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Antioxidants; from laboratory investigations to clinical studies

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Abstract

Antioxidants are substances that react with free radicals and neutralize them. They are able to prevent organs from injury. Antioxidants are also recognized as "free radical scavengers." These potent agents, which frequently come from the vegetables and fresh fruits, prohibit and in some circumstances even prevent, the oxidation of various molecules throughout the body. Most of the most powerful antioxidants are detected in herbs. This is due to the fact that herbs are exposed to ultraviolet light, all throughout the day. Hence, the advantages of antioxidants are very important for good health, because if free radicals are left unopposed, they can cause a wide range of diseases and chronic illnesses.

Introduction

Antioxidants are assumed to help to protect cells by removing free radicals before they cause cell damage. Antioxidants are chemical agents in many foods. Antioxidants keep the body's cells and organs from free radicals. In other words, an antioxidant is a molecule which prevents the oxidation of other agents (1-3). Oxidation is a chemical reaction which can create free radicals, directing to chain reactions which could injure cells. While oxygen is one of the most essential modules for living, it is also a double edged sword. As the dark side of oxygen, it is a highly reactive atom which is able to become a part of potentially harmful molecules commonly called "free radicals" (2-5).

Core tip
Antioxidants are substances that react with free radicals and neutralize them. They are able to prevent organs from injury. Antioxidants are also recognized as "free radical scavengers."

Materials and Methods

For this mini-review, we used a diversity of sources by searching through PubMed/Medline, Scopus, EMBASE, EBSCO and directory of open access journals (DOAJ). The search was conducted, using combination of the following key words and or their equivalents; antioxidants, medicinal plants, herbal antioxidants, free radicals, free radical scavengers, antioxidants, reactive oxygen species and phytonutrients.

Free radicals

Free radicals are unstable molecules which easily react with other substances and molecules. Free radicals are composed during normal cell metabolism consisting various chemical processes required for cell function, growth and also reproduction. Free radicals are made when the organs use oxygen. While, free radicals comprise an unpaired electron, they are unstable and reach out and take electrons from other agents in order to neutralize themselves (3-8). This process firstly stabilizes the free radicals, however generates another molecules in the subsequent process. Then, rapidly a chain reaction activates and thousands of free radical reactions can arise within a few seconds on the primary reaction (2-8).

Reactive oxygen species

Recent molecular investigations have revealed that, reactive oxygen species produced in cells comprise various agents like, hypochlorous acid (HClO), hydrogen peroxide (H_2O_2) and free radicals for instance, the hydroxyl radical (·OH) and also the superoxide anion (O_2^-). The hydroxyl radical is principally unstable and will react quickly and non-specifically with various biological substances (9-12). This kind of molecule is produced from hydrogen peroxide in metal-catalyzed redox reactions like the Fenton reaction. These oxidants can impair cells by initiating chemical chain reactions like lipid peroxidation, or through oxidizing DNA or

other proteins. Importantly, damage to DNA can trigger mutations and probably initiating various cancers, if not inverted by DNA repair mechanisms. Accordingly damage to proteins begins enzyme inhibition, denaturation and eventually protein degradation (3-10).

Various investigations have shown that, free radicals are able to attack the healthy cells of the organs. This may result to injury, various disease or even severe organ dysfunction. Additionally cell damage affected by free radicals seems to be a main contributor to aging process and some diseases like such as, cancers, cardiac disease, decline in brain function and suppression of immune system (12-18). However, free radicals can damage cells, which may lead to organ dysfunction or cancer. Oxidative stress is capable to damage to cell function and structure through excessive production of reactive oxygen-containing molecules and chronic disproportionate inflammation. Thus, an antioxidant is a substance that hinders the oxidation of essential organic molecules throughout the body (6-11). In fact, oxidation is a chemical reaction which transfers electrons or hydrogen from a molecule to an oxidizing substance. Oxidation reactions can create free radicals. Indeed, these radicals are able to initiate chain reactions. Once the chain reaction happens in a cell, it may trigger injury or even death to the cell (10-15).

Antioxidants dismiss these chain reactions via eliminating free radical intermediates, and prevent other oxidation reactions (11-15).

Generation of reactive oxygen species in body

The utilization of oxygen as a part of the process for generating metabolic energy generates reactive oxygen species. In this procedure, the superoxide anion is formed as a by-product of numerous steps in the electron transport chain. Mainly important is the diminution of coenzyme Q in complex III, while a highly reactive free radical is formed as an intermediate ($Q\cdot^{-}$) (15-19). This unstable intermediate can result to electron "leakage," when electrons jump directly to oxygen and form the superoxide anion, in place of moving across the normal series of well-controlled reactions of the electron transport chain. Peroxide is also created from the oxidation of diminished flavoproteins, like complex I. Since, these enzymes can generate oxidants, the relative significance of the electron transfer chain to other processes that make peroxide is unclear (14-19).

Types of antioxidants

There are various sources of antioxidants may administer in clinical and preclinical studies. These include antioxidants minerals, antioxidants protein (amino acids), like; thiol antioxidants, phytochemicals (antioxidants phytonutrients), antioxidants vitamins, enzymes named antioxidants enzymes, including antioxidants coenzymes and some chemical synthetic agents found having antioxidant properties such as statins (7-14). Regardless of sources of antioxidants, they can also classify to fat-soluble, water-soluble and both water-soluble and fat-soluble. This characteristics, defines, where the various antioxidants can be employed by the cells. They may be utilized within the cells or by the cell membranes or, the cells' surrounding. In fact, fat-soluble antioxidants exert the effectivity on the cell membrane, which is made of mostly fats and lipids, and on the neighboring lipids. Whereas, water-soluble antioxidants act their ameliorative properties on the blood plasma close to the cells. However, both water and fat-soluble types, are necessitated to work their effects on the cells – on the cell membranes, principally fats and lipids, and on the inward of the cells, as the cells include water (19-22).

Sources of antioxidants

Many natural whole foods, like, fruits, vegetables and whole grains, contain phytochemicals. Vegetables, nuts, spices and fruits are plentiful sources of antioxidants (2-6). The studies show that eating a diet with lots of fruits and vegetables is healthy and lowers risks of certain diseases. But it is not certain whether this is because of the antioxidants, something else in the foods, or other factors (22-25). Some good sources of specific antioxidants contain; beta-carotene – pumpkin, mangoes, apricots, carrots, spinach and parsley, allium sulphur compounds – leeks, onions and garlic, flavonoids – tea, green tea, citrus fruits, red wine, onion and apples. Anthocyanins – eggplant, grapes and berries, lycopene – tomatoes, pink grapefruit and watermelon and vitamin C – oranges, blackcurrants, mangoes, kiwifruit, broccoli, spinach, capsicum and strawberries (18-23).

Overzealous administration of antioxidants

While, there is little doubt that antioxidants are essential constituent for good health, however, there is little information that how much requires daily (8-12).

High-dose addition of antioxidants may be associated with health risks in various instances. Some antioxidant supplements may stimulate disease and increase mortality in humans under certain circumstances. Antioxidants supplements were first supposed to be risk-free but gradually we are becoming attentive of interactions and their potential toxicity (1,4,12-18). Interestingly in the normal concentrations detected in the body, vitamin C or beta-carotene are antioxidants, but at higher concentrations they are pro-oxidants. It is possible that, high doses of beta-carotene may intensify the risk of lung cancer in smokers. Similarly high doses of vitamin E may rise risks of prostate cancer and one type of stroke. Importantly, antioxidant in supplements may also interfere with other drugs. Thus it is necessary to consult with physician, when, patients are intended to add a supplement to their diet (20-26). Whereas, some supplements do not include a balance of minerals, enzymes or vitamins, and may have a negative influence on the health. Likewise, very little is known about the long-term consequences of overzealous administration of antioxidants. The body may able to tune the mechanisms are responsible to balance a variety of insults, however, the tuning mechanisms may fail finally and reverse the condition of the patients (22-28).

Conclusion

Antioxidants are substances that react with free radicals and neutralize them. They are able to prevent organs from injury. Antioxidants are also recognized as "free radical scavengers." These powerful agents, which frequently come from the vegetables and fresh fruits, prohibit and in some circumstances even prevent, the oxidation of various molecules throughout the body. Most of the most powerful antioxidants are detected in herbs. This is due to the fact that herbs are exposed to ultraviolet light, all throughout the day. Hence, the advantages of antioxidants are very important for good health, because if free radicals are left unopposed, they can cause a wide range of diseases and chronic illnesses.

Author's contribution

HN was the single author of the manuscript.

Conflicts of interest

The author declared no competing interests.

Ethical considerations

Ethical issues (including plagiarism, data fabrication, double publication) have been completely observed by the author.

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