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A Review on Natural Source of Antioxidants

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ABSTRACT: Antioxidants are the defense system of the body against the damage of reactive oxygen species, which is normally produced during the various physiological processes in the body. There are various sources of these antioxidants like endogenous antioxidant present in the body and exogenous food source. In recent decades, alternate of synthetic food antioxidants by natural ones has fostered interest on vegetable sources and the screening of inexpensive raw materials particularly from the agriculture for identifying new antioxidants. Polyphenols are the significant plant compounds with antioxidant activity, though not the only ones. Some but not only restricted to biological properties such as anticarcinogenicity, antimutagenicity, anti-allergenicity, and anti-aging activity have been reported for natural and synthetic antioxidants

KEYWORDS: antioxidants, vegetables, fruits, plants, herbs

I. INTRODUCTION

ANTIOXIDANT: The formations of oxygen reactive forms as a result of rigorous oxidative processes taking place in human organism are the potent precursors of systemic cells and tissues damage. Antioxidants being an inhibitor of the oxidation process remove these free-radical intermediates by oxidized themselves, even at quite diminutive concentration, and thus have assorted physiological function in the body to stop these oxidation reactions ultimately protecting the body from harmful chain reactions. Thus, they have reviewed by many researchers as nature's answer to physiological and environmental stress, atherosclerosis, aging, and cancer. Body's endogenous defense system against these free radicals plays an imperative role which can further be supported by the supplementation of antioxidants in the diet. Generally, antioxidants can be divided into two major categories such as synthetic and natural.

THE KIND OF ANTIOXIDANT WE NEED IN OUR FOOD

The results of epidemiological and scientific studies show that nutritional factor plays important role in prevention of the consequences of free radicals activity in the organism. A diet rich in natural antioxidants can significantly influence the increase of reactive antioxidant potential of the organism, and *ipso facto* decrease the risk of some diseases of free radicals origin. It is considered that adequate level of antioxidant supplied with diet induces immunological processes and increases defensive abilities of cell in proper way [Ghiselli et al. 2000, Prior 2003, Gałek and Targonski 2003, Grajek 2004].

Types of antioxidants present in fruits and vegetable

Polyphenols, present in fruits and vegetables, is a group of several low- and high-molecular weight compounds having antioxidant properties that prevent lipid oxidation [17]. Most of them are conjugates of mono and polysaccharides connected with one or more groups of phenol rings or may also present as functional derivatives such as esters and methyl esters. This major class of natural antioxidants can be obtained from teas, particularly green and red teas, as well as fruits such as grapes. However, polyphenols from teas have more significant than in fruits because of their bioavailability in blood. Approximately 15–20% polyphenols are absorbed in human blood from their consumed amount. This absorption is enhanced when there are no sugar molecules attached with them. So, teas have more absorption of polyphenols than in fruits because of high sugar content in fruits. Flavonoids, another important

antioxidant content, is a subclass of polyphenols present abundantly in most of the foods, such as potatoes, wheat, tomatoes, red berries, peaches, and almonds. Anthocyanin is a subcategory of flavonoids which is present in berries and red wine. It is a potent antioxidant with decreased bioavailability as compared to other flavonoids. Polyphenols show their antioxidant properties by preventing the oxidation of low-density lipoproteins (LDL), thus preventing plaque formation. Some types of polyphenols have also been found to inhibit the oxidation of some important enzymes and thus preserve their proper functioning. Carotenoids are another major class of phytochemical antioxidants from fruits and vegetables after polyphenols. They mostly found in vegetables, such as potatoes, carrots, papayas, and apricots. Among the vitamins obtained from fruits and vegetables, acting as antioxidants, vitamin C, also known as ascorbic acid, is a very potent water-soluble antioxidant commonly found in citrus fruits and vegetables such as oranges, lemons, and tomatoes. It is recommended that the fruits and vegetables containing vitamin C should be taken in small divided doses instead of having a large dose simultaneously because vitamin C shows less absorption when given in large quantities. Another vitamin with antioxidant properties is vitamin E, which is related to tocopherol family of antioxidant. It is a fat-soluble, nonpolar vitamin found naturally in lipid-rich fruits and vegetables, such as olives, sunflower, and nuts. Vitamin E shows higher bioavailability than vitamin C, which is perhaps due to its fat solubility and can be further enhanced when taken with fatty foods.

ANTIOXIDANTS PROPERTY OF FRUITS

Fruits belong to food products appreciated by dietitians and nutritionists. They contain several vitamins and mineral salts deciding about their nutritional value, and also dietary fiber. Majority of fruits are rich source of vitamin C, carotenoids and polyphenolic compounds. Especially berry fruits are precious in this regard. Among berry fruits, the content of particular substances with antioxidant activity is rather diversified—some of them are especially rich source of vitamin C, the other contain huge amounts of phenolic compounds. Fruits of blackcurrant have a high content of antioxidants. They contain huge amounts of vitamin C, in range of 120-215 mg/100 g [Hägg et al. 1995, Benvenuti et al. 2004], and also significant amounts of carotenoids, mainly lutein and β -carotene [Olsson et al. 2004]. In blackcurrant fruits phenolic compounds are also present, on the level of about 25 mg/g d.m., with anthocyanins consisting 1/3 [Kähkönen et al. 2001, Benvenuti et al. 2004]. Except anthocyanins, blackcurrant fruits contain phenolic acids, among which derivatives of hydroxycinnamic acid dominate, especially *p*-coumaric acid [Zadernowski et al. 2005]. The subject of many studies were antioxidative properties of strawberry fruits, which are rich source of vitamin C (35-104 mg/100 g), and phenolic compounds [Hägg et al. 1995, Hakala et al. 2003, Kłopotek et al. 2005]. Phenolic compounds are present in these fruits in amount about 20 mg/g d.m., where the biggest share have anthocyanins and ellagic acid with its derivatives (glycosides, ellagitannins), which can make 35-40% of total polyphenols content [Kähkönen et al. 2001, Kłopotek et al. 2005]. Among anthocyanins, present mainly in pulp, pelargonidin 3-glucoside dominates, while in stones—cyanidin 3-glucoside [Aaby et al. 2005]. Ellagic acid makes up also over a half of polyphenols amount in raspberries [Anttonen and Karjalainen 2005]. *Aronia melanocarpa* fruits are considered as the richest polyphenols source. Their total content is 40-70 mg/g d.m., with over 50% share for anthocyanins. The latter, contain group of polyphenols are the derivatives of hydroxycinnamic acid, represented mainly by chlorogenic and neochlorogenic acids. These compounds, together with epicatechins, decide about very tart taste of *Aronia melanocarpa* fruits, which causes that they are rarely consumed in raw state [Niedworak and Brzozowski 2001, Wu et al. 2004, Olsson et al. 2004, Oszmianski and Wojdyło 2005]. Phenolic compounds present in grapes, mainly in seeds and peel, are mainly anthocyanins and derivatives of hydroxycinnamic acid, flavonols and stilbenoids. The richest source are pomace received during vine production. Among polyphenols present in seeds of grapes dominate: gallic acid, catechins and epicatechins, while in peel—ellagic acid, myricetin, quercetin, kaempferol and trans-resveratrol [Pastrana-Bonilla et al. 2003, Kammerer et al. 2004]. It was shown, that this last compound is a very active antioxidant, which modulates lipid metabolism, inhibits lipoproteins oxidation and platelets aggregation, what is very important in atherosclerosis prevention. Its presence in red wine is an explanation of French paradox. Resveratrol influences the inhibition of tumour growth and metastasis of malignant tumours. From grape kernels para-pharmaceutical preparations recommended in prevention of ischaemic heart diseases are produced [Lutomski and Mscisz 2003]. The results of many studies showed that the best source of compounds with antioxidant activity are wild plants fruit. Bilberries, being very popular fruits in our country, contain vitamin C and carotenoids, but the most important antioxidants are phenolic compounds. Total content of phenolic compounds in bilberries reaches about 30 mg/g d.m., from this 70% consist anthocyanins, and next in order (10%)—derivatives of hydroxycinnamic acid [Kähkönen et al. 1999, 2001, Vinson et al. 2001]. Minor content of antioxidant compounds contain “high” blueberry known as “American”, which is contemporary one of more preferably cultivated in Poland and so its significance as a source of antioxidants in our diet increases [Halvorsen et al. 2002, Taruscio et al. 2004]. The rich source of phenolic compounds (about 20 mg/g d.m.) are cranberries. They contain anthocyanins (peonidin and cyanidin), flavanones and procyanidin,

and from flavonols – quercetin, myricetin and derivatives of hydroxycinnamic acid [Kähkönen et al. 1999, 2001, Taruscio et al. 2004, Määttä-Riihinen et al. 2004]. It is shown that biologically active phenolic compounds present in these fruit thanks to antioxidative properties decrease risk of atherosclerosis and inhibit tumorous cell growth. Fresh juice from cranberry fruits (which can be gained from frozen fruits) shows particularly high activity [Rodowski 2001, Ferguson et al. 2004].

Crowberry fruits are a valuable source of vitamin C, with its amount about 18 mg/100 g. They contain also carotenoids – lutein (about 3.6 µg/g d.m.) and β-carotene (2 µg/g d.m.) and also phenolic compounds (26-46 mg/g d.m.) [Kähkönen et al. 1999, 2001, Halvorsen et al. 2002, Olsson et al. 2004]. Among them, flavanols and procyanidins, cinnamic acid, trans-resveratrol and p-coumaric acid dominate. They decide about organoleptic features and healing properties of products made from these fruits [Kähkönen et al. 2001, Määttä-Riihinen et al. 2004, Ehala et al. 2005]. Polyphenolic compounds (about 23 mg/g d.m.) of blackberry first of all decide about its antioxidant activity [Benvenuti et al. 2004, Reyes-Carmona et al. 2005]. In their composition, besides anthocyanins and flavonols placed mainly in pulp, ellagic acid has the biggest share and the next in turn are procyanidins and epicatechins stored in seeds [Benvenuti et al. 2004, Siriwoharn et al. 2004, Siriwoharn and Wrolstad 2004, Bushman et al. 2004, Reyes-Carmona et al. 2005, Zadernowski et al. 2005].

Citrus fruits – grapefruits, lemons, oranges – are a rich source of antioxidants, because of big content of vitamin C (40-50 mg/100 g) and phenolic compounds, among which flavanones (hesperitin, naringenin, eriodictyol) dominate. Pink grapefruits show relatively high content of lycopene, too [Gorinstein et al. 2001, Lugasi et al. 2003, Cieslik et al. 2006, Saura-Calixto et al. 2007].

Many authors emphasise the significance of apples as a source of phenolic compounds (even to 5.0 g/kg), with their content about 7-times higher in peel than in pulp. Almost 80% of apple polyphenols contain polymeric procyanidins and monomeric flavanols, with dominating epicatechin and its dimer procyanidin B2. Next, according to the amount, are phenolic acids, dihydrochalcones and flavonols. Main phenolic acid in apples is chlorogenic acid, among dihydrochalcones – phloridzin and phloretin-2-xyloglucoside. These compounds influence juice quality (especially colour and taste) in a wide range [Lu and Foo 1997, 2000].

ANTIOXIDANTS PROPERTY OF VEGETABLES

Among vegetables the best sources of antioxidants are tomatoes, red pepper, *Brassica* vegetables, onion, garlic and red beet. Red pepper is appreciated mainly because of high content of vitamin C (144 mg/100 g) and cryptoxanthin, and tomatoes as a source of lycopene. Lycopene is present in tomatoes peel in amount of 3025 µg/100 g, however, considerably higher amounts, and better absorbed form is supplied by tomatoes preserves, for example ketchup (9900 µg/100 g) [Horbowicz and Saniewski 2000, Lugasi et al. 2003].

Considering vitamin C or β-carotene content, parsley roots, kale, carrot and pumpkin are listed among vegetables [Holden et al. 1999, Kopsell and Kopsell 2006]. Tomatoes are also a source of polyphenol compounds, mainly flavonols. Stewart et al. [2000] studies show that 98% of flavonols present in tomatoes are placed in fruit peel, from which 96% of it consists the quercetin. In pulp and seeds compounds of quercetin consist about 70%, while kaempferol – 30% of total flavonols content. So it means, that removing of tomato peel significantly decreases polyphenols level. *Brassica* vegetables such as white cabbage, kale, Chinese cabbage, broccoli sprouts, kale or cauliflower are known for their pro-healthy properties which are *inter alia* caused by presence of antioxidant compounds in high amounts. They contain vitamin C, in the amount – in dependence on gender – to a few dozen mg/100 g. Kale contains a high amount of this ingredient. It is considered that a higher content of vitamin C among vegetables is met only in red pepper. Kale is a good source of carotenoids (17-34 mg/100 g), and – in opinion of some scientists – surpasses such vegetables as carrot, tomatoes or spinach [Kurilich et al. 1999, Kopsell et al. 2004]. Plants of cabbage vegetables family contain also phenolic compounds, where particularly rich sources are: kale, broccoli and Brussels sprouts. Other vegetables from this group contain smaller (even several times) amounts of these compounds, but thanks to high consumption they are their significant source in everyday diet. *Brassica* vegetables contain also derivatives of hydroxycinnamic acid – caffeic, chlorogenic, ferulic, and synapic [Vallejo 2003] as well as flavonols.

Generally, the flavonoids group dominate among vegetable polyphenols. Bahr et al. [2004] found that flavonoids share in total content of polyphenols in 6 on 10 studied vegetables was in range of 51-79%. It is worth to be marked, that in non-processed vegetables flavonoids are rarely present in aglycon form. Free quercetin was determined in tomatoes and different kinds of onion. Free kaempferol was present only in tomatoes and free isorhamnetin in onion [Price et al. 1997, Stewart et al. 2000, Marotti and Piccaglia 2002]. Among glycosides of flavonol in onion were identified: 4-glucoside of quercetin and 3,4-glucoside of quercetin consisting from 83 to 93% of total polyphenol amount [Price et al. 1997, Marotti and Piccaglia 2002]. Derivatives of quercetin were

found also in lettuce [Romani et al. 2002]. Main polyphenol compounds of broccoli are quercetin 3-sophoroside and kaempferol 3-sophoroside [Price et al. 1998]. Over 20 compounds of quercetin and kaempferol were found in cabbage [Nielsen et al. 1998]. In red pepper, two derivatives of quercetin, i.e. luteolin and one – apigenin were found [Materska and Perucka 2005]. Anthocyanin pigments are found only in a few vegetables. They give characteristic colour of red cabbage, onion and lettuce with red leaves. They can also be found in peel of radish, aubergine and coloured potatoes. As regards potatoes, varieties with pink or violet coloured pulp are also cultivated.

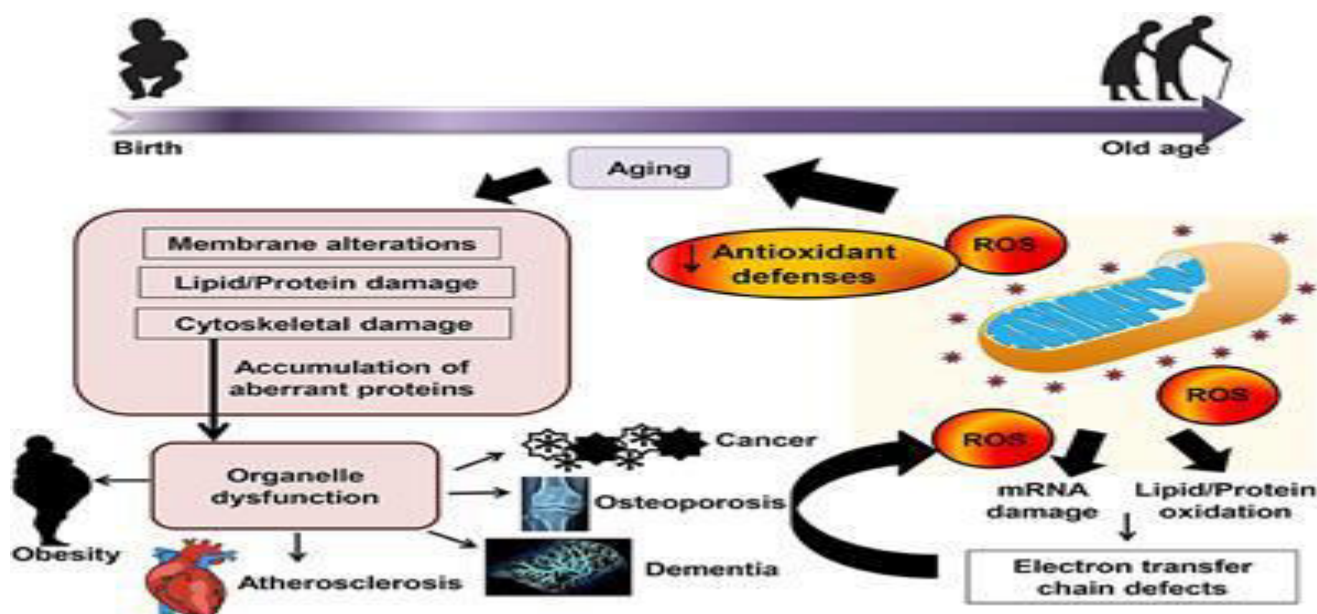
ANTIOXIDANTS FROM MARINE SOURCE

Marine ecosystem has been reported as a potential source of biodiversity and chemical activities. The organisms living in marine environment are gaining the attention of industries such as pharmaceuticals, nutraceuticals, and cosmetics because of possessing various interesting and useful chemical compounds. Marine biotechnologists are trying to produce the tool for the utilization of marine biodiversity for the production of cheap source of pharmaceutical products and functional foods. Seaweeds and sponges are considered as the richest source of bioactive compounds having the antimicrobial and antioxidant activities. Seaweeds and sponges with their associated bacteria have been found to possess various health-promoting and disease prevention effects due to their phenolic compounds, polysaccharides, and useful organic acids. These are supposed to be the most protective group of foods against environmental pollutants and radiation. Among various other useful compounds, the marine organisms also contain polyphenolic compounds that are responsible for antioxidant activity including flavonoids, benzoic acid, cinnamic acid, gallic acid, quercetin, and phlorotannins. Non-animal sulfated polysaccharides are reported to have antioxidant activities, which can be obtained from marine algae and other marine organisms from the phaeophyta group.

A large number of different species of algae and microalgae have been studied for the use of their bioactive contents as functional food components. Algae comprised of a huge and complex group of photosynthetic organisms with simple reproductive organs, which can be multicellular, known as macroalgae and unicellular called as microalgae. Algae grow in extremes of environmental conditions such as light, temperature, and salinity, which results in the production of a large number of reactive oxygen species (ROS). To cope with these ROS, algae produce various secondary metabolites with many antioxidant activities such as phycobilins, polyphenols, carotenoids, and vitamins.

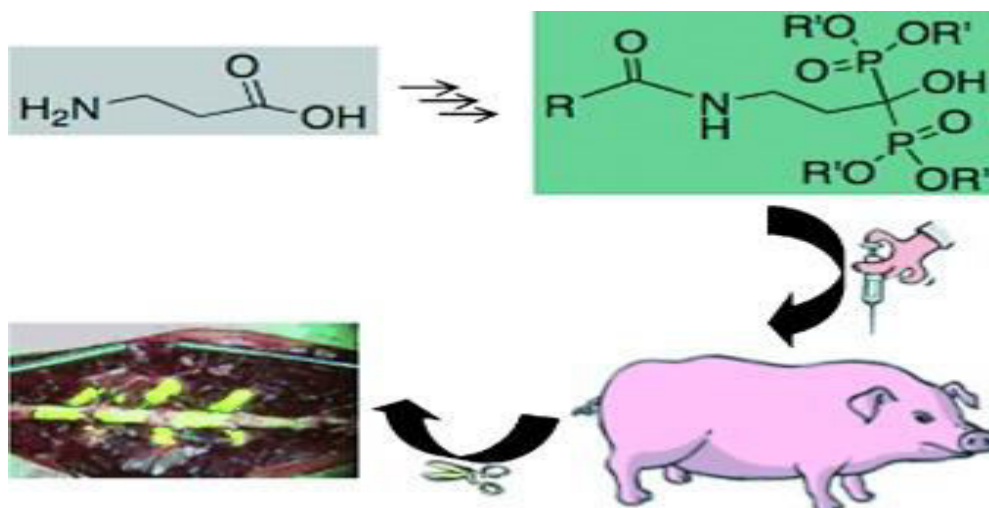
People living in coastal areas use many types of seaweed, both as fresh and dry forms, as a natural source of food, and from the research, it is known that these seaweeds contain a large amount of proteins, minerals, and vitamins. Although the composition of these seaweeds varies according to their species, geographical distribution, temperature, and seasonal variation, the overall nutritional value remains the same. Many compounds from marine algae possess anticancer activity, and recently, seaweeds have gained attention as a rich source of antioxidants. Many of these secondary metabolites produced by marine organisms resist the presence of chloride and bromide ions in seawater. Marine halogenated compounds assemble a large number of other useful compounds such as indoles, peptides, terpenes, phenols, acetogenins, and volatile halogenated hydrocarbons. This protective effect suggests the presence of antioxidant compounds that show their antioxidant activity as free radical scavengers, hydrogen-donating compounds, single oxygen quenchers, and metal ion chelators. Many biological compounds have previously isolated from some other marine organisms such as fish, crustaceans, and their byproducts. Seaweeds also create a suitable environment to a large number of bacteria that live on their surface having much more diversity of microorganisms as compared to other multicellular organisms. These associated microorganisms have a protective effect on the seaweeds from pathogen, and they produce a large number of bioactive compounds of biomedical importance. Exopolysaccharides produced by these bacterial species are used as an ingredient in food, petroleum, and pharmaceutical industries and emulsification of crude oil, vegetables, mineral oils, and bioremediation agents in environment management systems. Fish protein hydrolysate (FPH), which is prepared from various marine organisms such as mackerel, tuna, Alaska Pollock, and yellowfin sole, has also been reported to have antioxidant activity. Many types of peptides are obtained from fish muscle, bone, skin, and other tissues. All of these amino acids can scavenge free radicals, but the most powerful scavenging activity attributes to those who can easily donate hydrogen atoms. These amino acids are cysteine and methionine, which have nucleophilic sulfur-containing side chains or tryptophan, tyrosine, and phenylalanine, which have aromatic side chains. Peptide size and amino acid composition are important for the FPH because it determines its antioxidant nature. An in vitro study on phycocyanin, a pigment obtained from blue-green algae, reveals its antioxidant activity. It was evaluated in vitro by the use of luminol-enhanced chemiluminescence (LCL). Luminol reacts with oxygen (O_2), alkoxyl ($RO\cdot$), and hydroxyl ($OH\cdot$) radicals and shows a luminous signal measurable before and after antioxidant addition. This antioxidant activity was also confirmed in vivo by induction of inflammation in mice paw with glucose oxidase. The edema caused by

inflammation was reduced, and the luminous signal indicated that the phycocyanin can scavenge OH^\cdot and RO^\cdot . Algal antioxidants are also used in the cosmeceutical industries as anti-aging agents. A carotenoid pigment known as astaxanthin, found in microalga *Haematococcus pluvialis*, is reported to have anti-inflammatory, immunomodulatory, and antioxidant activities.



ANTIOXIDANTS IN ANIMALS DERIVED FOODS

Important group of natural antioxidants in animal-derived food products are aminocompounds: amino acids, peptides and proteins. Antioxidant activity of these compounds is connected mainly with amino acids which possess thiol groups (methionine, cysteine). Proteins, acting as antioxidants, scavenging of free radicals formed in biochemical processes of cells [Yamamoto et al. 1998, Decker et al. 2000]. Antioxidant activity of proteins from animal-derived products can be also connected with addition (in food technology) of concentrates and isolates gained from high-protein plants origin (legumes seeds) and animal origin (milk, eggs) raw materials. Isolated soybean proteins, because of their good functional properties, are wide used in meat industry and they can inhibit reaction of lipid oxidation [Ulu 2004]. Huge antioxidant activity have also preparations of albumin and globulin derived from seeds of legumes cultivated in Poland – bean, peas, and broad bean. In several studies, the ability of casein and whey proteins of milk to inhibit autooxidation of lipids was confirmed. Casein inhibits enzymatic, as well as non-enzymatic oxidation of lipids [Yamamoto et al. 1998]. Main non-protein thiol compound of animal tissues is glutathione (GSH). Its basic function in organism is protection of thiol protein groups from oxidation. Reduced form of glutathione is a scavenger of RFT. It is worth to add, that glutathione and other reduced thiol compounds can regenerate oxidized α -tocopherol radical to vitamin E [Decker et al. 2000]. In lipid tissue of animal organisms, the compounds that show the activity of vitamin E (tocopherols and tocotrienols), carotenes and xanthophylls and ubiquinone (coenzyme Q) are present. Tocopherols, among which α -tocopherol is dominant compound, are located mainly in 2-layer phospholipid structure of cellular membranes, and decide (with cholesterol) about their integrity. They possess ability to scavenge of radicals such as hydroxyl, alcoxyl, peroxy as well as hydroperoxide anion radical, and ability to quench of singlet oxygen. Animals and humans can not synthesise carotenoids, but have only the ability to metabolise them; classic example is reaction of carotene conversion to retinol (vitamin A). In animal organism, carotenoids are located mainly in the liver, they are also present in lipid tissue and blood lipoproteins (LDL and HDL) [Surai 2003].



Conclusion

An increasing interest has been observed from the past decade in exploring the natural ingredients to be used in the food and food products. The researchers from all over the world are focusing on the alternate sources other than the synthetic one, which will be more safe and convenient as dietary component. Although there are no such harmful reports have been observed regarding the use of synthetic antioxidants however the consumer's interest is also compelling toward the nature close products. Moreover, the synthetic antioxidants and preservatives in the food may lead to lipid peroxidation and deterioration of food flavor and quality. The use of natural herbs, spices, and plant ingredients is in practice from the ancient times and still practiced in the traditional food preparation as preservative, aroma, and flavor. This chapter is an effort to overview the potentials of various natural sources having reasonable

antioxidant potential. The literature reports compiled here will be beneficial to identify the significance of various natural sources based on their antioxidant capacity, active ingredients, and geographic availability. This chapter reveals that people can prioritize their dietary habits based on the antioxidant potential and cost-effectiveness of the available source because 70–80% of the world population cannot afford the modern supplement and medicines. As it mentioned antioxidant can be considered as a healthy compounds and you can find it in two form of natural and synthetic. Surveys show that the natural antioxidants are safer and have better effects on human. In this article, we talked about some common sources of natural antioxidants (Fruit and vegetables, cereals, legumes, nuts and oilseeds) and show you the antioxidant impact of these sources. Also the kind of antioxidant compound and its classification was mentioned. It can be concluded that using these compounds and products positively influence our health and we should use them in our diet.

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