

Research progress of natural antioxidants in foods for the treatment of diseases

Sen Li, Guowei Chen, Chao Zhang, Man Wu, Shuyan Wu, Qing Liu*

School of Medical Instrument and Food Engineering, University of Shanghai for Science and Technology, Shanghai 200093, China

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Abstract

A large amount of free radicals can be generated in human body during metabolic process. These free radicals can result in oxidative stress and homeostasis imbalance, even some chronic diseases and cancers if they are not promptly removed. Currently, many studies devote to exploring and utilizing natural antioxidants to remove excessive free radicals in human body, thus realizing the prevention and treatment of diseases. In the present study, the major species of natural antioxidants in foods that are benefit for the prevention and treatments of diseases have been summarized. Meanwhile, the research progress and future development have also been proposed. All of these studies, on the one hand, can provide a theoretical basis for the development of drugs and healthy foods; on the other hand, can offer novel development ideas for food industry, especially for food additive industry.

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During metabolic process and contact process with external environment, a large amount of free radicals are produced in human body and attack biological macromolecules such as proteins, fatty acids and nucleic acids, correspondingly causing oxidative damage on cells or tissues or even resulting in gene mutation. Free radicals at high concentration level in human body can cause oxidative stress, thus destroying internal redox balance and causing a variety of chronic diseases, even premature senility [1]. Current researches have confirmed that many diseases including cancers, arteriosclerosis, diabetes, cataract, cardiovascular diseases, Parkinson's disease, Alzheimer's disease and arthritis, are highly correlated with free radicals and cellular redox imbalance [2]. Therefore, free radicals have become the culprit for influencing human health. In order to scavenge superfluous free radicals and maintain the balance of homeostasis in human body as well as accomplish the prevention and treatment of diseases, the consumption of antioxidants is necessary. However, synthetic antioxidants have toxic effects to some extents. Therefore, the uptake of natural antioxidants from

foods is the first choice because natural antioxidants not only play an important role in the prevention and adjunctive treatment of diseases but also can avoid the adverse reactions to human health. In this article, common natural antioxidants such as vitamins (vitamin A, C and E), carotenoids (β -carotene, lycopene and astaxanthin), polyphenols (tea polyphenols and red wine polyphenols), and flavonoids (flavonoids, isoflavone, xanthenes and anthocyanins) in foods are summarized. Meanwhile, the antioxidant mechanisms and research progress of these bioactive components from Chinese herbs in the prevention and treatment of diseases are reviewed, as shown in Table 1, which will provide a novel strategy for the development of pharmaceutical, healthcare and food industries.

1. Vitamins (vitamins C and E)

Vitamins are essential trace substances to maintain normal physiological function of human body. The majority of vitamins cannot be synthesized by human body and only can be uptaken from foods. Vitamin C and vitamin E are the most well known antioxidants and extensively studied. Vitamin C (ascorbic acid) is mainly found in fresh vegetables and fruits. The antioxidant effect of vitamin C is reflected by its reducing capacity, meaning that it can be directly and rapidly reacted with superoxide ion O_2^- and singlet oxygen such

* Corresponding author at: School of Medical Instrument and Food Engineering, University of Shanghai for Science and Technology, Shanghai 200093, China. Tel.: +86 21 65710368.

E-mail address: liuq@usst.edu.cn (Q. Liu).

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Table 1
Natural antioxidants in foods and their roles in prevention and treatment of diseases.

Natural antioxidants	Target diseases	Foods rich in natural antioxidants
Vitamin C	Cardiovascular disease, cancer, and cirrhosis [3–5]	Fresh fruits and vegetables
Vitamin E	Lung, skin and prostate cancers [6,7]	Nuts, green fruits and vegetables
Carotene	Eye diseases caused by diabetes [8]	Dark green or red and yellow fruits and vegetables
Lycopene	Parkinson's and Alzheimer's diseases [9,10]	Tomatoes
Astaxanthin	Aging, Alzheimer's disease and inflammation [11–13]	Shrimp shell, oysters and salmon
Cocoa polyphenol	Arteriosclerosis, coronary heart disease, and alcoholic liver [14,15]	Cocoa bean
Green tea polyphenols	Aging, Alzheimer's disease, diabetes, cardiovascular diseases, tumors and inflammation [16–20]	Green tea
Red wine polyphenols	Diabetes, cardiovascular diseases [21,22]	Red wine, grape seeds
Peach polyphenols	Breast cancer [23]	Peaches
Flavonoids	Cardiovascular disease, arthritis, Alzheimer's disease, stroke [24–27]	Plants, berries, honey
Isoflavonoids	Prostate, ovarian, cervical and breast cancers [28–31]	Soybean
Anthocyanins	Cardiovascular disease, neurodegenerative diseases, liver cancer [32–34]	Black rice, purple sweet potato, blueberry, mulberry and other dark foods
Xanthones	Inflammation, nerve injury [35,36]	Mangosteen
Components from Chinese herbs	Inflammation, cancer, Alzheimer's disease, diabetes, cardiovascular disease [25,37–40]	Chinese herbs

as HOO^- or OH^- through dehydrogenation, and generate dehydroascorbate. As hydrogen donor, it can also play an indirect antioxidant effect through the reduction of oxidized vitamin E and thiol. The chemical equation of reaction can be expressed as: $\text{RO}^\bullet + \text{C}_6\text{H}_7\text{O}_6^- \rightarrow \text{RO}^- + \text{C}_6\text{H}_7\text{O}_6^\bullet \rightarrow \text{ROH} + \text{C}_6\text{H}_6\text{O}_6$. As a water-soluble vitamin, vitamin C plays its antioxidant role through circulation flow in blood, body fluid and cells, thus protecting cells and tissues from free radicals [41]. In recent years, a large number of basic and clinical studies have discovered that vitamin C has the protective role in a series of diseases caused by oxidative stress, such as cardiovascular disease, cancer and cirrhosis. Vitamin C can act as the superoxide scavenger in primary hypertension to eliminate the symptoms of patients [3]. By providing continuous medication of vitamin C at the dosage of 500 mg to cardiovascular patients for 10 weeks, the content of low-density lipoprotein (LDL) in blood is obviously reduced. LDL is the major component causing oxidative damage to blood vessel, suggesting that vitamin C can execute a treatment effect on cardiovascular disease [4].

Vitamin E is a kind of fat-soluble vitamin, also known as tocopherol including α -tocopherol, β -tocopherol, γ -tocopherol and δ -tocopherol. Vitamin E has a very extensive function of protecting biological membrane in human body and nucleic acids in cells from the attacking of free radicals [41]. Vitamin E can directly remove O_2^- , quench singlet oxygen and superoxide dismutase (SOD) and establish an antioxidant system in human body together with glutathione peroxidase (GSH-Px). Through the reaction with lipid oxygen radicals and lipid peroxy free radicals, vitamin E plays its antioxidant activity by providing the protons to interrupt lipid peroxidation chain reaction (as shown in Fig. 1). Vitamin E is rich in nuts such as almonds, walnuts,

vegetable oil, kiwi fruits and green vegetables. Vitamin E is found to have suppressive function to tumors. Sundaram has conducted high performance liquid chromatographic analysis for the samples from 5,000 women and reported that the content of vitamin E in women with breast cancer is significantly lower than that in the normal group (4.7 mg/L vs. 6.0 mg/L), suggesting that vitamin E can reduce the risk of breast cancer [6]. In the experiments using mouse lung cancer model induced by human lung cancer cell A549, the intraperitoneally injected vitamin E derivative, vitamin E succinate (VES) (150 mg/kg) can significantly inhibit the tumor growth of the mice [7].

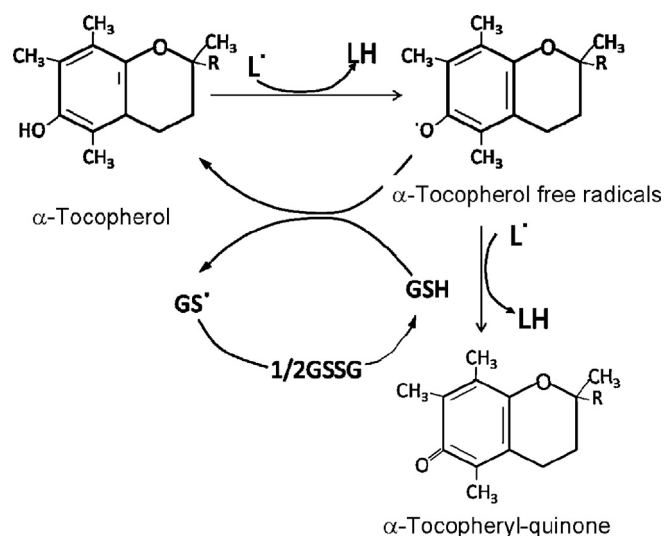


Fig. 1. Principle of scavenging lipid oxygen free radicals by α -tocopherol. L represents lipid oxygen free radicals.

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