



ANTIOXIDANTS OBTAINED FROM NATURAL SOURCES: A REVIEW

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ABSTRACT

Oxidation is a chemical reaction that involves the transfer of electrons from one compound to another compound. Oxidation reactions produce free radicals that make chain reactions and that cause cell death^[3] in human beings, antioxidants are used to stop the oxidation reactions in the body. These antioxidant agents remove the free radicals by being oxidized themselves. And prevent harmful effects of these oxidation reactions.^[4] Natural antioxidants are present in various dietary sources like vegetables, fruit, legumes, etc.^[1] The synthetic antioxidant gives harmful effects on the body. The natural antioxidant has the scavenging activity of free radicals. The use of natural antioxidants is low cost, compared with diet, and gives less harmful effects on the body.^[3] Polyphenols, phenolic acid, flavonoids, and vitamins are important antioxidants and they have anticancer activity, anti-aging activity, anti-inflammatory activity, etc.^[5] Antioxidants are used in the pharmaceutical industry, cosmetic industry. Antioxidants are used as preservatives.^[8]

KEYWORDS: Antioxidant, oxidation, harmful, phenolic acid, anticancer, anti-aging.

INTRODUCTION

What are Antioxidants?

Antioxidants are compounds that inhibit oxidation, a chemical of many different chemical form group together that inhibit the oxidation, chemical reaction that can produce the cell organism.^[1] In which the oxidation reactions produce the free radicals that can produce a chain reaction that causes damage and death to the cell.^[4] The antioxidant removes the free radicals intermediate by oxidizing themselves and inhibiting other reactions thus that stop the making harmful chain reaction.^[4] The important role of antioxidants is in biology. It is used in preventing the oxidation of unsaturated fats, which cause rancidity.^[2] Many natural antioxidants are extracted from a plant that contains antitumor properties.^[2] Various types of free radicals are scavenger antioxidants is found in dietary sources like fruit, vegetables.^[2]

CLASSIFICATION OF ANTIOXIDANTS

The antioxidants are divided into major two classes such as synthetic and natural.^[1] Then natural antioxidants are subdivided into enzymatic and non-enzymatic. Enzymatic antioxidants include primary such as superoxide dismutase, catalyze, glutathione peroxidase, and secondary GR, G6HD, etc.^[2] Then nonenzymatic antioxidant includes vitamin, such as vitamin A, E, C, and minerals such as iodine, zinc, Cooper, and polyphenols such as flavones, flavonoids, Gallic acid, Ellagic acid, ferulic in polyphenols acid, and in other antioxidants such as albumin, haptoglobin, lactoferrin in

protein and bilirubin, ubiquinol in non-protein. The all-natural source of antioxidants is polyphenol compounds.^[1]

LISTS OF ANTIOXIDANTS FROM NATURAL SOURCES

- 1) Carotenoids are obtained from dark leafy vegetables, carrots; sweet potatoes, tomatoes, citrus fruits, papaya, etc.
- 2) Catechism is found in green tea, berries, and certain oilseeds.
- 3) Flavonoids are found in eggplant, onion, black tea, pepper, etc.
- 4) Lycopene is present in Tomato, papaya, watermelon, guava.
- 5) Phenolic acid are obtained from oilseed and cereal, 1 grain
- 6) Vitamin c obtained from fruit and vegetables, berries, citrus, green pepper, potatoes.
- 7) Vitamin E is present in oilseed, vegetables, grain, egg, nuts.
- 8) Extract obtained from green tea, clove rice, bran, oat, thyme.

MECHANISM OF ACTION

Antioxidants are used for preventing rancidity. The various factors that affect lipid oxidation in the presence of oxygen and transition metal ions, moisture, heat, and light. To prevent, minimize or slow down the rate of lipid oxidation, oxygen and metal catalysts must be

removed, or sequestered to render them unreactive. For the mechanism of action of free radicals, we understand the generation of free radicals and their damaging of reaction.^[11] The antioxidant is produce a second-line defense mechanism against the generation of free radicals in the body.^[9] They are trapping the molecule that gives the electron to free radicals.^[9] The main function of antioxidants is to stop making chain reactions by removing free radicals and stop the oxidation reactions by oxidizing themselves.^[10] Antioxidants are also called reducing agents because of the loss of hydrogen atoms.^[10] The mechanism of antioxidants is divided into three steps: 1) generation of free radicals, 2) Damaging reactions of free radicals. 3) modulation of free radicals by Natural antioxidants.^[11] The enzymatic agent and non-enzymatic agent have different mechanisms of action.^[10] The mechanism of action includes the generation of free radicals in which the generation of reactive oxygen species starts gaining oxygen, activates the NADPH oxidase, and produces superoxide anion radicals.^[11] The free radical molecules contain unpaired electrons in the outer sides of the orbital. They are highly reactive in the body By removing the electron from the atom.^[10] The important source of ROS in mitochondria is produced by the electron transport chain in aerobic respiration.^[10] The oxygen is converted to hydrogen peroxide by SOD. The Road is also generated by the myeloperoxidasehalide-H₂O₂ system.^[11] SoD is found in three types of cell cu-in-SoD, Mn-SOD, Cu-SoD. Extracellular act as scavengers of free radicals.^[9] Nitric oxide synthase gives nitrogen species such as nitric oxide. The nitric oxide synthase acts as an oxygen quencher. And a very strong oxidant.^[11]

The second step is damaging reactions of free radicals. Ros producing oxidative stress is related to chronic disease, osteoporosis, and coronary heart disease.^[11] Free radicals attack human organs and produce many different diseases. When an electron is removed, the substance gets oxidized and when an electron is added, the substance gets reduced. In chemical reactions, the transfer of electrons occurs. The body forms energy by using our food in a regular manner and stores it in ATP.^[5] The process of lipid oxidation can be followed, where LH is the target of PUFA and R is oxidizing radicals. Oxidation of PUFA formed a fatty acid. Radicals that are added to oxygen to form fatty acid peroxy radicals? Peroxy radicals are oxidized and form a new chain reaction producing lipid hydroperoxides.^[11] in this process, radicals produce from mitochondria such as superoxide anion and hydroxyl radicals damage the sites of generations of free radicals.^[5] The third step of the mechanism is the modulation of free radicals by Natural antioxidants. The type is enzymatic and non-enzymatic. Antioxidants that modify the reactions of the free radicals. The body protects itself from ROS by using enzymatic antioxidant mechanisms. These antioxidants are useful for reducing levels of lipid hydroperoxides and hydrogen peroxide and protecting the structure and

function of the cell membrane and prevention lipid peroxidation. E.g. SoD, CAT. The non-enzymatic antioxidant is two types natural and synthetic.^[10]

Natural Antioxidant

Nature is always a significant and rich source of countless ingredients that can serve as a health-promoting agent.^[3] Many natural sources including fruit, vegetables, herbs, spices, and edible mushrooms that can be part of a routine diet.^[3] The natural antioxidant contains phenolic compounds.^[1] These antioxidants are of high or low molecular weight, can differ in their composition their physical and chemical properties, and their mechanism site of action.^[2] A natural antioxidant is found in fresh food e.g. when a cut apple turns brown, that is through oxidation and the use of lemon juice above the surface will change the color.^[2] The plant phenolic is multifunctional and acts as reducing agents, free radicals terminators, metal chelators and singlet oxygen quencher, fat-soluble vitamin and selenium, and also antioxidant obtained from food animals but in a smaller amount.^[3] Some natural antioxidants are obtained from marine sources.^[1]

Natural antioxidant from fruit and vegetables

Fruit contains mineral salt and vitamins and also dietary fiber. Most fruits are a high source of vitamin c, carotenoids, and polyphenols compounds. Polyphenols are present in fruit and vegetables in a group of low molecular weight compound that prevents lipid oxidation.^[1] The most antioxidant base conjugates of mono and polysaccharide connect within one or more groups of phenol rings present as ester and methyl ester.^[1] The natural antioxidant can be obtained from tea such as green tea, as well as fruit such as grapes depend on their bioavailability in blood. the absorption of tea is more significant than fruit because fruit contains high sugar contained.^[1]

Apple has strong antioxidant activity inhibits cancer cell proliferation and decreases lipid oxidation, lowers cholesterol.^[3] onion and onion scales are used in lipid oxidation model and radicals scavenger but yellow and red onion are poor antioxidant activity.³ green tea consists of essential oil, tannins, caffeine, vitamin, and pigment. Green tea consists of chlorophyll, the main pigment of green tea leaves but is easily divided into pheophytin and pheophorbide after the heating and storing process. Pheophytin has antioxidant activity.^[3]

Flavonoids are important antioxidant content present in food such as potatoes, wheat, tomatoes, red berries. anthocyanin is a flavonoid. Which is present in red wine, berries? Anthocyanin is more potent than other flavonoids.^[1] They show antioxidants activity by preventing the oxidation of low-density lipoprotein and preventing plaque formation. Vitamin E has antioxidant properties also known as tocopherol, it is a fat-soluble, non-polar vitamin naturally found in fruit and vegetables such as sunflower, nuts. Vitamin E has higher

bioavailability than vitamin c and Vitamin c also known as ascorbic acid. They are found in citrus fruit such as orange, lemon, and tomato. They are very potent water-soluble.^[4]

Natural antioxidant from legumes, nut, and oilseed

Antioxidant activity is found in very legumes such as green peas, yellow and black soybeans, peanut, peas.^[3] They contain polyphenols and phenolic acid.^[2] The major lipid-soluble antioxidant is present in peanut and other oilseeds are tocopherol.^[3] Flaxseed, sunflower, soybean, cottonseed are a type of antioxidants obtained from oilseed. The important group is the sterols.^[4] The antioxidant oil sunflower includes phenolic acid, tocopherol, and sterol while purple hulled contains high concentration big anthocyanin these compounds are prevented thermal oxidative degradation of oil.^[3] Tocopherol is a phenolic compound naturally in vegetables and gives protection against oxidation by terminating free radicals. The average tocopherol content in sunflowers is 650 ppm. With 94% as alpha and beta tocopherol, each contains 3% total.^[3]

Natural antioxidant from cereals

Cereals are the most common food compound and can be added to food components.^[3] Polyphenols are present in cereal grains, phenolic acid plays an important role.^[1] Ferulic acid is present in wheat and rye. Vanillic and coumarin acid plays an important role; they are present in small amounts.^[5] Rutin is the main polyphenol of buckwheat. Buckwheat contains 787 and 1314mg/100g flavonoids and 47 and 77 mg/100 g Rutin in the seed and hills respectively.^[3] Carotene and xanthophyll levels of yellow corn are 1.7 and 19.9 ppm respectively.^[3] The cereal grains are also a source of catechins. A higher amount is present in the seed of buckwheat, then rice bran oil contains 0.9%-2.9% oryzanol and 0.1-0.14 vitamin E components also it contains 608ppm tool and 2849 ppm oryzanol.^[3]

Natural antioxidant from fruit and vegetable waste

Fruit and vegetable waste materials are produced during industrial management, cultivation, processing, preservation, distribution.^[1] These waste materials are therapeutically beneficial, then these fruit and vegetable waste materials are recycled.^[1] the fruit and vegetables waste materials are seed, stem, peeling, pulp residues that are remained after extraction of juices and starch or sugar preparation.^[2] This waste constituent about 25-30%. A greater amount of phenols and ascorbic acid are present in waste scalps than their pulp and unripe from their ripened form.^[1] Most peels contain 2-27 times greater amount of antioxidants than pulp.^[1] A significant amount of bioactive phytochemicals, having strong antioxidant properties are obtained from tomato waste which includes tocopherol, carotenes, sterol, polyphenols. A lot of antioxidants such as vitamin c, carotenoids, and phenolic compounds are found in mango peels. The banana pulp contains 232 mg / 100g of phenolic components and this component 25% amount is

present in the banana peel.^[3] Cucumber peel is an important source of flavonoids. It has potent antioxidant activity. These all compounds have activity against many degenerative diseases such as cancer, Alzheimer's disease, Parkinson's disease.^[1] The waste of the winemaking industry includes degradable solid such as stem, skin, and seed which contains antioxidant which prevents degenerative process and contains health-promoting effect. A waste coffee from the coffee industry contains 6% polyphenols and about 4% tannins.^[2]

MECHANISM OF ACTION OF CELL DAMAGE

Protein Damage

- 1) Protein folding or unfolding
- 2) Protein fragmentation and polymerization reactions
- 3) Protease degradation of the modified protein
- 4) Formation of protein radicals
- 5) Formation of protein-bound ROS (reactive oxygen species)
- 6) Formation of stable end products e.g.: carbonyl compounds.

DNA Damage

- 1) Strand breaks
- 2) Base pair mutations (purine and pyrimidine bases)
- 3) Deletions;
- 4) Insertions;
- 5) Nicking;
- 6) Sequence Amplification

Hydroxyl Radicals-which is the cause of damage of all four bases

Its cellular targets include

Lipids-cause lipid peroxidation

Carbohydrates-It forms carbohydrate radicals or depolymerizing mucopolysaccharides

Protein- It is most potent in oxidizing aliphatic amino acids and causes hydroxylation of tyrosine, phenylalanine.

Peroxynitrite- responsible for cytotoxic effects in cells like

- 1) Lipid peroxidation;
- 2) Glutathione depletion by oxidation;
- 3) Inhibition of superoxide dismutase activity;
- 4) DNA damage by nitrosylation, deamination, and oxidation;
- 5) High concentrations cause cellular necrosis
- 6) Low concentrations cause apoptosis.

ANTIOXIDANT IS USED IN FORMULATION

Vitamins as Antioxidants

Carotenes: A carotene is one of four antioxidants that are vital for our general health and well being, there are four carotene compounds: α -carotene, β -Carotene-carotene, and γ -carotene. α -carotene β -carotene is the most powerful antioxidant.^[6] β -carotene is an anti-aging micronutrient and plays a significant role in reducing the effects of certain illnesses such as heart disease,

decreased immune functions, cataracts, and cancer. Much like alpha and beta carotenes are found in foods like Carrots, Sweet potatoes, Spinach, Broccoli, and Mango.^[5]

Ascorbic Acid (Vit-C): It is a hydrophilic antioxidant; it causes the neutralization of H₂O₂. It maintains healthy collagen in the skin. It repairs damaged tissue, healthy teeth and bones, and boosts the immune system. A free-radical fighter helps ward off wrinkles and many heart diseases and cancer. Vitamin C functions as an anti-inflammatory and helps the body fight inflammatory fibromyalgia, and chronic fatigue, angina, bronchitis, bruises, canker sores, constipation, diabetes, vitamin C helps the body absorb iron, it is also useful in treating deficiencies and anemia. They are found in strawberries, watermelon, potatoes, and spinach.

Tocopherols (Vit-E): It is lipid-soluble and among them, α -tocopherol is biologically active. It is an antioxidant present in all cellular membranes and protects against lipid peroxidation and normal aging. It directly acts on oxyradicals and severely important chain-breaking antioxidants. Vitamin E is used as a treatment for many chronic diseases including Alzheimer's disease, osteoarthritis. They are mainly found in Green leafy vegetables, whole grains, peanut oil, cottonseed oil, sunflower oil.

Phenolic acid as an antioxidant

Ferulic acid

Phenolic acids have very good antioxidant potential. Ferulic acid possesses hydroxycinnamic acid.^[6] It naturally occurs in many plants. It is found in tomatoes, blueberries, blackberries, strawberries, cereal grains. Ferulic acid absorbs UV and inhibits inflammation reactions. Induced by UV such as erythema, sunburn.^[6] This reaction plays a role in delaying skin aging and preventing cancer.^[8] Ferulic acid is used as a health promoter. This is more significant than vitamin c because ferulic acid stabilizes vitamin c. Ferulic acid gives antioxidant effects by decreasing the formation of reactive oxygen species.^[6] Therefore ferulic acid may be a protective agent in diabetic nephropathy. Diabetic nephropathy develops because of oxidative stress in the human body. Derivatives of ferulic acid also produce antioxidant activity. Ester derivatives of ferulic acid are isopentyl ferulate. These derivatives of ferulic acid are used as a new antioxidant agent.^[6]

Caffeic Acid

This caffeic acid is found in fruit, wine, coffee, and olive oil. Caffeic acid gives a good radical scavenging effect.^[6] antioxidant properties of caffeic acid are effective against many global diseases. Caffeic acid gives neuroprotective activity to cerebral ischemia.^[8] The modification of caffeic acid by the addition of glucose improves its biological properties. Caffeic acid improves the antioxidant activity in the skin cells model.^[6]

Polyphenols

Ellagic acid: Polyphenols have more antioxidant potential. Ellagic acid is one of the polyphenolic compounds. Ellagic acid is found in fruits and vegetables, strawberries, walnuts, and grapes.^[6] It produces antioxidant, anti-mutagenic, and anti-cancer activity. That potential antioxidant is introduced by diet, pharmaceutical preparations, or used as an anti-aging agent to external application on the skin. Ellagic acid produces great radical scavenging activity. Ellagic acid can inhibit the growth of several cancer cells by inhibiting their proliferation. Ellagic acid exhibits potent anticancer activity towards breast, colorectal, ovarian, pancreatic, lymphoma cells. Its antioxidant activity was measured by using in vitro methods such as DPPH, ABTS, and lipid peroxidation assay. Ellagic acid may be useful in the prevention of many diseases which are introduced by the formation of free radicals. liver injury is caused by oxidative stress and inflammation reactions. Ellagic acid exerted a protective effect against acute hepatic injury in mice.^[6]

Flavonoids as Antioxidants

Flavanol: Flavanols are phytochemical compounds found in high concentrations in a variety of plant-based foods and beverages. Based on their structure, flavanols are classified as flavonoids and include the following compounds: Quercetin, Kaempferol, and myricetin.^[5] The flavonoids have aroused considerable interest recently because of their potential beneficial effects on human health they have been reported to have antiviral, anti-allergic, antiplatelet, anti-inflammatory, antitumor, and antioxidant activities. Flavonoids may help protect against these diseases by contributing, along with antioxidant vitamins and enzymes, to the human body.^[6]

Like alpha-tocopherol (Vitamin E), flavonoids contain chemical structural elements that may be responsible for their antioxidant activities. The contribution of flavonoids to the antioxidant activities defense system may be substantial considering that the total daily intake of flavonoids can range from 50 to 800 mg. Antioxidant flavonoids such as Quercetin(a flavanol in vegetables, fruit skins, onions), Xanthohumol(a prenylated chalcone in hops and beer)Isoxanthohumol(a prenylated flavanone in hops and beer). The capacity of flavonoids to act as antioxidants depends upon their molecular structure, their position of hydroxyl groups, and other features in the chemical structure of flavonoids that are important for their antioxidant and free radical scavenging activities. Quercetin, the most abundant dietary flavanol, is a potent antioxidant because it has all the right structural features for free radical scavenging activity. The others are genistein (a major isoflavone constituent in soy), Naringenin (Nonprenylated flavone), and vitamin E.

ANTIOXIDANTS APPLICATIONS/USES

1) Antioxidants used in the cosmetic industry

Various antioxidants are present in human skin cells. Such as catalyze, glutathione peroxide, vitamin E, and vitamin C. Aging of the skin is the result of oxidation because of UV radiation and smoking, and the accumulation of free radicals.^[8] In the aging process, the skin cell is very less efficient for fighting against oxidation, wrinkles and senile plaque may appear. Antioxidants in cosmetics can be used to improve antioxidant capacity and remove free radicals and decrease the aging of the skin. Vitamin E and resveratrol are commonly found in cosmetics.^[7] The increase of free radicals in the body starts the wrinkling, photoaging, drying, and pigmentation of the skin. Topical antioxidants are used that remove the free radicals and stop oxidation reactions by oxidizing themselves. That can protect the skin from environmental changes.^[8]

2) Antioxidants Used in the pharmaceutical industry

In countries, infectious disease is no longer the major treatment instead of non-infectious diseases mainly chronic diseases such as cardiovascular disease and cancer. More amounts of free radicals present in the body may cause chronic disease.^[8] The antioxidants have anticancer and antibacterial activity. They can remove the free radicals from the body. Extracted polyphenols from colored avocado seed using methanol having high oxygen radical absorbance capacity which is a more effective inhibitor against lipid peroxidation. And antioxidants were introduced to improve the shelf life of pharmaceutical products.^[5] The phytochemicals such as genistein, tea, and polyphenols, isoflavones that have anticarcinogenic and anti-mutagenic effects and that interfere with a particular stage in the development of cancer and that can stop the division of the cancer cell. Vitamin E-alpha, tocopherol, vitamin A and vitamin B scavenger free radicals react with lipid and protein that give a mild anti-inflammatory effect and protect the lipid from peroxidation in the cell membrane. Also, antioxidants are used in developing medications for cardiovascular disease, diabetes, and coronary artery.^[8]

3) Antioxidants used in the health food industry

Antioxidants are used in chronic diseases such as atherosclerosis, neurodegeneration, and aging. Antioxidants are used in prepared health food products. A high amount of beta carotene and lycopene is present in carrots and tomatoes respectively.^[9] These natural antioxidant compounds prevent aging and decrease the risk of cancer. These compounds contain very less amount of antioxidant constituents. For the elder population, many health food products containing various antioxidants are prepared and marketed. For manufacturing of these health food products Chinese medicinal. Herb is required.^[8]

4) Antioxidants used in the food industry

lipid oxidation that affects the quality of food. This is a real challenge for food manufacturers companies and

scientists. Lipids are oxidized under heat, light, enzyme, metal, and microorganisms which lead to loss of active molecules such as amino acid and lipid-soluble vitamins.^[8] Antioxidants are used as preservatives in the various food industries because of their low volatility and high stability. Antioxidants prevent the food from deterioration during storage, processing, and transportation. Antioxidants prevent oxidation reactions in food.^[5] Antioxidants prevent the texture, odor, color, the function of food. Antioxidant maintains the nutrients substance in the food and increase products' shelf life.^[8]

CONCLUSIONS

Based on this review article, we mentioned antioxidants can be considered a healthy compound, and these compounds are found in two forms: synthetic and natural. Natural antioxidants are safer and have a better effect on human beings. In which we discussed antioxidants obtained from natural sources And the use of this source. We discussed various antioxidants used in the formulation, such as preservatives, anticancer, and anti-aging. We give some examples of natural antioxidants such as tocopherol, ascorbic acid, Ellagic acid, etc. And also mentioned the classification of antioxidants. It can be concluded that using these compounds and products positively influences health and we should use them in our diet. It has a useful effect on human beings.

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