Chapter

Antioxidants from Plant Sources and Free Radicals

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Abstract

Today, many factors such as advancing technology, environmental pollution, radiation, contaminated water, pesticides, heavy metals, stress and oxygen metabolism in living cells inevitably cause the formation of free radicals in the human body. Free radicals are very reactive forms of oxygen that destroy the cells of the organism. This calls for cardiovascular disease, cancer, cataracts, diabetes and many more diseases. To provide solutions to these diseases, firstly, we can eliminate the negative effects of free radicals and prevent the formation of diseases. While there is an antioxidant defense system in the human body that can prevent this, the environmental factors encountered break down this defense resistance and sometimes make it inadequate. We can strengthen our weakened antioxidant defense systems by eating a natural and balanced diet and consuming fruits and vegetables containing antioxidants, thus preventing illness. Research shows that free radicals have a significant effect on aging, free radical damage can be controlled with adequate antioxidant defense, and optimal antioxidant nutrient intake can contribute to improved quality of life. This review is intended to highlight once again the importance of alternative antioxidants in the body to eliminate free radicals and their harmful effects.

Keywords: Oxidative stress, free radicals, antioxidant vegetables and fruits, metabolic activities

1. Introduction

1.1 Free radicals and oxidative stress

Free radicals are short-lived, reactive molecules with unpaired electrons in their outer orbits. The most important of the free radicals are superoxide radical (O2 • −), hydroxyl radical (OH), singlet oxygen ($^1O_2$) and non-radical hydrogen peroxide (H_2O_2) and peroxynitrite (ONOO-) and they are known as "reactive oxygen species (ROS)". ROS can respond easily to biological molecules such as fats, nucleic acids, proteins and carbohydrates in the body. Therefore, they are held responsible for many diseases such as aging, cancer, cardiovascular diseases, immune system diseases, cataracts, diabetes, kidney and liver diseases [1, 2]. The main reason for the harmful effects of reactive species is that they are radicals, which may lead to the formation of radicals or have a higher oxidation potential [3]. Since the reaction between reactive oxygen species and

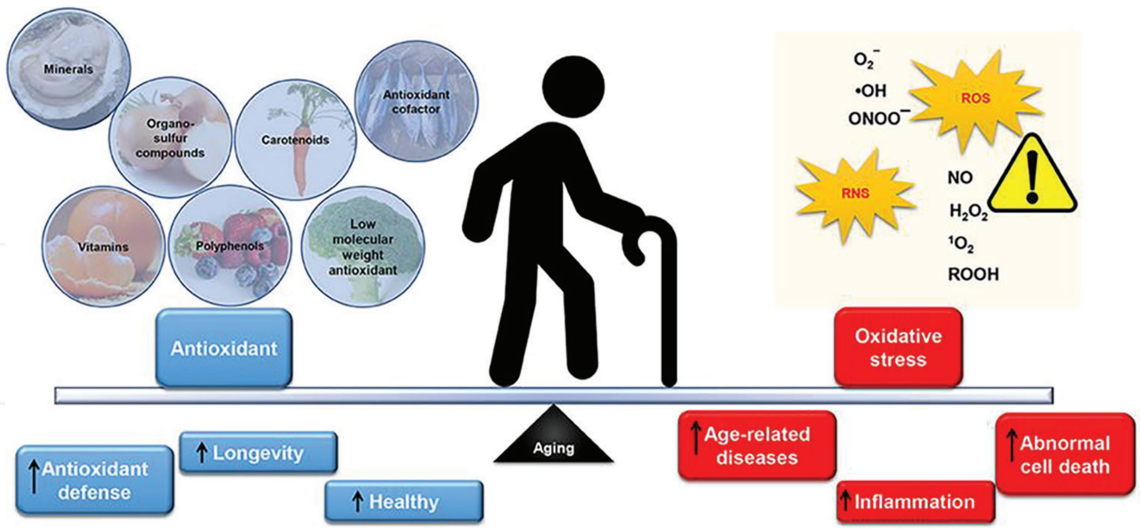

Figure 1.
Indicates the effect of oxidative stress and how aging interacts with age-related illnesses. Summarizes the dietary intake of anti-oxidants on oxidative stress in aging [4, 5].

bio-molecules is in the form of a radical chain reaction, oxidative damage is also in the form of chains. This chain reaction produces new reactive species that, in turn, damage other biomolecules (**Figure 1**) [1, 2].

Free radicals; It can be caused by activating phagocytes, antineoplastic agents, radiation, habit-forming substances, environmental agents and stress, autooxidation of small molecules, enzymes and proteins, mitochondrial electron transport systems, peroxisomes, plasma membrane and oxidative stressors [6]. Free radical formation happens continuously in cells due to enzymatic and non-enzymatic reactions. Enzymatic reactions that serve as sources of free radicals include reactions involved in the respiratory chain, phagocytosis, prostaglandin synthesis, and the cytochrome P-450 system [5, 7, 8]. Free radicals can also occur in non-enzymatic reactions of oxygen.

Some self-generated sources of free radicals [9].

- mitochondria
- xanthine oxidase
- Peroxisomes
- Inflammation
- Phagocytosis
- Arachidonate roads
- For exercise (depending on its intensity, length and type, exercise, metabolic processes and oxygen consumption increase, leading to free radical formation).
- Ischaemia/reperfusion injury.

Sources of external-produced free radicals include:

- Exposed to cigarette smoke
- Environmental pollutants
- Radiation
- Some medicines, pesticides
- Industrial solvents
- Ozone

Research shows that free radicals have a significant effect on aging, free radical damage can be controlled with adequate antioxidant defense, and optimal antioxidant nutrient intake can contribute to improved quality of life. Recent studies show that antioxidants can positively influence life expectancy. Numerous experiments have shown that DNA and RNA are susceptible to oxidative lesions. It has been reported that DNA is considered as the main target, especially in aging and cancer [10]. It has been found that oxidative nucleotides such as glycol, ditch and 8-hydroxy-2-deoxyguanosine increase during oxidative damage to DNA under UV radiation or It has been suggested that 8-hydroxy-2-deoxyguanosine can be used as a biomarker for oxidative stress [11].

1.2 Oxidative changes in DNA

DNA oxidation, along with DNA hydrolysis and DNA methylation, is a major contributor to genome instability and degradation. Spontaneous mutagenesis under aerobic conditions is greater than under anaerobic conditions, and deletion of the OxyR regulon, which prevents DNA damage in bacteria, significantly increases spontaneous mutations [11]. Among the DNA bases, guanine is the most susceptible to oxidative damage. The major mutagenic lesion is 8-Oxo-7,8-dihydroguanine (also called 8-oxoguanine or 8-hydroxyguanine), which forms base pairs with adenine instead of cytosine and therefore produces transversion mutations after replication [12]. Numerous DNA damage reactions and their degradation products have been studied [13]. The accumulation of 8-oxoguanine causes mitochondrial dysfunction and is oncogenic [14] and the enzyme human mutt homolog (MTH1), which detoxifies oxidized nucleotides, is a potential target in cancer therapy [15, 16] (**Figure 2**).

Reactive oxygen and nitrogen species such as superoxide anion, hydrogen peroxide, hydroxyl radical and nitric oxide and their biological metabolites also play an important role in carcinogenesis. The reaction of free radicals with DNA induces ROS DNA damage as it involves chain breakage, base modification and DNA protein cross-links. Numerous researchers have suggested the involvement of free radicals in carcinogenesis, mutation and transformation; their presence in the biosystem can lead to mutation, transformation and ultimately cancer [12]. The induction of mutagenesis, the best known of the biological effects of radiation, occurs mainly by DNA damage by H2O. Radical and other species are produced by radiolysis, and also direct radiation action on DNA, reaction effects on DNA. The radicals are mainly added to the double bond of the pyrimidine bases and hydrogen is abstracted from the sugar portion of the DNA

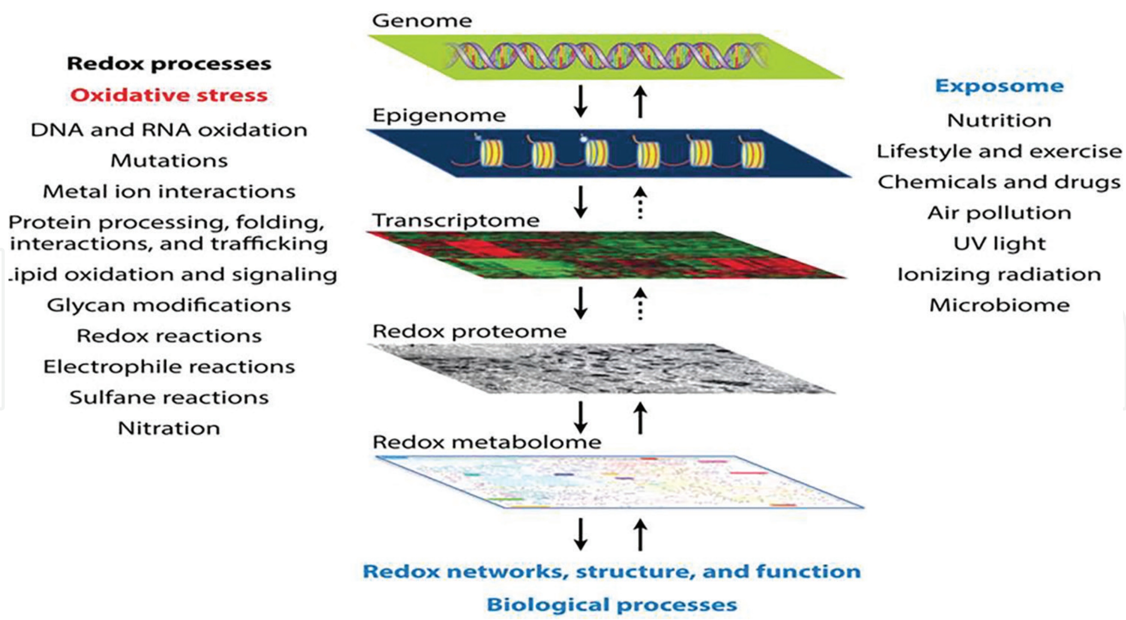

Figure 2.
Redox processes have fundamental implications in biology. Oxidative stress, either as reversible (oxidative distress) pervades all principal levels, from genome integrity and maintenance to the redox metabolism [12].

resulting in a chain reaction. These effects cause cell mutagenesis and carcinogenesis, and lipid peroxides are responsible for the activation of carcinogens [11, 17–19].

Free radicals and antioxidant balance in healthy people, this balance in unhealthy people in terms of free radicals. However, when antioxidant mechanisms are activated or this balance is shifted towards antioxidants, it becomes easier to cope with the complications of diseases caused by imbalance. They stand out as compounds that are effective in preventing diseases. Today, it has been a subject of interest, especially in the determination of the antioxidant capacity of dietary foods. In this review, some important antioxidant foods and their properties, which are consumed extensively in our country and especially in our region, will be explained [20, 21].

2. Antioxidants

There are many defense mechanisms to prevent the formation of reactive oxygen species (ROS) and the damage they cause. These mechanisms are known as "antioxidant defence systems" or "antioxidants" for short.

Antioxidants act in four ways. (1) It is the scavenging effect by affecting the free oxygen radicals, keeping them or converting them to weaker new molecules. Antioxidants, tracheobronchial mucus and small molecules exert this type of effect. (2) Reducing their activity or inactivating them by interacting with free oxygen radicals and transferring hydrogen to them is the suppressive effect. Vitamins, flavonoids have such an effect. (3) The chain-breaking effect is the effect of binding free oxygen radicals and breaking their chains and preventing their functions. Hemoglobin, ceruloplasmin and minerals show chain-breaking effects. (4) Repairing the damage caused by free radicals is a restorative effect [22].

Antioxidants can be of endogenous or exogenous origin. Antioxidants react with free radicals (bonding with them) and prevent them from damaging cells. These features increase the chance of living a healthier life with minimal effects on aging, as they reduce the risk of cells becoming abnormal and eventually forming tumors, as well as reducing cell destruction [23].

The overload of free radicals poses a danger to the body. However, they are also necessary for the body to see its functions and to be protected from diseases. Free radicals are controlled in a very delicate balance in the body. Some mechanisms prevent, destroy or reduce oxidative damage in cells. Substances that inactivate oxidants by direct action are called antioxidants. All antioxidants exert their effects in four main ways:

1. Collector effect

2. suppressive effect

3. Chain braking effect

4. Restorative effect

Antioxidants can be divided into two main groups: natural (endogenous) and unnatural (exogenous) antioxidants [24].

2.1 Endogenous antioxidants

Endogenous antioxidants are divided into two classes, enzyme and non-enzymatic.

Endogenous antioxidants that are enzymes are: (1) Superoxide dismutase (SOD), (2) Glutathione peroxidase (GSH-PX), (3) Glutathione S-Transferases (GST), (4) Catalase (CAT), (5) Mitochondrial cytochrome oxidase system, (6) Hydroperoxidase [25, 26].

Non-enzyme endogenous antioxidants are: (1) Melatonin, (2) Ceruloplasmin, (3) Transferrin, (4) Myoglobin, (5) Hemoglobin, (6) Ferritin, (7) Bilirubin, (8) Glutathione, (9) Cysteine, (10) Methionine, (11) Urate, (12) Lactoferrin, (13) Albumin [26].

2.2 Exogenous antioxidants

They can be classified as exogenous antioxidants, vitamins, drugs, and food antioxidants.

Vitamin exogenous antioxidants are: (1) α-tocopherol (vitamin E), (2) β-carotene, (3) Ascorbic acid (vitamin C), (4) Folic acid (folate).

Exogenous antioxidants used as drugs are: (1) Xanthine oxidase inhibitors (allopurinol, oxypurinol, tearing aldehyde, tungsten), (2) NADPH oxidase inhibitors (adenosine, local anesthetics, calcium channel blockers, nonsteroidal anti-inflammatory drugs, diphenylamine iodonium), (3) Recombinant superoxide dismutase, (4) Trolox-C (vitamin E analogue), (5) Those that increase endogenous antioxidant activity (ebselen and acetylcysteine, which increase GSH-PX activity), (6) Nonenzymatic free radical scavengers (mannitol, albumin), (7) Iron redox cycle inhibitors (desferrioxamine)), (8) Neutrophil adhesion inhibitors, (9) Cytokines (TNF and IL-1), (10) Barbiturates, (11) Iron chelators [27].

Exogenous antioxidants in foods are: (1) Butylated hydroxytoluene (BHT), (2) Butylated hydroxyanisole (BHA), (3) Sodium benzoate, (4) Ethoxyquin, (5) Propylgalate, (6) Fe-superoxide dismutase [28].

2.3 Antioxidants from plant sources

2.3.1 Herbs, fruits, and vegetables

The body produces some antioxidants, which it uses to neutralize free radicals. These antioxidants are called endogenous antioxidants. However, the body relies on external (external) sources, primarily diet, to obtain the rest of the antioxidants it needs. These exogenous antioxidants are often called dietary antioxidants. Fruits, vegetables, and grains are rich dietary sources of antioxidants. Some dietary antioxidants are also available as dietary supplements [19, 29].

Examples of dietary antioxidants include beta-carotene, lycopene, and vitamins A, C, and E (alpha-tocopherol). The mineral element selenium is generally thought to be a dietary antioxidant, but the antioxidant effects of selenium are most likely due not to selenium but to the antioxidant activity of proteins containing this element as an essential component (i.e., proteins containing selenium) itself [30].

Antioxidants can reduce oxidative stress-induced carcinogenesis by inhibiting cell proliferation secondary to direct clearance of ROS and/or protein phosphorylation. Beta-carotene may be protective against cancer through its antioxidant function because oxidation products can cause genetic damage. Thus, the photoprotective properties of β-carotene may protect against ultraviolet light-induced carcinogenesis. Strengthening the immunity of β-carotene may contribute to cancer protection. B-carotene may also have an anticarcinogenic effect by altering the hepatic metabolism effects of carcinogens [31]. Vitamin C may help in preventing cancer [32]. Possible mechanisms by which vitamin C can affect carcinogenesis include antioxidant effects, blocking nitrosamine formation, strengthening the immune response, and accelerating detoxification of liver enzymes. Takes place. Vitamin E, an important antioxidant, plays a role in immune competence by increasing humoral antibody protection, resistance to bacterial infections, cell-mediated immunity, tumor necrosis factor production by T-lymphocytes, inhibition of mutagen formation, repair and blocking of membranes in DNA. microcell line formation. [25]. Therefore, vitamin E may be beneficial in the prevention of cancer and may inhibit carcinogenesis by stimulating the immune system. Administration of a blend of the three antioxidants above revealed the greatest reduction in the risk of developing heart cancer.

Oxidative stress has been postulated to play a role in many conditions, including antersclerosis, inflammatory state, certain cancers, and the aging process. Oxidative stress is now associated with all inflammatory diseases (arthritis, vasculitis, glomerulonephritis, lupus erythematous, adult respiratory diseases syndrome), ischemic diseases (heart diseases, stroke, intestinal ischemia), hemochromatosis, acquired immunodeficiency syndrome, emphysema, organ transplantation, gastric ulcer, hypertension and preeclampsia, a neurological disorder (Alzheimer's disease, Parkinson's disease, muscular dystrophy), alcoholism, smoking-related diseases and others [34]. Excessive oxidative stress can lead to oxidation of lipids and proteins in association with changes in their structure and function. Heart disease remains the biggest killer, responsible for about half of all deaths. Oxidative events can affect cardiovascular diseases, therefore; has the potential to provide enormous benefits to health and lifespan. Polyunsaturated fatty acids are found as an important part of low-density lipoproteins (LDL) in the blood, and the oxidation of these lipid components of LDL plays a vital role in atherosclerosis [35]. The three most important cell types in the vessel wall are endothelial cells.; smooth muscle cells and macrophages can release free radicals that affect lipid peroxidation [36]. With continued highly oxidized lipids, blood vessel damage continues during the reaction process and can cause foam cells to form and plaque atherosclerosis symptoms. Oxidized LDL is atherogenic and is thought to be important in the formation of antersclerotic plaques. Also, oxidized LDL is cytotoxic and can directly damage endothelial cells. Antioxidants such as B-carotene or vitamin E play a vital role in preventing various cardiovascular diseases.

This situation becomes more evident in the later stages of the organism. Reactive species produced during oxidative stress are known to cause aging as mentioned above. Because with aging, there is an increase in the oxidative damage of reactive oxygen species on biomolecules [37, 38]. There is an antioxidant defense system against various oxidants that cause oxidative stress in the organism. This antioxidant defense system; shows its effect by preventing the excessive production of free radicals, reducing the effect of the formed free radicals or reducing or repairing the oxidative damage that occurs. These systems include endogenous antioxidant enzymes such as SOD, CAT and GPX, GSH, metal-binding proteins such as ceruloplasmin and transferrin, some antioxidant elements such as Zn and Cu, and antioxidant vitamins such as A, C, and E [7]. Aerobic organisms with antioxidant defense systems prevent the formation of reactive oxygen species (ROS) produced as a result of aerobic respiration and substrate oxidation. Small amounts of reactive oxygen species, including hydroxyl radicals (OH), superoxide anions (O2 • −), and hydrogen peroxide (H2O2), are constantly produced by aerobic organisms in response to both internal and external stimuli [39, 40].

Antioxidants are divided into primary and secondary antioxidants, according to their reaction mechanism. Some antioxidants show more than one mechanism of action and they are called multifunctional antioxidants. Primary antioxidants (type-1 or chain-breaking antioxidants) are free radical receptors that delay or inhibit the initial stage of autoxidation or interrupt the advanced stage of autoxidation [41]. In addition to these, primary antioxidants; slow down the rate of new radical generation, initiating new oxidation chains. They can act by reducing hydroperoxides (such as glutathione, peroxidase, catalase) or by removing transition metal ion catalysts (transferring) [42]. Secondary (type-2 or protective antioxidants) antioxidants have a wide variety of reaction mechanisms. These antioxidants slow down the oxidation rate but do not convert free radicals into more stable products. Secondary antioxidants can cheat and deactivate prooxidant metals, decompose hydroperoxides to non-radical species, deactivate singlet oxygen, absorb ultraviolet radiation, or act as deoxidizers.

These antioxidants generally increase the activity of primary antioxidants. Citric acid, ascorbic acid, ascorbyl palmitate, lecithin, tartaric acid, EDTA and β-carotene can be given as examples of secondary antioxidants [43]. Plants play an important role in human nutrition and life. Many plants, especially the leaves or various parts of which are consumed as vegetables, are also used for therapeutic purposes among people. As in all countries of the world, medicinally measures of plants are being researched in Turkey and these plants are being developed as a remedy for many diseases.

2.3.2 Polyphenols, flavonoids, anticyanides

Many antioxidant compounds naturally found in plant sources have been identified as free radicals or active oxygen scavengers [44]. Attempts have been made to examine the antioxidant potential of a wide variety of vegetables, such as potatoes, spinach, tomatoes, and legumes [45]. Several reports are showing the antioxidant potential of fruits [45]. Strong antioxidant activities have been found in strawberries. Cherries, citrus, prunes and olives. Green and black teas have been extensively studied in the recent past for their antioxidant properties, as they contain 30% of the dry weight as phenolic compounds [46].

Besides dietary sources, Indian herbs also provide antioxidants, including (with common/Ayurvedic names in parentheses) *Acacia catechu* (chair), *Aegle marmelos* (Bengal quince, Bel), *Allium cepa* (Onion), *A. Sativum* (Garlic) is found., Lahasuna), *Aloe vera* (Indain aloe, Ghritkumari), Amomum subulatum (Great cardamom, Bari elachi), *Andrographis paniculata* (Kiryat), Asparagus recemosus (Shatavari), *Azadirachta indica* (Neem, Nimba), Bacopa monniera (Brahmi), *Butea monosperma* (Palas, Dhak), *Camellia sinensis* (Green tea), Cinnamon acupuncture (Cinnamon), Cinnamon tamala (Tejpat), Curcma longa (turmeric, Haridra), *Emblica officinalis* (Inhian gooseberry, Amlaki), Glycyrrhiza glapra), (Yashtim) Hemidesmus indicus (Indian Sarasparilla, Anantamul), *Indigofera tinctoria*, *Mangifera indica* (Mango, Amra), *Momordica charantia* (Bitter gourd), *Murraya koenigii* (Curry leaf), *Nigella sativa* (*Nigella sativa*), *Ocimum sanctum* (Holy basil), *Onosma echioides* (Ratanjyot), Picrorrhiza kurroa (Katuka), Piper beetle, Plumbago zeylancia (Chitrak), *Sesamum indicum*, *Sida cordifolia*, Spirulina fusiformis (Alga), Swertia decursata, Syzigium cumini (Jamun), Terminalia ariuna (Arjunica), Terminalia ariuna (Arjunica) (Beheda), Tinospora cordifolia (Heart leaf moon seeds, Guduchi), Trigonella foenum- graecium (Fenugreek), Withania somifera (Winter cherry, Ashwangandha) and Zingiber officinalis (Ginger) [47].

Indian systems of medicine believe that complex diseases, unlike western ones, can be treated with complex combinations of botanicals with single medicines. This is why in India whole foods are used as functional foods rather than supplements. Spices such as onions, garlic, mustard, paprika, turmeric, cloves, cinnamon, saffron, curry leaves, fenugreek and ginger are some medicinal plants and dietary components with functional properties. Some herbs, such as *Bixa Orellana*, and vegetables such as Emilia, wheatgrass, soybeans, and Garcinia Cambodia have antitumor effects. Other medicinal plants with functional properties include *A. marmelos* [47].

Polyphenols are plant metabolites containing various phenol groups. In this group, there are about 4000 compounds gathered in 13 classes (flavonoids, phenolic acid, anthocyanin, catechins, flavones, flavonol, flavanone, isoflavones, lignans, proanthocyanidin, procyanidin, Resveratrol, tannin). They are abundant in green tea, grapes, and soy. The most important polyphenol group is phenolic acids. It has anti-inflammatory, antiallergic, antiviral, anti-aging, anticarcinogen and antioxidant properties. It has been reported to have positive effects on the cardiovascular system [48].

Some polyphenol hydroxyls are highly reactive: I. Neutralizing free radicals by donating a hydrogen atom or an electron, II. Chelation with metal ions in aqueous solutions, III. It has the properties of binding to proteins and forming precipitation. Polyphenols can increase the antioxidant activity of oral fluids. It has been reported that tea polyphenols increase the antioxidant capacity of saliva by keeping green or black tea in the mouth for 2–5 minutes25, and consumption of 2 grapefruits per day for 2 weeks increases the phagocytic capacity of gingival sulcus fluid (DOS) neutrophils has been shown to affect [49].

Flavonoids belong to the group of Polyphenols. According to their chemical structure, flavonoids are divided into subgroups of flavanones (Ex: Luteolin), flavonols (Ex: Quercetin, kaempferol), flavan-3-ols (Ex: Catechin), anthocyanins and isoflavones. Flavonoids have attracted the attention of researchers because they are free radical scavengers, regulate enzyme activities, inhibit cell proliferation, and act as antibiotics, antiallergic, antidiarrheal, antiulcer and anti-inflammatory drugs. It has antioxidant, antiviral, antibacterial properties. They are found in vegetables, fruits, grains, tea and some spices. It is present in high amounts in citrus fruits, blueberries, blackberries, onions, peppers, tea and parsley [50].

Antioxidants are mainly represented by vitamin C and polyphenols such as anthocyanins, phenolic acids, flavanols, flavonols and tannins. These fruits are known as natural antioxidants because of their high antioxidant concentration, berry fruits are increasingly mentioned in the literature as natural functional foods. The biological value of berries is due to the presence of components such as vitamins, provitamins and related compounds, minerals, phytosterols and phenolic compounds [50]. The health benefits of these fruits are attributed to their high antioxidant properties and phenolics, which are the main bioactive components of berry fruits [50, 51]. Blackberry (Rubus sp.), blueberry (*Vaccinium myrtillus*), red currant (Ribes rug rum), blueberry (*V. Corymbosum*), Aronia (*Aronia melanocarpa*), cranberry (*V. macrocarpon*), laurel berry (Myrica sp.), raspberry (R. Ideas), black raspberry (R. Occidentalise) and strawberry (Fragaria ananassa) are an important source of bioactive compounds that are generally consumed as fresh or processed products in human nutrition [52, 53]. Some Foods Containing Polyphenols; Green Tea has been reported to have protective effects against cancer development and cardiovascular diseases due to its catechin content. It has been shown that catechins inhibit periodontal pathogens and prevent periodontal tissue destruction [54]. Contrary to these results; In a study conducted with Korean adults, consumption of less than one cup of green tea per day was associated with a decrease in the prevalence of periodontal disease; It has been reported that consumption of green tea once or more per day increases the prevalence of moderate to severe periodontitis [55–58].

Curcumin shows antioxidant properties by reducing the oxidizing effects of free radicals as a result of the interaction of the phenolic and methylone groups in its structure with free radicals [59]. Curcumin has a scavenging effect on reactive oxygen radicals such as superoxide anion, hydroxyl radical, singlet oxygen, nitric oxide, and peroxynitrite. It can protect lipids, hemoglobin and DNA from oxidative destruction. It can also play an antioxidant role with its ability to increase the intracellular GSH release and bind to iron. Bakır et. al. administered curcumin to rats orally and observed that it increased the intracellular release of GSH, played an antioxidant role with its iron binding capacity, and reduced cellular bone loss [60].

The antioxidant activities of carotenoids are primarily increased by their conjugated double bond structures that de-localize unpaired electrons. This is related to the ability of α-carotene to physically block singlet oxygen without degradation, and to the chemical reactivity of α-carotene to radicals such as proxy, hydroxyl, and superoxide radicals. Sufficient concentrations of carotenoids protect lipids from peroxidative damage. In addition, it has antiproliferative effects on cancerous cells. Foods containing vitamin C include strawberries, papaya, red and green hot peppers, citrus fruits, fresh spices, broccoli, kiwi, melon and cauliflower. Vitamin C plays an important role in a strong immune system, collagen production, regeneration of skin, cartilage, tendons and blood vessels. Its deficiency increases the risk of various diseases, including serious diseases such as heart diseases, arthritis, and cancer [61]. Vitamin C cooperates with vitamin E to regenerate α-tocopherol from α-tocopherol radicals found in cell membranes and lipoproteins [62].

Vegetable oils such as wheat germ oil, sunflower oil, corn and soybean are very rich in vitamin E. Almond, spinach, chard, kale, ground hot pepper, asparagus, garlic and peanuts contain vitamin E. Vitamin E is a tool in chemical structure. Different compounds of tools (tocopherol and tocotrienol) show vitamin E activity. The most active form of vitamin E in humans is α-tocopherol. Its main antioxidant function is its protective feature from lipid peroxidation. During the antioxidant reaction, αtocopherol is converted to α-tocopherol radical with the transition of the mobile hydrogen atom to the lipid or lipid peroxyl radical. The alpha-tocopherol radical can be reduced to its original form of ascorbic acid. Vitamin E acts as an antioxidant by disrupting free radical chain reactions [63].

The body produces some antioxidants, which it uses to neutralize free radicals. These antioxidants are called endogenous antioxidants. However, the body relies on external (external) sources, primarily diet, to obtain the rest of the antioxidants it needs. These exogenous antioxidants are often called dietary antioxidants. Fruits, vegetables, and grains are rich dietary sources of antioxidants. Some dietary antioxidants are also available as dietary supplements [30, 31].

Examples of dietary antioxidants include beta-carotene, lycopene, and vitamins A, C, and E (alpha-tocopherol). The mineral element selenium is generally thought to be a dietary antioxidant, but the antioxidant effects of selenium are most likely due not to selenium but to the antioxidant activity of proteins containing this element as an essential component (i.e., proteins containing selenium) [33].

Many plants with antioxidant properties belong to the Labiatae family. The genera belonging to the Labiatae family include plants with important physiological activities (antioxidant and antimicrobial) especially because they contain terpenic compounds (mono-, di-, triterpenes), flavonoids, and phenolic acids [64].

Colored flavonoids are responsible for the color formation of many fruits and vegetables. However, various colorless flavonoids can also be found in nature. Anthocyanins, which are in the flavonoid subgroup, are pigment substances that give the leaves, flowers and fruits of plants, their characteristic clear blue, red, purple, violet color. They also contain a group of important antioxidant substances. The findings are showing the in-vitro antioxidant activity of anthocyanins and anthocyanin compounds. In some of the studies, it has been determined that anthocyanins reduce the risk of cardiovascular disease and cancer, and have analgesic and antidiabetic effects [55].

Flavonoids have attracted the attention of researchers because they are free radical scavengers, regulates enzyme activities, act as antibiotics, intelligence, antidiarrheal, antiulcer and anti-inflammatory drugs [56]. The role of phenolic compounds as antioxidants has enabled natural components containing phenolic compounds to be included in various product formulations and to be widely used in functional food development studies. Many studies have reported that these compounds reduce blood cholesterol levels, have osteoporosis and anticarcinogenic effects, and have antioxidant activity. There are also opinions that these substances can inhibit unwanted bacterial infections [56].

It is estimated that there are more than 600 anthocyanins in nature and this number is expected to increase with new studies. These natural compounds are commonly found in the human diet. They are normally observed at concentrations between 0.1% and 1.0% dry weight, especially in red, blue or purple fruits and vegetables. Due to their pigmentation and structural properties, anthocyanins are also used in industry as natural colorants. Anthocyanins have been observed to reduce chronic disease risks by enhancing antioxidant defense and modulating antioxidant and inflammatory signaling pathways. In addition, it has been determined that these compounds alleviate oxidative damage and inflammation, repair DNA damage, trigger apoptosis in cancer cells, reduce lipoprotein oxidation, normalize lip profiles, improve vascular endothelial function, decrease platelet reactivity and contribute to the improvement of neurotoxicity. The majority of anthocyanins (~90%) are composed of six common anthocyanidin glycosides: pelargonidin (Pg), cyanidin (Cy), delphinidin (Dp), peonidin (Pn), petunidin (Pt), and malvidin (Mv) [57]. People's daily anthocyanin intake is highly variable depending on their eating habits [7, 11]. The richest resources to meet this requirement are flowers and fruits. However, it is found in significant concentrations in the stems, leaves and storage organs [58]. Colorful fruits such as peaches, strawberries, pomegranates, cherries, plums, and grapes, as well as many dark vegetables (black beans, red radishes, red onions, eggplant, red cabbage, purple corn, and purple sweet potatoes), are all rich in anthocyanins [58, 59]. These molecules have been found not only in natural sources but also in processed forms in foods and beverages such as red wine, fruit juices, yoghurt and jelly [58, 59].

The high content of anthocyanins found in fruits indicates that a daily intake can be achieved with regular consumption of fruits and fruit drinks. Anthocyanins have higher antioxidant capacities (AC) than other antioxidants with free radical scavenging potential. Anthocyanins have also been observed to reduce the risk of chronic disease by enhancing antioxidant defense and modulating antioxidant and inflammatory signaling pathways [61]. The beneficial cardiovascular protective effects of polyphenols, including anthocyanins, have been demonstrated in human studies [62]. Anthocyanins are thought to exert their cardiovascular protective effects through anti-inflammation and antiplatelet activity reported to be mediated by their colonic metabolites [61]. Various studies suggest that the intake of anthocyanin-rich fruits provides some beneficial effects against age-related neurodegeneration and cognitive decline. Studies in animal models have found that the intake of freeze-dried fruits or, anthocyanin fruit extracts (plum and blackberry) delays the decline of nerve functions and improves cognitive and motor performance [62]. However, anthocyanins have been shown to alleviate oxidative damage and inflammation [63], repair DNA damage [63], trigger apoptosis in cancer cells, reduce lipoprotein oxidation [64], normalize lip profiles, improve vascular endothelial function, reduce platelet reactivity, as demonstrated in cell and animal studies. And contribute to the improvement of neurotoxicity [64]. However, anthocyanins are considered to be anti-inflammatory, anti-cancer [63], anti-hemostatic and antiobesity agents that, when taken together, can reduce cancer risk, cardiovascular diseases, and neurological disorders including Alzheimer's disease [61, 65]. The anticancer activity of anthocyanins is also demonstrated in different animal models.

For example, in mouse models of bowel cancer fed cherry extract anthocyanins, the researchers observed a 74% reduction in cecum tumors in the treated animals relative to the control group [61]. In mouse models of colon cancer fed bilberry, Aronia, or grape anthocyanins, a 26–29% reduction of abnormal crypts obtained by reducing cell proliferation and COX-2 gene expression has been observed [61]. However, in a randomized, double-blind, and placebo-controlled study of 120 dyslipidemic participants consuming 320 mg/day anthocyanin supplement (containing 17 purified anthocyanins from black currant and blueberry) for 12 weeks, circulating high-density lipoprotein (HDL) increased, cholesterol and low-density lipoprotein (LDL) cholesterol concentrations were found to decrease [66–68]. Inflammation is a complex biological response to tissue damage, associated with the onset, development and progression of cancer or tumors, provided there is a favorable microenvironment. Flavonoids have been found to have immunomodulatory properties in vitro. The antioxidant activity of tea, in which anthocyanins have several anti-inflammatory effects, is mainly due to the phenolic substances it contains.

Langley-Evans [69] stated that 35–45% of dietary antioxidants originate from tea flavonoids, and as the temperature increases during brewing, the number of antioxidants in the brew increases. Dillard and German [70] in a study conducted on 805 men aged 65–84, reported that the average daily flavonoid intake was 25.9 mg per day, 61% of which was due to tea.

Trevisanato and Young-In Kim [71] investigated the relationship between tea consumption and some types of cancer, and in oral cancer: 37.9% partial reduction in lesions after 6 months of green tea administration, in gastric cancer: green and black tea In those who consume 7 or more cups of green tea per day. Up to 31% reduction in cancer risk, in pancreatic cancer: 12% cancer risk in men consuming green tea up to 200 g/month, 53% in women; Those who consumed more than 200 g/month saw a 43% reduction in men, 47% reduction in women and a 4% reduction in the risk of colon cancer in those who consumed 2 or more cups of black tea per day [72].

It has been reported that green tea has high antioxidant activity due to the high flavanols it contains, while black tea has high antioxidant activity due to its flavanol content as well as secondary phenolic substances formed in the enzymatic oxidation stage [71]. Berries are known to contain a wide variety of bioactive compounds such as phenolic compounds, organic acids, tannins, anthocyanins and flavonoids. The chemical structure of phenolic compounds is characterized by one or more aromatic rings with hydroxyl groups. These compounds are classified into 5 main groups according to their structural properties: phenolic acids, Stevens, flavonoids (flavonols or catechins, flavonols, flavones, flavonols, isoflavonoids, anthocyanins), tannins and lignans [71].

It has been tried to be proven by studies that anthocyanin-rich raspberry, strawberry, cherry and blueberry are very effective in preventing the emergence of some diseases that cause premature death such as some types of cancer, vascular and heart diseases [72]. Phenolic compounds in the studies (mg/100 g fresh fruit); Blueberry (*Vaccinium myrtillus*) 525 mg/100 g, [73], Blackberry (*Rubus fruticosus*) 361 mg/100 g, 417-555 mg/100 g [74, 75], Black Currant (Ribes nigrum) 318.15 mg/100 g, 498-1342 mg/100 g [76, 77]. Blueberry (Vaccinium corymbosum) 181.1-473 mg /100 g, 261-585 mg/100 g [73, 75], Raspberry (Rubus ideaus) 113.73-177.6 mg/100 g, 192-359 mg/100 g [78–80], 20 Strawberry (Fragaria ananassa) 317.2 mg/100 g [71], 443.4 102 mg/100 g [81–85].

Researching ways to lead a healthy life and prevent diseases is one of the most studied research in the medical world. For this reason, the effects of natural vegetables, plants and fruits on the human body are gaining more and more importance every day. The fact that antioxidant substances taken with plants create a protective shield against the effects of oxygen and other harmful substances entering the body, which causes the cells to deform, increases the interest in such natural products [86].

3. Result

The danger of oxidative stress manifests itself when reactive oxygen species damage cellular molecules. Damage to proteins, lipids, and RNAs is relatively reversible, but damage to DNA can lead to irreversible problems. By using more foods with high antioxidant capacity, your body's cellular damage (oxidative stress) caused by free radicals can be reduced. In addition, many factors such as environmental pollution, radiation, contaminated water, pesticides and oxygen metabolism in living cells inevitably cause the formation of free radicals [87].

Research shows that free radicals have a significant effect on aging, free radical damage can be controlled with adequate antioxidant defense, and optimal antioxidant nutrient intake can contribute to improved quality of life. Antioxidants are natural substances found in vegetables and fruits, protecting cells from aging and rusting, preventing cancer and weakening of immunity. The antioxidant capacities of vegetables and fruits vary depending on the amount and type of antioxidant compounds they contain. Because not all foods contain these compounds in the same amount. Fruits with red-purple content such as strawberries, blueberries, cranberries, raspberries and blackberries contain a significant amount of antioxidants. Tomatoes to be consumed in their season contain high levels of vitamins A, C and folic acid. In addition, Lycopene, which increases in amount when cooked, is a very powerful antioxidant. By using more foods with high antioxidant capacity, you can reduce your body's cellular damage (oxidative stress) caused by free radicals. Studies have shown that foods with high antioxidant capacity have a high capacity to absorb free oxygen radicals that damage cells and life of man. Many plants, in particular leaves or various parts that are consumed as vegetables, are also used for therapeutic purposes amongst people. As in all countries of the world, medical measurements of plants are being researched in Turkey and these plants are under development as a remedy for many diseases [88]. There is safe data that foods with higher antioxidant capacity, protect cells better and lead to longer and healthier lives. To protect our health, we should consume plenty of fresh fruits and vegetables in the season, pay attention to the variety of foods and improve our eating habits in the light of healthy eating principles.

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