalized Medicine → Antioxidant Treatments According to Genetic Differences

Nutrigenomics → Relationship Between Nutrition and Gene Expression

Pharmacological Applications → Development of New Antioxidant Drugs

Potential Future Applications of Antioxidants

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Natural Resources → Pharmacological Applications → Personalized Medicine

Conclusion

Antioxidants have great potential in preventing cellular damage caused by oxidative stress and protecting health. This study has examined in detail the definition, types, mechanisms of action, and effects of antioxidants on health. Scientific studies have supported that antioxidants play a protective role in many pathological processes such as cancer, cardiovascular diseases, neurodegenerative disorders, and aging. It has been shown that especially exogenous antioxidants such as vitamin C, vitamin E, and polyphenols prevent cellular damage by neutralizing free radicals.

However, there are still unanswered questions about the effects of antioxidants. For example, the ability of antioxidants to exhibit pro-oxidant effects at high doses and genetic differences between individuals complicate the use of these compounds. In addition, ensuring consistency between the methods used to evaluate the effectiveness of antioxidants (in vitro, in vivo, and clinical studies) is also an important challenge.

In the future, antioxidant research has great potential in the fields of personalized medicine and nutrigenomics. The discovery of natural antioxidant sources and the pharmacological applications of these compounds will be the focus of future studies. More research on the correct use and potential risks of antioxidants will help us better understand the effects of these compounds on health. As a result, antioxidants will continue to be an indispensable tool for modern medicine and health sciences and will find wider applications in the future.

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