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Health Benefiting Natural Antioxidants: Present and Future Perspectives

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Antioxidants are substances that can prevent oxidative damage in the living cells. The dietary sources of natural antioxidants are derived from both plant and animal foods; they can also be extracted from natural sources or synthesized. In recent years, due to increasing concern with possible hazardous side effects from synthetic antioxidants, emphasis is being given on natural antioxidants. Dietary antioxidants have the potential to prevent diseases caused by oxidative stresses and hence are used for treatment of these diseases.

Introduction

Though oxygen is an indispensable element for our life, under certain cases it has detrimental effects on human health. Most of the potential harmful effects of oxygen are due to the formation of free radicals and reactive oxygen species (ROS), which have a tendency to donate oxygen to other substances, thereby damaging biologically relevant molecules such as DNA, proteins, carbohydrates and lipids (Young and Woodside, 2001).

Antioxidant is a stable molecule which donates an electron to a free radical, and neutralizes it, thus reducing its capacity to damage the cell. These are substances that can prevent oxidative damage through scavenging free radicals and reactive oxygen species (ROS), chelating metal ions, acting as reducing agents, or by quenching secondary products of lipid oxidation. The evolution of angiosperm plants, 200 to 50 million years ago, resulted in the development of many antioxidants such as ascorbic acid, polyphenols and tocopherols, as chemical defenses against ROS, which are byproducts of photosynthesis.

Generation of ROS

Oxidation begins with the formation of a free radical. This first step, called initiation, can be a result of exposure to light, ozone, alcohol, metal ions or free radicals as well as produced through normal body functions such as respiration. Following initiation and the formation of a free radical is propagation, which is the reaction of free radicals with oxygen and other stable molecules to form ROS and new free radicals. Propagation can continue uninterrupted causing

oxidative stress in the body or producing off flavors and decreasing nutrients content in foods. Termination ends the chain reaction of propagation, is the reaction of free radicals to form nonreactive products. Free radicals and other ROS are derived either from normal essential metabolic processes or from external sources such as air pollutants, cigarette smoking, industrial chemicals, X-ray exposure or ozone, through both enzymatic and non-enzymatic reactions in the cell.

Types of Antioxidants

Antioxidants can be classified into two classes, based on how they prevent oxidation. Primary antioxidants act to prevent propagation by donating hydrogen for the formation of more stable radicals, while secondary antioxidants slow the rate of oxidation through a variety of mechanisms such as chelating metal ions, scavenging oxygen, and regenerating primary antioxidants. Phenolic compounds, phenolic acids, flavonoids, stilbenes, coumarins, and tannins, are the main sources of dietary antioxidants, which can act as both primary and secondary antioxidants by hydrogen donation, stabilizing unpaired electrons, and through metal chelation.

Assay of Antioxidant Capacity

Antioxidant capacity is defined as the potential of the antioxidant to prevent oxidation. The two most used methods for measuring antioxidant capacity, which measure the free radical scavenging ability, are based on hydrogen atom transfer and electron transfer (Shahidi and Zhong, 2007). Oxygen radical absorbance capacity (ORAC) and total radical-trapping antioxidant parameter (TRAP) are the most widely used hydrogen atom transfer-based methods. Electron transfer methods, consisting of a probe and an antioxidant, measures the ability of the antioxidant to reduce the probe resulting in a color change.

Sources of Antioxidants

Antioxidants	Natural Sources
Vitamin C	Citrus Fruits, Green Peppers, Broccoli, Green Leafy Vegetables, Strawberries, Raw Cabbage, and Potatoes.
Vitamin E	Wheat Germ, Nuts, Seeds, Whole Grains, Green Leafy Vegetables, Vegetable Oil, and Fish-liver Oil.
β-Carotene	Carrots, Squash, Broccoli, Sweet Potatoes, Tomatoes, Kale, Collards, Cantaloupe, Peaches, and Apricots.
Selenium	Fish, Shellfish, Red Meat, Grains, Eggs, Chicken, and Garlic.
Poly-phenolics	Apples, Blackberries, Broccoli, Cabbage, Cantaloupe, Celery Cherries, Chocolate, Coffee, Cranberries, Green Tea, Grapes, Olive Oil, Onion, Parsley, Pears, Plums, Raspberries, Red Wine, and Strawberries.
Glutathione	Asparagus, Avocado, Grapefruit, Squash, Potato, Cantaloupe, Peach, Zucchini, Spinach, Broccoli, Watermelon, Strawberries, Fish, and Meat.
Peroxidase	Horseradish Root, Soybean, Mango Fruit, and Turnip.
Cysteine	Animal and bean proteins.
Flavonoids	Cranberries, Kale, Beets, Berries, Red and Black Grapes, Oranges, Lemons, Grapefruits, and Green Tea.

While antioxidants occur naturally in foods, they can also be extracted from natural sources or synthesized. However, due to increasing concern with possible hazardous side effects from synthetic antioxidants such as butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT), and propyl gallate (PG), hence, emphasis is being given on investigation of natural sources of antioxidants. The replacement of synthetic antioxidants by natural ones may have benefits due to health implications and functionality; however, some of them such as those from spices and herbs have limited applications despite their high antioxidant activity, as they impart a characteristic herb flavor to the food.

Health Benefiting Natural Antioxidants

Oxidative stress has been linked to aging and numerous diseases such as cancer, cardiovascular diseases (CVD), atherosclerosis, Alzheimer's disease, and other degenerative diseases. In our body, extent of main source of defense against free radicals, such as vitamins C and E, decreases with age due to repeated exposure to pollution, radiation, and other environmental stressors. Dietary antioxidants have been recognized as a preventative measure against diseases caused by oxidative stress and have also been shown to have some beneficial effects in the treatment of these diseases. Additionally, dietary antioxidants have been shown to act synergistically with antioxidant systems naturally present in the body by regenerating antioxidants such as vitamins C and E. Also, dietary antioxidants can act simultaneously with other antioxidants by utilizing different mechanisms.

Poly-phenolic-rich foods such as diets rich in fruits, vegetables, and whole grains have been associated with a lower risk of many chronic diseases like CVD, including those caused by oxidative stress. Consumption of polyphenolic-rich foods has also been linked to a decreased risk for certain cancers such as lung, breast, esophageal, ovarian, stomach, and colon. In spite of this, the consumption of flavonoids has showed a decreased risk in both coronary heart disease and the risk of mortality from myocardial infarction.

Potential of Antioxidant Supplements to Damage Health

Recent findings show that some antioxidant supplements may promote disease and increase mortality in humans. Hypothetically, free radicals induce an endogenous response which protects against exogenous radicals. Recent experimental evidences strongly suggest that this is indeed the case, and that such induction of endogenous free radical production extends the life span of *Caenorhabditis elegans* (Schulz *et al.,* 2007). Most importantly, this induction of life span is prevented by antioxidants, providing direct evidence that ROS act as essential signaling molecules to promote metabolic health and longevity (Ristow and Schmeisser, 2011).

Conclusion

Current research reveals the different potential applications of antioxidant/free radical manipulations in prevention or control of diseases. Synthetic antioxidants are recently reported to be dangerous to human health; hence the search for effective, nontoxic natural compounds with anti-oxidative activity has been intensified in recent years. In future, it could be possible to enhance *in-vivo* antioxidants concentration in the body through gene therapy, genetically

engineered plant products with higher level of antioxidants, synthetic antioxidant enzymes (SOD mimics), and novel bio-molecules having better anti-oxidative capacity with no side effects.

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