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Review Article

THE HEALTH BENEFITS AND RISKS OF ANTIOXIDANTS

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ABSTRACT

Oxidant by-products of normal metabolism can cause extensive damage to DNA, protein, and lipid. This damage is a major contributor to aging and to degenerative diseases of aging such as cancer, cardiovascular disease, immune-system decline, brain dysfunction, and cataracts. Antioxidant is micronutrient and a collective name for the vitamins, minerals, carotenoids, and polyphenols that protect the body from harmful free radicals. Antioxidants scavenge free radicals from the body cells, and prevent or reduce the damage caused by oxidation. Low dietary intake of fruits and vegetables doubles the risk of most types of cancer, heart disease and cataracts but overdose of antioxidant supplement can cause adverse effect.

Keywords: Free radicals, Scavenge, Micronutrient, Natural antioxidants, Antioxidant over-supplement.

INTRODUCTION

The ability to utilize oxygen provides benefit of metabolizing fats, proteins and carbohydrates for energy. Being highly reactive oxygen atom is capable of becoming part of potentially damaging molecules known as "free radicals". Free radicals are not only capable of attacking the healthy cells of the body, but also causing them to lose their structure and function.[1] Free radicals have been implicated in the etiology of several human diseases as well as ageing.[2,3] Cell damage caused by free radicals appears to be a major contributor to aging and to degenerative diseases of aging such as cardiovascular disease, cataracts, cancer, brain dysfunction and immune system decline.[4] Overall, it is found that free radicals have been implicated in the pathogenesis of at least 50 diseases.[1] Antioxidants are able to scavenge free radicals from the body cells and thus prevent or reduce the damage caused by oxidation.[5] Rich diet of antioxidants may reduce the risk of many diseases.

Purpose

Great interest in this topic is due to study of antioxidants which prevent cutaneous damage and degenerative diseases caused by free radicals. Therefore it is interesting to compare their dietary benefits and risks of overdose of supplement.

Free Radicals & Their Role

The free radicals play important roles in our body and skin, as bactericidal and forming connections between collagen fibers in the skin. On the other hand, these molecules have a significant disadvantage; they are unstable and over active.[6] An unpaired electron present in free radicals causes them to seek out and capture electrons from other substances in order to neutralize themselves. The initial attack causes the free radical to become neutralized, and a new free radical is formed in the process, causing a chain reaction to occur and until subsequent free radicals are deactivated, thousands of free radical reactions can occur within seconds of the initial reaction.[1] O_2 is metabolized in animal tissue by successive reductions in superoxide anion ($O_2^{\cdot -}$), hydrogen peroxide (H_2O_2) and hydroxyl radical

($^{\cdot}OH$). These different metabolites are called Reactive Oxygen Species (ROS). ROS are either free radicals (with an unpaired electron in their outer orbital sphere) ($O_2^{\cdot-}$,$^{\cdot}OH$) or non radical (H_2O_2, singlet oxygen ($^1O_2$)).[7] All are capable of reacting with membrane lipids, nucleic acids, proteins and enzymes, and other small molecules, may cause cellular damage.[1]

Disease-Fighting Antioxidants

Antioxidants biological role in the body is very important for protection against oxidative damage, thus prevention from cardiovascular, carcinogenic, neurological diseases and delaying chronic health problems like cataracts.[8,9] The Food and Drug Administration (FDA) defines antioxidants only as dietary supplements to be taken in addition to normal food consumption in an effort to prevent some diseases.[10] Antioxidants can inhibit the production of ROS by direct scavenging, decrease the amount of oxidants in and around our cells and thus prevent ROS from reaching their biological targets, limit the propagation of oxidants.[11] Antioxidants have capability of stabilizing, or deactivating free radicals before they attack cells.[1] Deficiency of antioxidants can cause a lot of free radicals to roam in the cells, damaging them. Free radicals can also damage the DNA of the cells.[5] When genetic material like DNA is damaged inside a cell, all cells duplicated from the original damaged cell will have the same genetic damage. Some diseases that may develop due to free radicals are:

- Cancer
- Rheumatoid arthritis
- Eye disease
- Heart disease
- Alzheimer's disease
- Parkinson's disease

Low intake of certain antioxidants can cause many problems. The risk of many diseases, including heart disease and certain cancers can be reduced by a diet high in antioxidants. Antioxidants have property to scavenge free radicals from the body cells, and prevent or reduce the damage caused by oxidation.[5] Due to not getting enough antioxidants Some people are at greater risk. The following groups of people have a high risk of not getting enough of antioxidants:

- Older adults, since the body makes less of its own antioxidants
- People who drink a lot of alcohol regularly
- People who are regularly exposed to tobacco smoke

Dietary Sources of Antioxidants

Vitamin C

Vitamin C is a water-soluble vitamin also known as ascorbic acid, found in all body fluids, so it may be one of our first lines of defense. This antioxidant cannot be stored by the body, so it's important to get it regularly by eating fruits and vegetables. Important sources are green leafy vegetables, strawberries, green peppers, citrus fruits, broccoli, raw cabbage, and potatoes.

Figure 1: Vitamin C rich food

Vitamin E

A fat-soluble vitamin that can be stored with fat in the liver and other tissues, There is a range of purposes-from healing sunburn to delaying aging which promotes vitamin E (tocopherols, tocotrienols). Important sources include seeds, whole grains, green leafy vegetables, wheat germ, nuts fish-liver oil, vegetable oil.

Beta-Carotene

There are more than 600 different carotenoids that have been discovered, dark green, yellow and orange vegetables and fruits are protected from solar radiation damage by beta-carotene (lycopene, carotenes). It is believed that it plays a similar role in the body. Broccoli, Carrots, tomatoes, squash, sweet potatoes, cantaloupe, peaches, and apricots are particularly rich sources of beta-carotene.

Figure 2: Sources of beta carotene

Selenium

Selenium can probably interact with every nutrient that affects the antioxidant balance of the cell. It also help to fight cell damage caused by oxygen-derived compounds and thus may help protect against cancer. It is best to get selenium through foods like red meat, fish, shellfish, grains, chicken, eggs, and garlic.

Figure 3: Sources of Selenium

Polyphenol Antioxidants

In polyphenol antioxidants (resveratrol, flavonoids) several phenol functional groups are present. It is believed that in human health these compounds are, instrumental in combating oxidative stress. The main source of polyphenol antioxidants are most legumes; fruits such as apples, blackberries, cherries, cranberries, grapes, pears, plums, raspberries, and strawberries; and vegetables such as broccoli, cabbage, celery, onion, and parsley are rich in polyphenol antioxidants. Red wine, chocolate, green tea, olive oil, bee pollen, & many grains are alternative sources.

Glutathione

Glutathione protects cells from free radicals. Glutathione is produced in human body from the synthesis of three key amino acids-glycine, cysteine, and glutamic acid. Food sources with the highest amounts of naturally occurring

glutathione include; avocado, zucchini, asparagus, potato, watermelon, squash, grapefruit, peach, spinach, broccoli, cantaloupe, and strawberries. To increase & maintain body glutathione levels meat, Fish, and foods which yield sulfur containing amino acids are the preferred.

Peroxidase

It is an enzyme which occurs especially in plants, milk, and leukocytes and consisting of a protein complex with hematin groups which catalyzes the oxidation of various substances. Food sources are horseradish root, soybean, mango fruit, and turnip.

Cysteine

It is an important antioxidant in cellular systems which blocks oxidants of the free radical. To protect cells against free radical oxidant damage cysteine is incorporated in the cellular glutathione, which works along with vitamin E. Cysteine is manufactured from other amino acids in the liver so it does not have to be obtained directly through the diet. It is synthesized in the liver from methionine. Animal protein is higher in sulfur amino acids. Beans are generally higher in sulfur amino acids than grains. Excessive intake of cysteine can result in kidney stone formation, liver damage or even some forms of schizophrenia.

Flavonoids

Flavonoids play important role in promoting antioxidant activity, cellular health, normal tissue growth and renewal throughout the body. With vitamin C it also reduces oxidative stress for the water based portion of the cell and may slow down some of the effects of aging. More than 4,000 unique flavonoids are present and they are most effective when several types are consumed together. Sources are:, oranges, lemons, kale, beets, cranberries berries, red and black grapes, grapefruits, and green tea.[12]

In May, 2005, the most comprehensive study of the antioxidant content of common foods was published in the June 2004 edition of the Journal of Agricultural and Food Chemistry. According to this study, the 20 most antioxidant-rich foods are as follows:[13]

Rank	Food	Serving Size	Antioxidant Capacity per Serving
1	Small red beans, dried	1/2 cup	13727
2	Wild blueberries	1 cup	13427
3	Red kidney beans, dried	1/2 cup	13259
4	Pinto beans	1/2 cup	11864
5	Blueberries, cultivated	1 cup	9019
6	Cranberries	1 cup	8983
7	Artichoke hearts, cooked	1 cup	7904
8	Blackberries	1 cup	7701
9	Dried prunes	1/2 cup	7291
10	Raspberries	1 cup	6058
11	Strawberries	1 cup	5938
12	Red delicious apple	One	5900
13	Granny Smith apple	One	5381
14	Pecans	1 ounce	5095
15	Sweet cherries	1 cup	4873
16	Black plum	One	4844
17	Russet potato, cooked	One	4649
18	Black beans	1/2 cup	4181
19	Plum	One	4118
20	Gala apple	One	3903

The highest ranked foods in four major categories are as follows:

Fruits

Blueberries, cranberries and blackberries.

Vegetables

Beans, artichoke hearts and surprisingly, russet potatoes.

Nuts

pecans, walnuts and hazelnuts.

Spices

Cinnamon, oregano and ground cloves[13]

Intake Limit and Risks

It is believed that antioxidants and other protective constituents from vegetables, legumes and fruit need to be consumed regularly from early life to be effective.[5] Evidence shows that effectiveness of antioxidant is more when obtained from whole foods, rather than isolated from a food and presented in tablet form and some supplements can actually increase risk of cancer. If vitamin A is purified from foodstuffs can increase risk of lung cancer in smokers. The American Heart Association does not currently recommend using antioxidant vitamin supplements. It is very important that we should not "over-supplement" our bodies, by taking much more than the recommended daily value of certain vitamins and minerals. Vitamins A and E are soluble in fat, means excess amounts are stored in the liver and fatty tissues, so instead of being quickly excreted, it may create a risk of toxicity. A well-balanced diet, which includes consumption of antioxidants derived from fruits, veggies & whole grains is best.[14] If you insist on taking a supplement, seek supplements which contain all nutrients at the recommended levels.[5]

CONCLUSION

Antioxidants help to protect our body from damage caused by free radicals. Free radicals are produced when the body is exposed to environmental factors, such as smoke, tobacco or radiation. Antioxidant is a free radical destroyer. There are many different antioxidant substances, including beta-carotene and vitamins A and vitamin C. Antioxidants play important role in preventing certain diseases, like heart disease and cancer therefore the best way to get antioxidants is by eating a variety of healthy food, especially vegetables, fruits, and nuts. Antioxidant supplements are expected to be beneficial but when taken in excess they can cause adverse effect. As a preventive measure against certain diseases, the best approach for healthy individuals is to regularly consume adequate amounts of antioxidant-rich foods, eg. Fruits, vegetables and whole grains.

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