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Review Article

REVIEW OF OXIDATIVE STRESS AND ANTIOXIDATIVE

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ABSTRACT

Oxidative stress is one of the causative factors of many diseases. According to the pathophysiology, monocytes, macrophages, and normal white cells are produced in large quantities that produce reactive oxygen species (ROS) as well as cytokines that can stimulate cell and tissue damage. Oxidative stress occurs when there is an imbalance between free radicals and antioxidants within the body. ROS (free radicals) are produced by normal cellular metabolism and interact with biomolecules such as protein, lipids, and DNA to cause cellular damage and are responsible for degenerative changes. These processes are responsible for causing many diseases such as cardiovascular diseases. The agents responsible for this damage are reactive oxygen and nitrogen species resulting from various processes that destroy intracellular components such as nucleic acids, proteins, and lipids. These agents can lead to necrotic cell death or apoptosis by activating specific intracellular signaling pathways.

Keywords: Oxidative stress, Antioxidant, Reactive oxygen species, Disease.

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INTRODUCTION

Oxidative stress is an imbalance between the ratio of free radicals and antioxidants in the human body. Free radicals are oxygen-containing molecules with an odd number of electrons. The odd number allows it to easily interact with other molecules, such as oxidation reactions that cause cell damage. Thus, these interactions are harmful to the human body and potentially beneficial [1].

If the number of free radicals exceeds the permissible limit inside the body, these radicals begin to cause damage to fatty tissue, DNA, and proteins. These harmful molecules make up a large part of the human body, so the damage can lead to a large number of diseases over time. These include: Atherosclerosis, high blood pressure, or diabetic atherosclerosis, inflammatory conditions, neurodegenerative heart diseases, such as Parkinson's and Alzheimer's cancer, and oxidative stress helps accelerate aging [2].

TYPES OF REACTIVE SPECIES

Reactive species are the common term for both free radicals, reactive oxygen species (ROS), reactive nitrogen species (RNS), and non-radicals, such as hydrogen peroxide. The free radicals are any species capable of independent existence that contains one or more unpaired electrons but the non-radicals species that have strong oxidizing potential and fever the formation of strong oxidants. Fig. 1 shows the types of radicals and non-free radicals of ROS.

Fig. 2 shows the types of radicals and non-free radicals of RNS.

In addition, Fig. 3 shows how free radicals destroy healthy cells [1].

ANTIOXIDANTS

Antioxidants are substances that protect against cell damage caused by free radicals, the unstable molecules that the body produces in response to stress. Antioxidants are substances that provide an electron to free radicals without losing their stability. This causes the free radicals to stabilize and become less dangerous and less able to interact with other molecules. Fig. 4 shows how antioxidants work by eliminating free radicals [4].

THE MOST ABUNDANT NUTRITIONAL ANTIOXIDANT

Flavonoids

Flavonoids are a class of polyphenolic compounds with a benzo-γ-pyrone structure largely represented in plants, responsible for several pharmacological activities. These substances have the ability to play an antioxidant role because they contain the hydroxyl functional group. This functional group works to get rid of free radicals and metal electrolytes that cause damage to the cells of the body [4-6].

One example of flavonoids is genistein. Genistein ($C_{15}H_{10}O_5$) is a natural compound that structurally belongs to a class of compounds known as isoflavones, which possess many pharmacological functions as an antioxidant, anti-inflammatory, and antibacterial.

The reason for this is the chemical structure consisting of many functional hydroxyl groups, which makes the compound, have good polarity and solubility. This compound also has a good lipophilic substance because it contains aromatic rings, so it is well absorbed and reaches the target site well. Fig. 5 shows the chemical structure of genistein [4-6].

Ascorbic acid

One of the vital roles of ascorbic acid (vitamin C) is to act as an antioxidant to protect cellular components from free radical damage. Ascorbic acid is a water-soluble vitamin. Vitamin C has an antioxidant property that eliminates free radicals directly in the aqueous phases of cells and the circulatory system. In addition, ascorbate also reduces metal ions such as Fe^{3+} and Cu^{3+}, which cause the appearance of amounts of free radicals in the body. As it is known that free radicals are responsible for causing cytotoxicity, which causes DNA damage [4,8,9].

Vitamin C has an antioxidant property due to its chemical structure. It contains many functional hydroxyl groups. Fig. 6 shows Chemical structure of Vitamin C.

Polyphenols

Polyphenols are powerful antioxidants, according to the several studies. Thus, polyphenols are considered essential substances that protect the

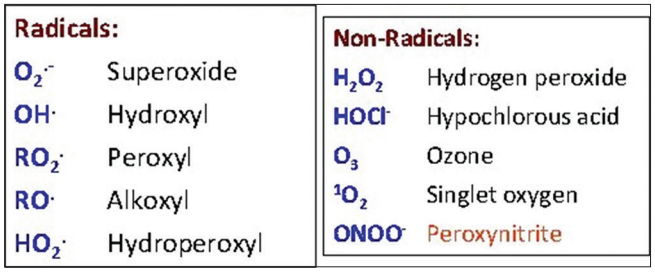

Fig. 1: The types of reactive oxygen species (ROS)

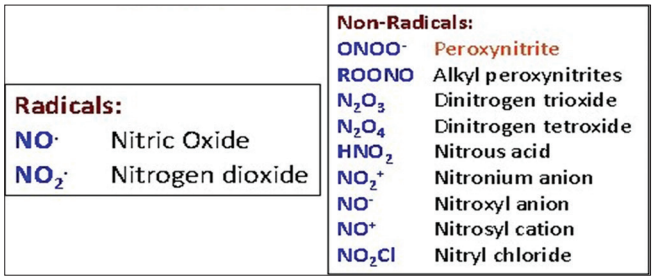

Fig. 2: The types of reactive nitrogen species

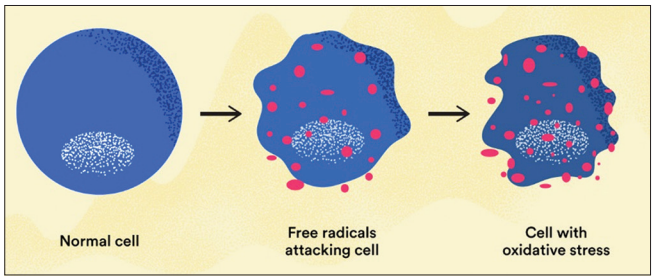

Fig. 3: How free radicals harm cells [3]

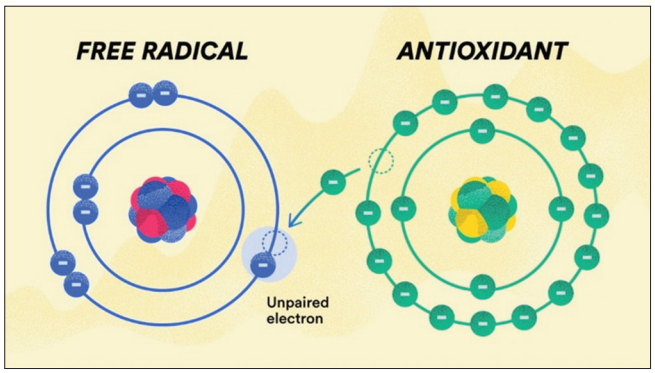

Fig. 4: How antioxidants work by eliminating free radicals [3]

body from free radical damage, which protects the body from many diseases that occur due to free radicals over time. Polyphenols have been shown in several studies to inhibit tumors caused by free radicals in experimental animals, and the role of ROS generation is still poorly understood, and the reason for this is the lack of clinical trials in the human body [4,11,12].

Polyphenols also contain many functional hydroxyl groups that play the role of antioxidants, in addition to aromatic rings and therefore these substances have hydrophilic and lipophilic properties and this leads to good absorption and good bioavailability. Fig. 7 shows Chemical structure of polyphenols.

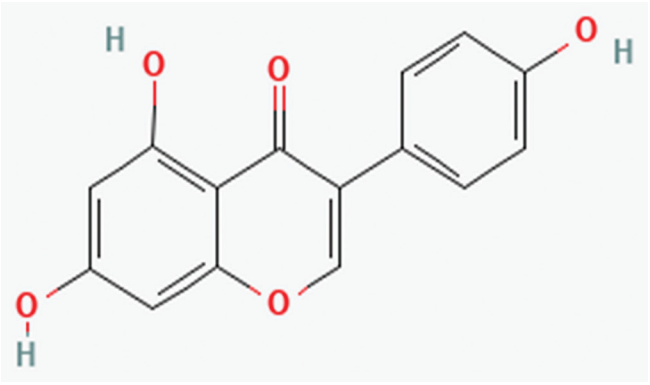

Fig. 5: Chemical structure of genistein [7]

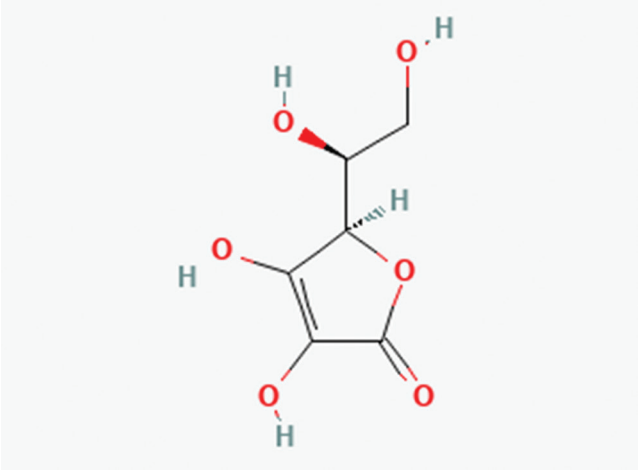

Fig. 6: Chemical structure of Ascorbic Acid [10]

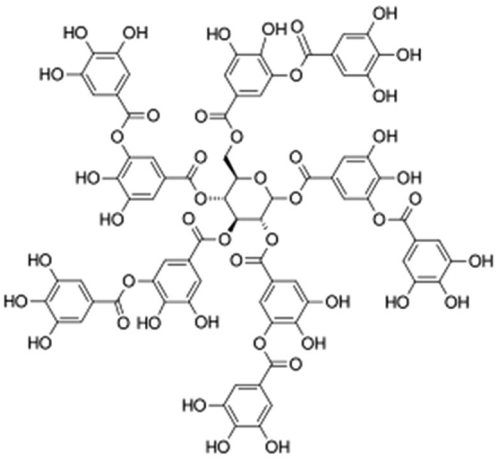

Fig. 7: Chemical structure of polyphenols [13]

SOME DISEASES RELATED TO OXIDATIVE STRESS

Cancer and oxidative stress

Free radicals affect intracellular signal transduction and cause disruption of transcription factors, these lead to damage and mutations causing cancer. There are many cancers that occur due to free radicals, such as lung cancer, leukemia, and skin cancer [14]. In lung cancers, p53, which is associated with the production of ROS, is often mutated and defective in inducing apoptosis. When mutated, p53 accumulates in the cytoplasm and functions as an oncogene.

Neurological disease and oxidative stress

Parkinson's disease (Parkinson's disease) is defined as a neurological disease, a disorder and disorder of the motor system. The cause of the disease is a decrease in the amount of dopamine within the brain as a result of damage to the dopamine production system in the substantia nigra, which is one of the nuclei within the basal nuclei in the basal region of the brain, and this disease is named after the English physician James Parkinson.

The principal protein component of these deposits is α-synuclein. The oxidative stress associated with PD could be the result of a breakdown in the regulation of dopamine (neuromelanin)/iron biochemistry. A diverse array of evidence is emerging that α-synuclein has a role in modulating the activity of do-pamine [14].

Heart disease and oxidative stress

Cardiovascular diseases (CVD) are complex and heterogeneous pathophysiological mechanisms, and free radicals have been shown to play a significant role in the pathogenesis of CVD. Oxidative stress plays an important role in the pathogenesis and development of CVDs, including hypertension, arteriosclerosis, dyslipidemia, myocardial infarction, heart failure, and angina [15].

CONCLUSION

We can reach to the conclusion that oxidative stress contributes to initiation and progression of several pathologies, ranging from CVD to cancer. Antioxidants gained enormous attention from the biomedical research community, because these compounds showed a good degree of efficacy in terms of disease prevention and/or treatment. Hence, although oxidative stress is one of the biggest damages to people's health and wellness, it can also be exploited as a therapeutic tool when and if we can fine-tune this. Process inside the human being.

REFERENCES

1. Manisha, Hasan W, Rajak R, Jat D. Oxidative stress and antioxidants: An overview. Int J Adv Res Rev 2017;2:110-9.
2. Keshari AK, Verma AK, Kumar T, Srivastava R. Oxidative stress: A review. Int J Sci Technol 2015;3:155-62.
3. Available from: https://greatist.com/health/free-radicals
4. Pizzino G, Irrera N, Cucinotta M, Pallio G, Mannino F, Arcoraci V, Squadrito F, *et al*. Oxidative stress: Harms and benefits for human health. Oxid Med Cell Longev 2017;2017:8416763.
5. Mahomoodally MF, Gurib-Fakim A, Subratty AH. Antimicrobial activities and phytochemical profiles of endemic medicinal plants of Mauritius. Pharm Biol 2005;43:237-42.
6. Pandey AK. Anti-staphylococcal activity of a pan-tropical aggressive and obnoxious weed *Parihenium histerophorus*: An *in vitro* study. Natl Acad Sci Lett 2007;30:383-6.
7. Available from: https://pubchem.ncbi.nlm.nih.gov/compound/genistein
8. Belin S, Kaya F, Duisit G, Giacometti S, Ciccolini J, Fontés M. Antiproliferative effect of ascorbic acid is associated with the inhibition of genes necessary to cell cycle progression. PLoS One 2009;4:e4409.
9. Migliozzi JA. Effect of ascorbic acid on tumour growth. Br J Cancer 1977;35:448.
10. Available from: https://pubchem.ncbi.nlm.nih.gov/compound/54670067
11. Nakazato T, Ito K, Miyakawa Y, Kinjo K, Yamada T, Hozumi N, *et al*. Catechin, a green tea component, rapidly induces apoptosis of myeloid leukemic cells via modulation of reactive oxygen species production *in vitro* and inhibits tumor growth *in vivo*. Haematologica 2005;90:317-25.
12. Jeong JC, Jang SW, Kim TH, Kwon CH, Kim YK. Mulberry fruit (*Moris fructus*) extracts induce human glioma cell death *in vitro* through ROS-dependent mitochondrial pathway and inhibits glioma tumor growth *in vivo*. Nutr Cancer 2010;62:402-12.
13. Available from: https://en.wikipedia.org/wiki/polyphenol
14. Rahman T, Hosen I, Islam MM, Shekhar HU. Oxidative stress and human health. Adv Biosci Biotechnol 2012;3:997-1019.
15. Senoner T, Dichtl W. Oxidative stress in cardiovascular diseases: Still a therapeutic target. Nutrients 2019;11:2090.