

## Antioxidants and Disease Prevention

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### ABSTRACT

Antioxidants play important role in the prevention of free radical formation and helps in reducing various disorders such as cancer, aging, cardiovascular disease, cataracts, immune system decline, and brain dysfunction. There are several foods such as fruits, green leafy vegetables, tea, coffee, nuts and oilseeds which have been found to have good antioxidants potential. These dietary antioxidants such as vitamin A, vitamin C, vitamin E, carotenoids, phytochemicals etc. are found to have various disease preventive capacities. These antioxidants play an important role in protection against photo oxidative processes by acting as oxygen and peroxy radical scavengers. These have the capacities of preventing cardiovascular diseases include atherosclerosis, coronary heart disease, arterial hypertension, and heart failure. Antioxidants stimulate the immune system by enhancing T-lymphocyte proliferation in response to infection increasing cytokine production and synthesis of immunoglobulin and protect membrane stability, including quenching or scavenging Reactive Oxygen Species. The present review highlights the health benefits of antioxidants with supporting evidence from animal studies and humans.

**Key words:** Antioxidants, vitamin A, vitamin C, carotenoids, phytochemicals.

### INTRODUCTION

Oxygen is the most crucial factor which is essential for life of all living organism. No one can live on earth without oxygen but it can be harmful when it becomes toxic. Oxygen is a highly

reactive atom that is capable of becoming part of potentially damaging molecules commonly called “free radicals.” Free radicals have tendency of attacking the healthy cells of the body, causing them to lose their structure and function. Cell damage caused by free radicals appears to be a major contributor to aging and to degenerative diseases of aging such as cancer, cardiovascular disease, cataracts, immune system decline, and brain dysfunction. [1] Overall, free radicals have been implicated in the pathogenesis of at least 50 diseases. [2, 3] In plants and animals these free radicals are deactivated by antioxidants.

## ANTIOXIDANTS AND THEIR TYPES

Antioxidants are defined as “The substance that delays, prevents or removes oxidative damage to a target molecule”. [4] In the same year [5] defined antioxidants as “substance that directly scavenges ROS (Reactive Oxygen Species) or indirectly acts as inhibitor of ROS production”. Compounds which have the ability, after scavenging the radical, to form a new radical that is stable through intramolecular hydrogen bonding on further oxidation are called as antioxidants. [6]

‘Antioxidants’ are substances that neutralize the actions of free radicals. [7] Every cell in nature is endowed naturally with several protective mechanisms against any harmful effects of free radicals: superoxide dismutase (SOD), glutathione reductase, glutathione peroxidases are the enzymatic antioxidants.  $\alpha$ -Tocopherol (vitamin E) is an essential nutrient which acts as a chain-breaking antioxidant preventing the propagation of free radical reactions in all cell membranes in the human body. Ascorbic acid (vitamin C) is also an antioxidant which protects against free radicals. Carotenoids, flavonoids and polyphenols,  $\alpha$ -lipoic acid, glutathione etc are the other non-enzymatic antioxidants. [7, 8] These antioxidants plays diverse physiological role in body by inhibiting the process of oxidation, even at relatively small concentration.

## MAJOR ANTIOXIDANTS & THEIR SOURCES

There are various food items contains antioxidants-

**Vitamin C-** Fruits and vegetables, eg. Oranges, guava, amla, pineapple, tomatoes, spinach, carrots.

**Vitamin E-** Vegetable oils eg, soybean, corn, and safflower and vegetable oil products eg, margarine, whole grains, wheat germ, nuts and seeds, and green, leafy vegetables.

**$\beta$ -Carotene** - Yellow-orange fruits (eg, cantaloupe) and vegetables (eg, carrots) and green, leafy vegetables. [9, 10, 11, 12]

**Polyphenolic antioxidants** - Tea, coffee, soy, fruit, olive oil, chocolate, cinnamon, oregano and red wine. [13]

## **ANTIOXIDANTS AND THEIR ROLE IN PREVENTION OF DISEASES**

### **CAROTENOIDS**

Carotenoids are a family of pigmented compounds that are synthesized by plants and microorganisms but not animals. Carotenoids in plants protect photo damage by contributing to the photosynthetic machinery. In human diet fruits and vegetables constitute the major sources of carotenoid [14-16]. Carotenoids are thought to be responsible for the beneficial properties of fruits and vegetables in preventing human diseases including cardiovascular diseases, cancer and other chronic diseases [17, 18]. They are important dietary sources of vitamin A [17]. In humans and animals carotenoids play an important role in protection against photooxidative processes by acting as oxygen and peroxy radical scavengers [19].  $\beta$ -Carotene is a fat soluble member of the carotenoids which are considered provitamins because they can be converted to active vitamin A. Betacarotene is converted to retinol, which is essential for vision. It is a strong antioxidant and is the best quencher of singlet oxygen.[20]

### **LYCOPENE**

Lycopene, a member of the carotenoid family of phytochemicals is a lipid soluble antioxidant that is synthesized by many plants and microorganisms. Lycopene is not synthesized by animals and human. [21] It is responsible for the red color of many fruits and vegetables such as the tomatoes. Lycopene have a half life of about 2–3 days and is a predominant carotenoid in human plasma. [22] The antioxidant property of lycopene has been the main focus of research to study its biological role. Lycopene has been found preventive against cancer, through various diseases. A follow up met analysis of 72 different studies in 1999 showed that lycopene intake as well as serum lycopene levels were inversely related to several cancers including prostate, breast, cervical, ovarian, and liver and other organ sites. [23] Lycopene protects cells against oxidative damage and there by prevent or reduces the risk of several cancers.

Lycopene have also appeared as cardio protective in various literatures. [24–26] Serum cholesterol is as a biomarker for the risk of CHD. Oxidation of the circulating low density lipoprotein (LDL), which carries cholesterol into the blood stream, to oxidized LDL (LDLox) is also thought to play a key role in the pathogenesis of arteriosclerosis which is the underlying disorder leading to heart attack and ischemic strokes. [27-29] Lycopene was also shown to significantly reduce the levels of oxidized LDL (LDLox) in subjects consuming tomato sauce and tomato juice. [30] In another small study, lycopene was shown to reduce serum total cholesterol levels and thereby lowering the risk of CVD. [31]

### **POLYPHENOLS**

Polyphenols are produced by plants typically as a defense against herbivores and various stresses in general. In Western countries, polyphenol intake is approx. 0.4-1g/d and capita [32], with higher intake for persons following a vegetarian diet. Food sources that are especially rich in polyphenols include potato, plums, leafy vegetables, whole grain products, and coffee. [33]

Like as phenolic acids, flavonoids are secondary metabolites of plants with polyphenolic structure thus flavonoid groups of poly phenolic compounds have low toxicity in mammals and are widely distributed in plant kingdom. [34]

Major dietary sources of Flavonoides in the form of flavonols, flavones, isoflavones, flavonones are, tea, red wine, apple, tomato, cherry, onion, thyme, parsley, soyabeans, and other legumes, grape fruit, orange, lemon, ginkgo, and neem.[35]

Salucci *et al.*, reported that dietary flavonoids like epicatechin, galate, gallic acid, quercetin-3-glucoside possess strong antioxidant activity. [36]

Flavonoids have been used extensively since centuries for the treatment of various diseases. Cardiovascular diseases are today the principal cause of death in both developing and developed countries. Cardiovascular diseases include atherosclerosis, coronary heart disease, arterial hypertension, and heart failure. The major reason behind CVS diseases is oxidative stress and hence with the help of antioxidant decreases the oxidative stress. It is generally accepted that most of, if not all, the beneficial health effects of flavonoids are attributed to their antioxidant and chelating capacities. [37]

## **VITAMIN C**

Ascorbic acid, commonly known as vitamin C plays significant functions in the human body, though its function at the cellular level is not very clear. Vitamin C is needed for collagen synthesis, the protein that serves so many connective functions in the body. Among the body's collagen-containing materials and structures are the framework of bone, gums and binding materials in skin muscle or scar tissue. Production of certain hormones and of neurotransmitters and the metabolism of some amino acids and vitamins require vitamin C. This vitamin also helps the liver in the detoxification of toxic substances in the system, and the blood in fighting infections. Ascorbic acid is important in the proper function of the immune system. As an antioxidant, it reacts with compounds like histamines and peroxides to reduce inflammatory symptoms. Its antioxidant property is associated with the reduction of cancer incidences [38, 39]

Vitamin C appears to have a lowering effect on systolic pressure, more than it has on diastolic pressure. [40]

In addition, supplementation with vitamin C has been demonstrated to stimulate the immune system by enhancing T-lymphocyte proliferation in response to infection increasing cytokine production and synthesis of immunoglobulins. [41] Vitamin C may also play a significant role in the regulation of the inflammatory response. [42]

## **VITAMIN E**

Vitamin E chemically known as tocopherol is one of the most important lipid-soluble primary defense antioxidants. [43, 44, 45] It is a generic term used for several naturally occurring tocopherols and tocotrienols. In its function as a chain-breaking antioxidant, vitamin E rapidly transfers its phenolic H-atom to a lipid peroxy radical, converting it into a lipid hydroperoxide

and a vitamin E radical. [46] Palm vitamin E (30% tocopherols, 70% tocotrienols) has been extensively researched for its nutritional and health properties. The tocotrienols have been reported to be natural inhibitors of cholesterol synthesis. [47] Tocopherols (vitamin E) and tocotrienols (provitamin E) are powerful antioxidants that confer oxidative stability to red palm olein (RPO) as well as help to keep the carotenoids and other quality parameters of the oil stable.[48] Vitamin E scavenges peroxy radical intermediates in lipid peroxidation and responsible for protecting Poly Unsaturated Fatty Acid (PUFA) present in cell membrane and low density lipoprotein (LDL), against lipid peroxidation. [49] Tocopherols, a lipid soluble antioxidant are considered as potential scavengers of Reactive oxygen species (ROS) and lipid radicals. Tocopherols are considered general antioxidants for protection of membrane stability, including quenching or scavenging ROS. Out of four isomers of tocopherols ( $\alpha, \beta, \gamma, \delta$ ) found in plants,  $\alpha$ -tocopherol has the highest antioxidative activity due to the presence of three methyl groups in its molecular structure. [50]

## CONCLUSION

Free radicals are the causative agents that play important role in altering many crucial biological molecules leading to loss of form and function. These changes cause undesirable changes in body and various diseases occur. Antioxidants are emerging as prophylactic and therapeutic agents and have been found to be pharmacologically active in the prevention of several diseases. Antioxidants are also used as nutritional supplements for curing various diseases along with drug therapy. For effective and immediate treatment it is necessary to develop new supplementary methods so that the role of antioxidants is improved. Antioxidants protects against the free radicals at various levels. Major sources of antioxidants are the plant foods. Indian spices, fruits, vegetables and medicinal plants are rich sources of natural antioxidants. They are present in sufficient amount in these foods which can protect from various damages occurring inside the body and improves health. Development of functional foods by including high level of antioxidants in functional foods is one strategy is gaining importance in various countries and it may play disease preventive role for mankind.

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