



The Role of Antioxidants in Food Products

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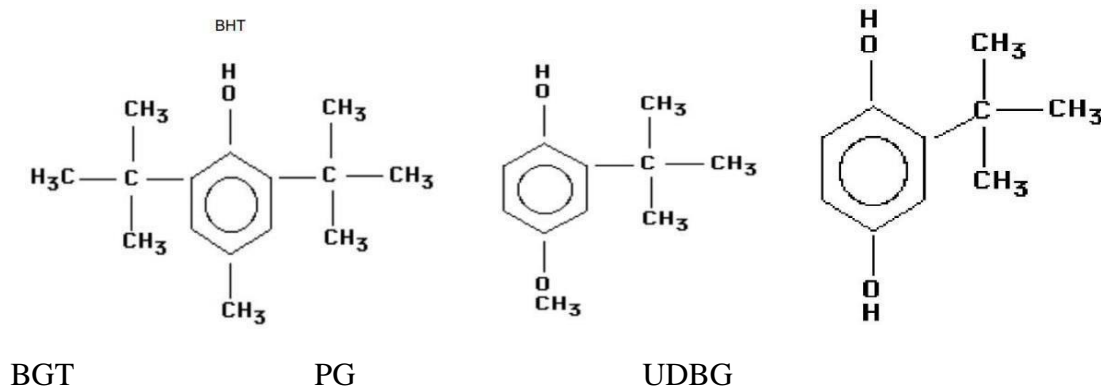
Abstract: The reaction of antioxidants against the oxidation process, properties of delaying the oxidation process. Functions of antioxidants. Mechanism of free radical damage. Analysis of the finishing stage and distribution stages in the mechanism of action of antioxidants. Antioxidant sources: Synthesis of synthetic antioxidants.

Keywords: Antioxidant, Radical, butylated hydroxyl anisole (BGA), butylated hydroxyl toluene (BGT), propyl gallate (PG), carotenoids, vitamin C (ascorbic acid), vitamin E (tocopherols), vitamin A (carotenoids), various polyphenols.

Introduction

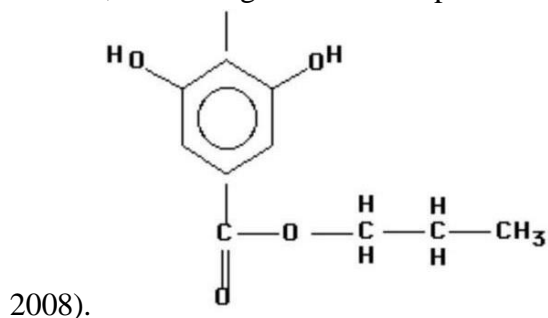
An antioxidant is any substance that delays, prevents, or removes oxidative damage to a target molecule. It can be found in many foods, including fruits and vegetables. The role of antioxidants in foods is to delay or control oxidation. The process of autoxidation and development of rancidity in foods involves a free radical chain mechanism through initiation, propagation and termination stages. Although radicals are formed in the "initiation" step, they react with unsaturated fatty acids to remove the least energy-requiring hydrogen atom in the "propagation" step. [1]. Reactions in the propagation phase form a chain reaction until the "termination" reaction occurs. Due to its high stability and low volatility, it contributes to the nutritional level, texture, color, taste, freshness, functionality, aroma and appeal to consumers such as the elderly [2].

Different antioxidants found in foods. natural antioxidants, synthetic antioxidants, dietary antioxidant, endogenous antioxidant play an important role in food preservation. Vitamin C, vitamin E, α -carotene, lycopene, polyphenol and others are the main sources of antioxidants. They can be present in food products as endogenous factors or added to protect their lipid components from deterioration. The most commonly used antioxidants in food include butylated hydroxyl anisole (BGA), butylated hydroxyl toluene (BGT), propyl gallate (PG), and tertiary butyl hydroquinone (UDBG) [3].



Antioxidants in foods are important for our health, and eating five to seven servings of fresh fruits and vegetables a day has been shown to help protect against heart disease, cancer, and other diseases[4]. Eating plenty of fresh fruits and vegetables is the best source of antioxidants. An antioxidant is "any substance that delays, prevents, or eliminates oxidative damage to a target molecule" (Halliwell et al., 2007) [2].

Antioxidants are compounds or substances that prevent lipid breakdown in processed or processed foods by scavenging free radicals. It increases the oxidative stability of food, controls free radicals, pro-oxidants and other oxidative mediators [5]. These are called reactive oxygen species (ROS) and they exhibit two unpaired electrons in the highest energy level in different orbitals, making them prone to radical formation (Pham-Huy et al.,



BGA

ROS are oxygen-derived free radicals such as superoxide anion (O_2^\bullet), hydroxyl radical (HO^\bullet), peroxide radical (RO_2^\bullet), and alkoxy radical (RO^\bullet), as well as hydrogen peroxide, a radical produced by oxygen metabolism. (H_2O_2) (Circu et al. 2010) [7].

Antioxidants are also naturally involved in food processing. Antioxidants can be present in foods as endogenous factors or added to preserve their lipid components. Antioxidants are not only present in dietary supplements, but also in dietary supplements, and their levels should be measured in body tissues and fluids (Franco et al., 2017) [8.]

Mechanism of action of antioxidants



The possible mechanisms of action of antioxidants were first studied when it was discovered that a substance with antioxidant activity may itself be a substance that is easily oxidized. An antioxidant can be defined as: "any substance that, when present in low concentrations relative to the substrate to be oxidized, delays the oxidation of this substrate" (Rosenblat M, et al., 2006) [9].

Two main mechanisms of action have been proposed for antioxidants. The first is a chain-breaking mechanism in which primary antioxidants donate electrons to free radicals present in the system, such as lipid radicals (Mahantesh SP et al., 2012) [10].

Chain-breaking antioxidants act by scavenging free radicals and donating hydrogen atoms (Beer D, et al., 2002) [4].

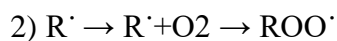
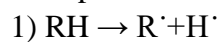
The second

mechanism involves removal of ROS and RNS initiator

Quenching chain initiator catalyst [11].

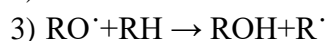
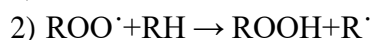
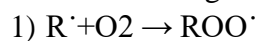
In the first stage of the biological oxidation reaction, systems RH abstraction radicals R[•] are formed H[•] of a hydrogen atom:

Start phase:



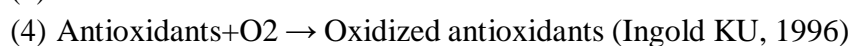
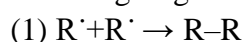
After the initiation, propagation of the free radical chain occurs, reactive radical species react with oxygen molecules from the environment, resulting in the formation of peroxides and peroxy radical ROO[•]. These intermediates can further promote free radical reactions [12].

Distribution stage



In the last stages, the interaction of two radicals can lead to the formation of a non-radical adduct and the termination of a free radical chain.

Finishing stage



Different types of antioxidants: Currently, there are different types of antioxidants in food products: natural antioxidants, synthetic antioxidants, dietary antioxidants, and endogenous antioxidants that play an important role in food preservation [13].

Natural antioxidants: Natural antioxidants are oxidants found in natural sources such as fruits, vegetables and meat (Grozea, 2012). There are several common natural antioxidants found in everyday foods, the most common of which are vitamin C (ascorbic acid), vitamin E (tocopherols), vitamin A (carotenoids), various polyphenols including flavonoids, anthocyanins, lycopene (of a kind). carotenoid) and coenzyme Q10, also known as Ubiquitin, a type of protein (Yadav et al., 2016) [13] Natural antioxidants are found in most fresh foods



Table 1. Sources of some natural antioxidants

Unions	Natural resources
Ascorbic acid	Citrus fruits, green peppers, green leafy vegetables, etc
Tokoferol	Vegetable oils, nuts, peanuts, almonds, seeds, etc
Carotene	Mango, papaya, pumpkin, pepper, etc
Anthocyanin	Berries, cherries, red onions, red beans, etc
Lycopene	Carrots, pumpkins, grapes, etc
Extracts	Extracts from green tea, rosemary, cloves, oregano, thyme, oats, rice bran, etc.

Synthetic antioxidants: Synthetic antioxidants are chemically synthesized because they do not occur in nature and are added to food as preservatives to prevent lipid oxidation (Shahidi et al., 1992)

Some synthetic antioxidants currently approved for use in foods include BHT, BHA, propyl gallate (PG), and tertiary butylhydroquinone (TBHQ).

- BHA: Butylated hydroxy anisole is a mixture of two isomers. It is called "blocked phenol" because of the proximity of the tertiary butyl group to the hydroxyl group. This can hinder the effectiveness of the vegetable and oils, but BHA increases the potential of known "transfer".

- Propyl gallate: three hydroxyl groups make it highly reactive. Low solubility. Trace minerals like iron tend to chelate, forming colored complexes. They are heat resistant, especially in alkaline conditions.
- BHT: Butylated hydroxytoluene is also a "sterically hindered" phenol, prone to loss through volatilization in high temperature applications. [14]

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Table 2. Sources of some synthetic antioxidants

Compounds	Sources
BHA	Bakery products, meat products, spices, grains, yeast, vegetable oils, drink mixes, dessert mixes, nuts, etc.
PG	Lard, vegetable oils, cereals, packaging coatings, animal feed, etc.
BHT	Breakfast cereals, baked goods, potato chips, vegetable oils, operational foods, butter, margarine, frozen seafood, chewing gum, etc.
TBHQ	Cereals, edible oils, pizza kits, potato chips, poultry, meat, and more

Dietary antioxidants: Dietary antioxidants such as ascorbates, tocopherols and carotenoids are well known and there are many publications related to their role in health (Boscow et al., 2005) [5].

The health benefits of fruits and vegetables are mainly attributed to antioxidant vitamins supported by a large number of phytochemicals, some of which have antioxidant properties (Dimitrios, 2006) [10]

Vitamin C, vitamin E, β -carotene, and other carotenoids and oxycarotenoids, such as lycopene and lutein, are among the most studied dietary antioxidants. β -carotene and other carotenoids are



also believed to provide antioxidant protection to lipid-rich tissues. Studies show that β carotene can work synergistically with other vitamins (Percival 1996) [15].

Functions of antioxidants

- Antioxidants such as vitamin C and vitamin E increase our immune system.
- Some phytochemicals have beneficial effects on heart diseases.

Antioxidants lower LDL cholesterol levels, thereby preventing plaque buildup in blood vessels. It is useful in preventing cancer.

Antioxidants neutralize harmful substances. Therefore, nutrition plays a very important role in the maintenance of antioxidant enzymes, because some trace elements such as selenium, copper, iron, manganese and zinc act as cofactors or are part of their prosthetic groups. If micronutrients are insufficient, the enzyme defense system may be impaired (Fang et al., 2002) International Journal of Chemical Research genetic material through oxidation [4].

Reduces free radicals.

- Protects cells from premature and abnormal aging.

It helps fight age-related molecular degeneration

Antioxidants in food There are many food components with antioxidant properties such as α -tocopherol, γ -tocopherol, tocotrienol, ascorbic acid, β -carotene and other substances such as phenolic compounds (Mataix-Verdú et al., 2009) [19].

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