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## Role and Importance of Antioxidant in Medical Science- A Review

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**Abstract:** Antioxidants are natural substances that may prevent some types of cell damages. Natural antioxidants of interest are of plant origin and belongs to the phenolic and polyphenolic class of compounds. The constant exposure of the skin and other organs to oxidative stress results in damage to cellular DNA and cell membrane, lipids and proteins. A number of natural antioxidant ingredients also have anti inflammatory properties and can be used in repair of oxidative damage such as photo ageing. Cardiovascular diseases are also characterized by an enhanced state of oxidative stress. Antioxidants are generally evaluated for *in vitro* antioxidant action on SOD, LPO, and DPPH. Our review focuses on oxidative stress, free radicals, reactive oxygen, nitrogen species, anti-oxidative therapy, The review on oxidative stress and anti-oxidative therapy in various diseases were reviewed in detail. Various factors that cause oxidative stress in skin and organs and effects of antioxidants in the prevention and treatment of this oxidative stress are summarized, questioned, and discussed in this review.

**Keywords:** Antioxidant activity, Oxidative Stress, Free radicals, Reactive Oxygen

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## I. INTRODUCTION

Antioxidants are natural substances that may prevent some types of cell damage. Consumers are recently demanding natural foods that shows antioxidant property which enhances health and food preservation and hence developed a great demand for antioxidants derived from natural resources. Antioxidants are important for cure of many human diseases.<sup>1,2,3</sup> Cancer prevention agents are substances that can forestall or ease back harm to cells brought about by free radicals, precarious atoms that the body creates as a response to ecological and different weights and are called "free-radical foragers."<sup>1</sup>. The wellsprings of cell reinforcements can be characteristic or counterfeit. Certain plant-based the food necessary for growth, health, and good condition, are believed to be wealthy in cancer avoidance. Plant-based cell reinforcements are a sort of carotenoid, or plant-based supplement. The body likewise delivers a few cancer prevention agents, known as endogenous cell. Cell the action or process of reinforcing or strengthening that originate from outside the body are called exogenous. Free radicals are squander substances delivered by cells as the body formsbased the food necessary for growth, health, and good condition and responds to the earth. In the event that the body can't process and evacuate free radicals effectively, they are the oxidative pressure can result. This can hurt cells and body work in the forms. Free radicals and others radicals are otherwise called receptive oxygen species (ROS). A part or element of a larger whole, especially a part of a machine or vehicle, that expansion the creation of free radicals in the body can be inner, for example, aggravation, or outside, for instance, contamination, UV introduction, and tobacco smoke. Oxidative pressure has been connected to coronary illness, malignancy, joint pain, stroke, respiratory maladies, invulnerable insufficiency, emphysema, Parkinson's infection, and other provocative or ischemic conditions. Cell the action or process of reinforcing or strengthening are said to help kill free radicals in our bodies, and this is thought to support in general wellbeing and others. Antioxidants are natural and man made substances that may prevent some important types of cell damage. Natural antioxidants has greatly increased or decrease in the recent years. Consumers are demanding natural foods that show antioxidant property in all they which enhance health and food preservation and hence developed a great demand for the antioxidants derived in the from natural resources. The property of antioxidant agents are generally indirect or directly proportional to the number of the hydroxyl group present in their aromatic ring. Antioxidants are the important for human diseases.

### 1.1 Example of antioxidants

- Vitamin E,
- Vitamin C
- Lycopene
- Carotenoids

Oxidants and free radicals which are harmful for the body health and their over production which cannot steadily be destroyed thus consequently generates oxidative stress. Natural antioxidants have greatly increased in recent years. The large number of antioxidant agents is generally proportional to the number of hydroxyl groups present in their aromatic ring.<sup>3</sup>

## 1.2 Types of Antioxidants

### 1.2.1 Nutrients (Natural)

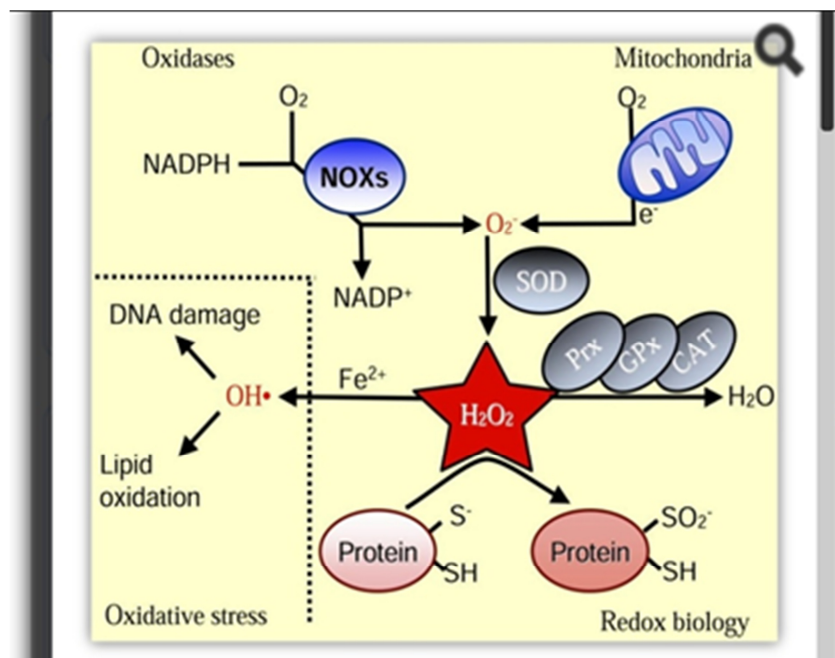
- B carotene – Provitamin A
- Ascorbic Acid – Vitamin C
- Tocopherols
- Sulphur amino acid – cysteine
- Selenium
- Zinc

### 1.2.2 Non Nutrients

- Carotenoids (Lycopene, Xanthophylls)
- Lutein,  $\alpha$ - and  $\gamma$ - carotene (zeaxanthin)
- Anthocyanins<sup>4</sup>

## 1.3 Effects of Antioxidants

Research for neurological diseases like parkinson's and Alzheimersfound to have these free radicals as one of the main causes<sup>4</sup>. ROS Pathway - Reactive oxygen species (ROS) are byproducts of aerobic metabolism. ROS include the superoxide anion ( $O_2^-$ ), hydrogen peroxide ( $H_2O_2$ ), and hydroxyl radicals (OH), all of which have inherent chemical properties that confer reactivity to different biological targets. ROS is often associated with the principle of oxidative stress which suggests ROS induce pathology by damaging lipids, proteins, and DNA. However, in the past two decades it has become apparent that ROS also serve as signaling molecules to regulate biological and physiological processes. It appears early in evolution, nature selected for ROS as a signal transduction mechanism to allow for adaptation to changes in environmental nutrients and the oxidative environment. Indeed in prokaryotes, there are well-described mechanisms whereby ROS directly activate transcription factors for adaption to stress.<sup>5</sup>



Courtesy-Cell Biology

Fig 1.ROS Pathway

Example – Vitamin E, Tocopherols, tocotrienols, beta-carotene, selenium is the most potential antioxidant properties.

**1.4 Prevention / Treatment of diseases**

Adequate intake of antioxidants, such as beta- carotene and vitamin c supplements or some fruits and vegetables which have been reported as essential antioxidants play a vital role in decreasing the risk of cancer and coronary heart disease.

**1.5 Application**

Oxidative stress has been linked to heart disease, cancer, arthritis, stroke, respiratory diseases, immune deficiency, emphysema, Parkinson's disease and other inflammatory or ischemic conditions.<sup>6</sup>Antioxidants are said to neutralize free radicals in our bodies, and this boost overall health. They can act as Anti-cancer agents. Antioxidants therapy found extremely useful in the treatment of acute central nervous system injury. Some internally generated sources of free radicals are –

Some internally generated sources of free radicals are

- Mitochondria – it is a double-membrane-bound organelle found in most eukaryotic organisms. Some cells in some multicellular organisms may, however, lack them.
- Xanthine oxidase -it is a form of xanthine oxidoreductase, a type of enzyme that generates reactive oxygen species.<sup>2</sup> These enzymes catalyze the oxidation of hypoxanthine to xanthine and can further catalyze the oxidation of xanthine to uric acid.
- Peroxisomes- it is a membrane-bound organelle (formerly known as a microbodies) found in the cytoplasm of virtually all eukaryotic cells.<sup>2</sup> Peroxisomes are oxidative organelles.
- Inflammation
- Phagocytosis
- Exercise

- Radiation
- Ozone
- Industrial solvents
- Certain drugs, pesticides
- Cigarette smoke

**1.6 ARS(Antioxidants and Redox signaling)**

Higher plants, as other high-impact creatures, require oxygen for the proficient creation of vitality .During the decrease of O<sub>2</sub> to H<sub>2</sub>O, receptive oxygen species (ROS), to be specific superoxide radical (O<sub>2</sub>•-), hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>), and hydroxyl radical (OH•) can be framed .Most cell compartments in higher plants can possibly turn into a wellspring of ROS. Ecological burdens that limit CO<sub>2</sub> obsession, for example, dry season and salt pressure, ozone and high or low temperatures, lessen the NADP<sup>+</sup> recovery by the Calvin cycle, subsequently, the photosynthetic electron transport chain is over-decreased, creating superoxide radicals and singlet oxygen in the chloroplasts .To forestall over-decrease of the electron transport chain under conditions that limit CO<sub>2</sub> obsession, higher plants advanced the photorespiratory pathway to recover NADP<sup>+</sup> As a major aspect of the photorespiratory pathway, H<sub>2</sub>O<sub>2</sub> is created in the peroxisomes, where it can likewise be shaped during the catabolism of lipids as a result of β-oxidation of unsaturated fats. Due to the exceptionally cytotoxic and receptive nature of ROS, their aggregation must be under tight control. Higher plants have exceptionally proficient enzymatic and non-enzymatic cancer prevention agent barrier frameworks that permit rummaging of ROS and insurance of plant cells from oxidative harm. The unmistakable subcellular confinement and biochemical properties of cancer prevention agent proteins, their differential inducibility at the compound and quality articulation level and the plenty of non-enzymatic foragers render the cell reinforcement frameworks an adaptable and adaptable unit that can control ROS collection transiently and spatially.<sup>2</sup>

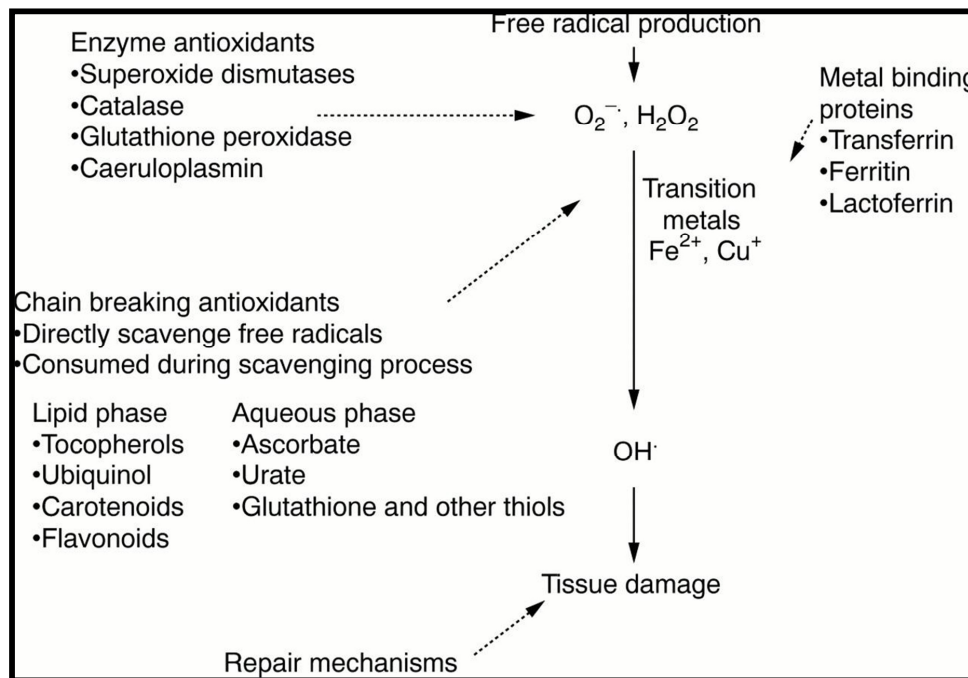
It includes –

- ROS / RNS as messengers.
- Gaseous signal transducers.
- Hypoxia and tissue oxygenation.
- MicroRNA.
- Prokaryotic systems.

- Lessons from plants biology.

### 1.7 Oxidative stress

Oxidative stress is an imbalance between free radicals and antioxidants in your body. Free radicals are oxygen – containing molecules with an uneven number of electrons.



**Fig 2. Antioxidant's mechanism of action**

Antioxidant exert their effects via several basic mechanisms which include , scavenging the species that initiate peroxidation, quenching singlet oxygen, chelating metals, breaking free radical chain reaction, and reducing the concentration of oxygen. Fig-3.

### 1.8 Antioxidants

It is a substance used for neutralizing free radicals. It acts as a cure for cellular damage, prevention of cell damage, etc carbohydrates, protein, DNA.

### 1.9 Classification of Antioxidants

There are two types of Antioxidants

- 1- Natural antioxidants
- 2- Synthetic antioxidants

#### 1.9.1 Natural antioxidants

There are two types

- a- Endogenous natural antioxidants
- b- Exogenous natural antioxidants

#### Endogenous natural antioxidants

There are two types

- Enzymatic endogenous natural antioxidants
- Non – enzymatic endogenous natural antioxidants

#### 1.9.2 Synthetic antioxidants

There are five types

- a- Butylatedhydroxyanisole (BHA)
- b- Butylatedhydroxytoluene (BHT)
- c- Propyl gallate (PG)
- d- Tertiary Butyl hydroquinone (TBHQ)
- e- Nordihydroguaiaretic acid (NDGA)

#### 1.10 Source of antioxidants

Sources of antioxidants are mostly from Polyphenol, Cystine, Peroxidase, Licopene, Beverages, Hot drinks, Vitamin C, Vitamin E.

#### 1.11 Function of antioxidants

Antioxidants play an important role in the protective influence exerted by plant foods. It will reduce the risk of different types of diseases. It acts a role to control the level of free radicals.<sup>7,8</sup>Antioxidants are substances that may protect your cells against free radicals, which may play a role in heart disease, cancer and other diseases. Free radicals are molecules produced when your body breaks down food or when you're exposed to tobacco smoke or radiation.

#### 1.12 Aging of antioxidants

Aging is a process characterized by the progressive loss of tissue and organ function. The oxidative stress theory of aging is based on the hypothesis that age-associated

functional losses are due to the accumulation of RONS-induced damages (Rice Evans CA 1995).<sup>9</sup> It was proposed by Denham Harman in the 1950s<sup>10</sup> that Free radical results in damage to biomolecules and DNA. In the 1970s, this idea of mitochondrial production of reactive oxygen species was given Lass A et al, Packer L, Witt EH. *et al* 1995.<sup>6,11</sup> The basic mechanisms of aging and its retardation by caloric restriction (CR) remain unclear. One suggested means by which CR could retard aging is based on production of mitochondrial free radicals, and efficiency of their subsequent metabolism.

### 1.13 Effect of antioxidants on skin

In healthy skin cells, it produces reactive oxygen (ROS). Endogenous antioxidants maintain homeostasis. The fine balance between the free radicals and endogenous antioxidants, this phenomenon is called oxidative stress.<sup>12</sup> Oxidative stress also plays an important role in various dermatological disorders such as – aging of skin, solar elastosis, telangiectasia, allergy, deep wrinkles, etc. In intrinsic aging process, damage to mitochondrial DNA, and increased ROS production.<sup>13,14</sup>

### 1.14 Generation of free radicals

Free radicals are natural by-product of aerobic cell metabolism. They are produced by a number of actions including infections, diseases and lifestyle. The generation can be endogenous (within the body) or exogenous (outside the body). The exogenous source of free radical is from the environment. According to Rice University, once free radicals are formed, a chain reaction can occur. The domino effect can damage and disrupt the whole cell<sup>15</sup>. Antioxidants destroy free radicals and disrupt the growth of free radicals by preventing oxidation. Oxidative stress is an important part of many human diseases, therefore, antioxidants play an important role in preventing the disease by inhibiting oxidation in a living system. Antioxidants are substances that may protect cells from the damage caused by unstable molecules known as free radicals. Antioxidants interact with and stabilize free radicals and may prevent some of the damage free radicals might otherwise cause. Free radical damage may lead to cancer. Consumption of fruits, vegetables, herbs, or their phytochemical constituents in diet helps in cancer prevention<sup>16,17,18</sup>. Research has shown that people who eat more vegetables and fruits have

lower risks of several diseases; however, it is not clear whether these results are related to the amount of antioxidants in vegetables and fruits, to other components of these foods, to other factors in people's diets, or to other lifestyle choices. Compounds such as vitamin C, vitamin E and osmarinic acid are commonly used in foods as well as cosmetics for their potent antioxidant activity that aids in product stability. They help the skin look younger by enhancing the collagen production and in turn reducing the appearance ageing on skin.<sup>19,20</sup> A recent study on diabetes showed that there is a link between enhanced oxidative stress and both insulin dependent (type 1) and non-insulin-dependent diabetes (type 2). Various studies on antioxidants show that oxidative stress can be overcome by interaction with antioxidants resulting in the cure of various diseases.

## 2. CONCLUSION

Free radicals damage contributes the etiology of many chronic health problems such as cardiovascular and inflammatory disease, cataract, and cancer. Antioxidants prevent free radical induced tissue damage by preventing the formation of radicals, scavenging them, or by promoting their decomposition.

## 3. ACKNOWLEDGEMENT

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## 4. AUTHORS CONTRIBUTION STATEMENT

Jagriti Singh collected the data with the supportive help of Er Srinath Pandey and Dr Ved Kumar Mishra under the supervision of Dr Vinay Dwivedi and Co Advisor Dr Satyam Khanna. All authors contributed equally for this drafting of manuscript.

## 5. CONFLICT OF INTEREST

Conflict of interest declared none.

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