

4. ANTIOXIDANTS IN FOOD AND FOOD ANTIOXIDANTS

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One of the major changes that occurs during processing, distribution and final preparation of food is oxidation. The main adverse effect of food oxidizing is a change in sensory quality, rancidity, vitamin destruction, color and food quality loss. Antioxidants are one of the principal ingredients that protect food quality by preventing oxidative deterioration of lipids. It is well known that lipid-containing food oxidizing mediated by free radical driven chain reaction, which involve alkyl R° , alkoxy RO° , peroxy ROO° radicals and active forms of oxygen – singlet oxygen and peroxide anion radical. Antioxidation of polyunsaturated lipids of food is most frequently initiated by exposing lipids to light, heat, ionizing radiation, metal ions, or metalloprotein catalysts. Enzyme lipoxygenase can also initiate oxidation. The classic mechanism of antioxidation can be divided into the three stage: initiation (production of lipid free radicals),

propagation and termination (production of nonradical products). Autoxidation is a natural process that takes place between O_2 and unsaturated lipids in food. The molecules of oxygen are the main source of oxidizing in the food systems. The reaction between molecules of oxygen, which normally are in the ground state (3O_2) and organic compounds proceeded very slowly because of their high energy of activation (146-273 kJ/mol). An activation of triplet oxygen, containing two unpaired electrons on the outer orbitals $2p_y$ and $2p_z$ as an oxidant in redox reactions, consumes too much energy (92 kJ/mol). The conversion of triplet oxygen to singlet oxygen may occur in many ways, the most important is via photosensitization of the natural pigments present in foods. These include natural pigments that are generally present in foods such as chlorophyll, pheophytin, myoglobin, hemaporphyrin, flavin, riboflavin. Metal ions could be involved in activating molecular oxygen to produce singlet oxygen.

The main method of food protection against oxidation is an overall utilization of special additives, inhibiting this process. Antioxidants are substances that when present in foods at low concentrations compared to that of an oxidizable substrate markedly delay or prevent the oxidation of lipids. Antioxidants delayed the rate of food oxidation by several mechanisms: playing a role of free radical scavenger, formation of chelate complexes with prooxidant metals (Fe, Cu, Zn etc.), singlet oxygen and photosensitizes quenching, suppression of radical NO accumulation, peroxydinitrite and lipoxygenases deactivation. Food manufacturers have used food-grade antioxidants to prevent quality deterioration of products and to maintain their nutritional value. Synthetic antioxidants such as butylated hydroxyanisole, butylated hydroxytoluene, propyl gallate, tert-butylhydroquinone are commonly used in food formulations. Citric acid, EDTA or their derivatives were found to act as metal deactivators or chelating agents in combination with phenolic antioxidants. Due to safety concerns interest in natural antioxidants has intensified. Mixed tocopherols, herbal extracts such as those of rosemary and sage, as well as tea extracts have been commercialized for food applications. The most active dietary antioxidants belong to the family of phenolic and polyphenolic compounds. Examples of common plant phenolic antioxidants include flavonoid compounds, cinnamic acid derivatives, coumarins, tocopherols and polyfunctional organic acids. Some natural antioxidants have already been extracted from plant sources and are produced commercially. For example antioxidant extracts (molecular or vacuum distilled) from rosemary are available as a fine powder. They are recommended for use at concentrations ranging (200-1000 ppm) of processed product. Synergistic antioxidant effect is the action of rosemary extract (200 ppm) and ascorbic acid (500 ppm) in the processes of lard autooxidation.

Lipid oxidation affects essential sensory traits of meat products, causing flavour, color and texture deterioration. The use of antioxidants is one method to minimize rancidity, retard the formation of toxic oxidation products, maintain nutritional quality and increase the shelf life of food products. The increased interest in natural antioxidants has led to the antioxidant evaluation of many species of vegetables, herbs, fruits, spices and cereals. For example, extract of *Moringa oleifera* leaves are safe, bioactive and powerful antioxidant in cooked goat meat parties.