

An Introductory Review of Antioxidants and Human Health

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Abstract : Antioxidants and their implications in issues related with human health are important in terms of increasing the diet quality in modern times. The biochemistry of antioxidants affecting the complex cellular biology is still not clear. However, studies have reflected antioxidant's therapeutic effectiveness. This article introduces about the antioxidants and their uses in medical and nutritional sciences.

INTRODUCTION

Free radicals are the toxic by-products of aerobic respiration. Their production demarcates the shifting from anaerobic to aerobic respiration. In living organisms, the energy to support life processes is derived from food molecules. This generation of energy is being done by digestive oxidants. Free radicals are generated simultaneously in this energy production. These free radicals are harmful for the living systems therefore nature has provided a counter in the form of antioxidant compounds. Free radicals tend to cause various types of cell damages and antioxidants neutralize them to prevent or decrease the rate of such damage. For sustaining a healthy living system, equilibrium is required between the amount of free radicals generated and the antioxidants neutralising them. To achieve this balance there can be three ways: first is to increase the intake amount of antioxidants, the second is to decrease the generation of harmful free radicals by decreasing the oxidative stress exposure and the third one is to apply both of the above said methods. The requirements of antioxidants are fulfilled by a normal healthy diet. However, there are certain factors that can imbalance the equilibrium between the antioxidants and oxidative stress. These factors include diet quality, environmental pollution and health condition. Some foods are especially richer in antioxidants and their consumption can improve health, e.g., fruits and vegetables. There are evidences for lower risk of several diseases in persons who consume higher amounts of vegetables and fruits. However, exclusive effect of antioxidants were not confirmed by these studies.¹ There is a possibility that some other factors like, lifestyle choices or other constituents of food, might acted to effect the lowering of the risk of various diseases.

Triggering of biochemical pathways by antioxidants is still unclear. Possible protective effect of Antioxidant's towards degenerative diseases has been implicated in large epidemiological trials. These trials have shown that diets rich in plant food can increase human lifespan. Because of these results, there has been a lot of research on antioxidant supplements. The theories of positive effects of antioxidants helping to reduce the risk of diseases coexist with those theories that call for the toxic over supplementation of antioxidants. Supplementation of antioxidants cannot replace antioxidants derived from food.² Antioxidant supplements can confer increased risks for mortality too. Studies have also shown that not all the antioxidants are bioavailable, i.e., get absorbed into blood stream from the digestive system. Therefore, the ability of antioxidant containing foods needs to be tested carefully to suggest their actual efficacy.

FREE RADICALS AND CAUSES OF THEIR GENERATION

Free radicals are formed as a part of body's natural metabolic processes. During conversion of food into energy and exercise, free radicals are naturally formed.³ Free radicals can also be generated by

environmental factors like stress, usage of pesticides, smoking or related habits, sunlight, air pollutants, xenobiotic compounds, medications etc. Severe damage to DNA and cellular components can be caused by free radicals:

- Enhancement in the rate of bone, organ, brain and skin aging
- Interference with cell replications
- Malignant tissue formation
- Enzyme malfunctioning

Age related macular degeneration, cataracts, cardiovascular diseases, cancer, Parkinson's disease, Alzheimer's disease, diabetes are caused by the oxidative stress which is produced due to free radicals.

WHAT ARE ANTIOXIDANTS?

Antioxidants are the substances that prevent the oxidation of a substrate even at very low concentrations. The oxidizable substrate may occur at par higher concentration than that of the antioxidants. Food or biological constituent molecules like, lipids carbohydrates, proteins and nucleic acids are the oxidizable substrates for antioxidants.⁴ Antioxidants are grouped together based on their function. All antioxidants possess the property of neutralising the effects of harmful free radicals. Antioxidants have three major functions:

- prevent the formation of free radicals, e.g., carotenoids
- inhibition of chain breaking process by neutralisation of free radicals
- repair the damage caused by free radicals

CLASSIFICATION OF ANTIOXIDANTS

Antioxidants are broadly grouped in to two classes:

1) Primary or natural antioxidants: These are synthesized by plants and are present in the foods made from plant materials. These include:

- Antioxidant minerals: these are cofactors of antioxidants enzymes, e.g., zinc, copper, selenium, iron, and manganese.
- Antioxidant vitamins: they are involved in all metabolic functions, e.g., vitamin B, vitamin C and vitamin E.
- Phytochemicals: The active chemical components present in a plant that account for its medicinal properties, e.g., flavonoids.

2) Secondary or synthetic antioxidants: These are prepared by extraction from plant sources and are taken as supplements in concentrated form. Synthetic antioxidants are also used to increase the shelf-life of foods. They include:

- Butylated hydroxyl anisole (BHA).
- Butylated hydroxytoluene (BHT).

- Propyl gallate (PG) and metal chelating agent (EDTA).
- Tertiary butyl hydroquinone (TBHQ).
- Nordihydro guaretic acid (NDGA).

RESEARCH ON THERAPEUTIC USES OF ANTIOXIDANTS

Earlier observational and experimental studies on the benefits of antioxidant rich foods in preventing diseases seemed very promising. Therefore, large and long term clinical trial studies were conducted. These clinical trials tested whether antioxidant supplements, when taken over a few years, could help prevent diseases such as cardiovascular diseases and cancer. These clinical trial studies were designed to provide insights to specific questions about how antioxidants affect health. In majority of these studies, antioxidant supplementation didn't help to prevent disease.

Unlike majority of the clinical trial studies, the Age-Related Eye Disease Study (AREDS), led by the National Eye Institute and cosponsored by National Institute of Health (USA), showed a beneficial effect of antioxidant supplements.⁵ Combination of antioxidants (vitamin C, vitamin E, and beta-carotene) and zinc decreased the risk of developing the advanced stage of age-related macular degeneration by 25 % in patients with the intermediate stage of this disease or who had the advanced stage in only one eye. Antioxidant supplements used alone decreased the risk by about 17 %. In the same study, however, antioxidants did not help to prevent cataracts or slow their progression.

WHAT MAY BE THE REASON BEHIND LACK OF EFFICACY OF ANTIOXIDANT SUPPLEMENTS IN DISEASE TREATMENT?

No significant results have been shown by the clinical investigations on beneficial effects of of antioxidant supplements. These results were found to be similar for the effects on disease progression and cure. Many reasons are probable for these findings:

- The beneficial effects of antioxidant rich diet may be because of presence of other molecules of unknown nature. The benefits may also be present not due to antioxidants but because of the lifestyle choices and other dietary habits. These factors can confer the variability in the beneficial effects of antioxidant supplements.
- Dosing differences between antioxidant supplementation and natural antioxidant intake in foods may confer variance in beneficial effects. Antioxidant supplements provide very high and concentrated doses of antioxidants in comparison to natural food products.
- Antioxidant supplements can be made artificially through chemical processes. Such supplements may have different chemical composition than that of natural antioxidants present in foods. This can result in differences in their activity, absorbance etc.
- The source of antioxidants may also confer variability in beneficiary effects in treating specific diseases. The artificial antioxidant supplements may not provide the same benefits as those provided by the ones made in specific organs. For example, eye specific antioxidants can prove more effective in treating ophthalmic diseases.
- The complexity of biological systems and the multifactorial nature of diseases also plys role in deciding the effectiveness of antioxidants. The complex balance between oxidative stress/antioxidants and health is influenced by the complexity of biological systems as well as their interaction with environmental factors.

- Chronic diseases develop over very long durations; therefore shorter supplementation of antioxidants may not show their potential in treating these disorders.
- The clinical trials have been conducted on different races. There are differences in the genetic makeup of populations in reference to the genes of therapeutic importance. So, antioxidant supplementation may not provide similar effects for different populations.

CONCLUSION

Cellular damage can be induced by the disturbed equilibrium between the free radicals and body's defense mechanisms by increase in the oxidative burden. Overall, these changes lead to the advancement of pathological mechanisms of many diseases. Many observational and experimental studies have shown the role that antioxidants play in living organisms for prevention of various diseases. Therapeutic usage of antioxidant supplements is advised when the free radical induced injury overpowers body's natural supply of antioxidants. Free radical clearance results in improved health. However, the benefits and risks associated with supplementation of antioxidants are much debated. In the present scenario, antioxidant supplementation can't be said to replace healthy diet and conventional medical care. However, much effort is needed to explore the proper dosing of antioxidant supplements.

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