Chapter

Antioxidant Effective Aromatic Compounds

Hulya Celik and Kader İlhan

Abstract

Systems that destroy the effects of free radicals are called antioxidants. Today, reliability concerns on synthetic antioxidants are increasing. Therefore, the interest of the health and food industry in aromatic plants and natural antioxidants obtained from these plants has also increased. Aromatic plants have been used in many fields, such as food, medicine, cosmetics, and spices since the beginning of human history. Interest in plants, which are natural sources of antioxidants, has increased in recent years. Due to this interest, studies on the use of aromatic plants as natural antioxidant sources continue to increase day by day. As a result of research on this subject, it has been shown that aromatic plants contain many phytochemical compounds with high antioxidant activity. Among these compounds, especially phenols stand out as a secondary metabolite group and play an important role in the total antioxidant activity of medicinal plants. In fact, studies have shown that there is a positive relationship between the total phenol content of medicinal plants and aromatic plants and their antioxidant capacity. Phenolic compounds are obtained from plants and contain one or more hydroxyl groups in their aromatic rings. These biologically active components in herbal essential oils have been used as therapeutic agents, as they are natural sources of antioxidants, inactivate free radicals, reduce oxidative stress, and have been implicated in the pharmaceutical, cosmetic, and food research fields. Thymoquinone is the main active ingredient of Nigella sativa L. It has been used in the treatment of various animal and human diseases for hundreds of years in world history. Thymol and carvacrol are the main components of known thyme, and its derivatives and are widely used in pharmacology. In this review, the antioxidant activities of some aromatic plants, whose importance is increasing day by day, and thymoquinone, thymol, and carvacrol phenolic compounds that can be used instead of synthetic antioxidants in the food industry are mentioned.

Keywords: aromatic compounds, antioxidant, biologically active, pharmacology

1. Introduction

The development of science and technology, environmental pollution, and many other factors have exposed us to various toxic substances. The number of human

diseases caused by these toxic substances is increasing day by day. These diseases can be solved by controlling free radicals. Free radicals are the main factor provoking the occurrence of these diseases.

Many systemic diseases can occur in our fully functioning bodies throughout our lives due to the proliferation of free radicals after a certain age. As we get older, our defense mechanism weakens and the body's free radical balance is disturbed. Therefore, it is important to consume natural foods that contain antioxidants to restore balance. Some compounds in plants have the effect of delaying the onset of this process. These compounds, which have been studied for a long time, are called antioxidants [1].

Antioxidants are compounds that protect cells from the harmful effects of free radicals. Recently, in the field of medicine, new methods to treat diseases are being investigated, while efforts are made to maintain a healthy life and prevent diseases. One of the most important issues, in this case, is natural antioxidants [2].

The number of studies investigating the use of herbs and spices as natural sources of antioxidants is increasing. The pharmacological properties of vegetable essential oils and their components have been examined and their use in the medical, cosmetic, and industrial fields has been shown to be beneficial. The use of natural antioxidant substances obtained from vegetable materials in place of synthetic antioxidants and preservatives has created an intense interest in natural antioxidants.

First, spices are used in the treatment of diseases, in other words, aromatic plants are as old as human history. After a while, it began to be used in religious ceremonies and in the production of fragrance agents. Protecting food; the field of use has improved with flavoring and other uses [3].

The protective effects of many spices with antioxidant effects in foodstuffs were looked at and compared with other antioxidant properties. The antioxidant effect is determined by the values of peroxide and is especially measured at certain time intervals. Members of the Labiatae family, such as rosemary, sage, thyme, and mint, have been compared with spices with other synthetic antioxidants and their antioxidant effects have been found to be higher.

The most important groups of natural antioxidants are phenolic substances. These substances, which are seen in all parts of plants, are polyphenolic components, the most common among vegetable phenolic antioxidants: Favonoites, cinnamic acid derivatives, coxins, tocopherols, and phenolic acids. They are known to protect substances found in nutrients that can be easily oxidized from oxidation. Aromatic plants, which have long been used as additives to increase the properties of nutrients, such as smell and taste, are therefore becoming increasingly important. In this review, information will be given about natural antioxidants and some aromatic plants that are considered one of the largest sources of antioxidants.

Although oxygen is indispensable for human life, some types of reactive oxygen produced during normal metabolism have the potential to cause intense damage to the body. Atoms or molecules that hold an uncommon electron are called free radicals. In response to the harms of reactive oxygen species, different natural defense systems in the body control free radicals. Antioxidants prevent oxidation caused by free radicals and are also capable of capturing and stabilizing free radicals. Antioxidants delay aging, they achieve this by binding free radicals to themselves or neutralizing them, minimizing possible damage to the body. The most commonly used antioxidants on your day include beta-carotene, vitamins C, E, lycopene, coenzyme Q-10, selenium, zinc, and manganese, as well as organic and inorganic substances [4].

2. Classification of antioxidants

Antioxidants help the body's defense mechanism against the negative effects of free radicals, so today it has gained great importance in terms of health.

In this respect, when we consider the classification of antioxidants both in terms of health and food, we can collect them under two headings. **Table 1** given in the first is natural antioxidants and the second is synthetic antioxidants [5].

Antioxidants			
Natural Antioxidants			Sentetic Antioxidants
Enzymatic	Non-Enzymatic		BHT, BHA
SOD	Endojen	Eksojen	Troloks
Gutatyon peroksidaz	Glutatyon	Vitamin E	Askorbil palmiat
Glutathione reductase	Serüloplazmin	Beta-karoten	Propil Gallat
Glutatyon-S-transferaz	Bilirubin	Ascorbic acid	Tersiyel Bütil
	Albumin	Flavanoidler	Hidrokinon

Table 1.
Classification of antioxidants.

2.1 Mechanism of action of antioxidants

According to the chain reaction theory, the substance (lipid molecule) activated by energy absorption is oxidized by combining with oxygen, and the activated peroxide molecules formed in this way continue autooxidation by transferring their energy to other oxidizable molecules of the substance. With the use of antioxidants, activation energy is used by the antioxidant molecule, it is not able to transfer this energy to other molecules. With the intervention of the antioxidant molecule, many molecules of the substance, which can be autoxidized, are no longer oxidized, that is, oxidation is slowed down and partially stopped.

$$R\bullet + AH \rightarrow RH + A\bullet$$
$$RO\bullet + AH \rightarrow ROH + A\bullet$$
$$OH\bullet + AH \rightarrow H2O + A\bullet$$
$$ROO\bullet + AH \rightarrow ROOH + A\bullet$$
$$A\bullet + The \rightarrow AO$$

The active molecule of the antioxidant does not transfer its energy to fat molecules, it is usually oxidized to inactive molecules (AH: Antioxidant molecule, A•: Active antioxidant molecule, AO: Inactive antioxidant molecule).

Antioxidants to be used in foods should have some properties. Some of them include:

- It must be harmless to human health,
- It should be used in very small quantities so that it does not increase the cost,

- The natural smell, appearance, and taste of food should not be disturbed,
- It must dissolve in the substance, it will protect or mix thoroughly,
- It should not lose its effect during normal production [6].

2.2 Aromatic compounds

Plants that have smell and taste properties and are also used as medicines due to their therapeutic properties are called aromatic plants. Plants and essential oils have been used to obtain aromatic foods and beverages since the beginning of human history. Their use in hiding smells, attracting the attention of others, controlling health problems, and providing welfare to people and animals shows a cultural and economic status. Essential oils are usually liquid, transparent, multicolored, and complex. The existing compounds they contain are volatile. These compounds are characterized by a strong odor and are secondarily synthesized to protect plants from microbes and insects [7].

2.3 Antioxidant activities of aromatic plants

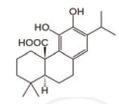
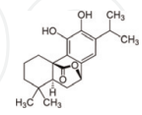
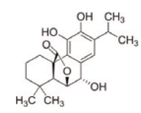
The antioxidant activity of aromatic plants is related to the phenolic compounds in their structure. The most abundant of these compounds are flavonoids, phenolic acids, and phenolic terpenes. The antioxidant effect of phenolic compounds is due to such reasons as clearing free radicals, forming compounds with metal ions (metal chelation), and preventing or reducing singlet oxygen formation.

The compounds can provide the hydrogen contained in hydroxyl groups in their aromatic rings to prevent lipids and other biological molecules from being oxidized by free radicals. Flavonoids and other phenolic compounds are found mainly in the leaves, flowers, and woody parts of plants. For this reason, aromatic plants are often used as medicines by drying the leaf and flower parts or as essential oil extracts obtained by methods, such as extraction and distillation. Since the chemical compositions of aromatic plants vary depending on many factors, their antioxidant effects will also vary. Akgül and Ayar examined the antioxidant effects of 31 aromatic plants grown in sunflower oil in Turkey and determined that rosemary followed by rosemary and bone to the strongest antioxidant [8].

2.3.1 Rosemary

Rosemary is a valuable essential oil and spice plant from the Lamiaceae family. Important chemical components in rosemary include carnisol, rosmanol, geraniol, pinene, limonene, apigenin, naringenin, luteolin, rosmarinic, vanilic, caffeic acid. Thanks to the polyphenolic components found in rosemary and cyclic diterpene diphenols, carnosolic acid, carnosol, epirustol, rosmanol, iszorosmanol, rosmarinic acid, and hisperidine, antioxidant activity is high. It is used in foods as an antioxidant or natural preservative. Carnosic acid can be used in the treatment of Alzheimer's disease because it protects the brain against free radicals. Rosemary, which is also consumed as a spice, is also known to have a protective effect against diseases. High antioxidant capacity from rosmarinik acid and carnosol is obtained in many ways by civilized dust extract and these powder extracts are used in foods. Essential oils obtained from this plant are used to prevent oxidation caused by fat and protein

degradation in meat and meat products. It is stated that carnasol and carnocyclic acid in particular have higher antioxidant activity than BHA, BHT, and propyl galat, which are used as synthetic antioxidants in membrane lipid peroxidation [9].

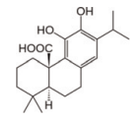
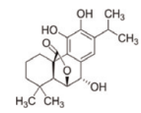
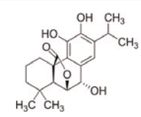
Polyphenolic compounds	**Chemical structure**
Carnosic acid	
Karnosol	
Rosmanol	

2.3.2 Salvia officinalis *L.*

Sage is another aromatic plant that has a significant antioxidant effect. The most important phenolic compounds in its structure, such as rosemary, are carnosol, carnosic acid, rosemary aldehyde, rosmarinol, epirosmarinol, and methyl carnosine [11].

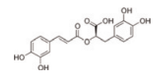
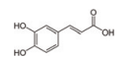
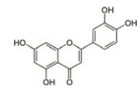
Sage contains many polyphenol compounds, including phenolic acids and flavonoids. Some of these are caffeic acid and its derivatives, rosmarinic acid, salvianolic acid, luteolin, apigenin, kaempferol, and quercetin. At the same time, sage is a rich essential oil plant, mostly terpenoids. Its antioxidant activity is very high due to the α-thujon, 1,8-cineole, and camphor components in sage essential oil. Medicinal sage is more important than other types of sage due to its high antioxidant activity.

Its high antioxidant activity is mainly due to its structure, which includes sage kumarin, rosmarinic acid, salvianolic acid, and carnocyclic acid. In another study, the components found to have a high antioxidant effect were carnosol, rosmarinic acid, carnocyclic acid, caféic acid, and rosmarinol. These components are reportedly effective in free radical sweeping action and superoxide dysmutase sweeping action. Research has shown that it is also good for forgetfulness and Alzheimer's disease, especially due to its high antioxidant activity. Studies have shown that it has a high-cleansing effect on free radicals and a high effect on DDPH [10, 11].

Phenolic compounds	**Chemical structure**
Carnosic acid	
Karnosol	
Rosmanol	

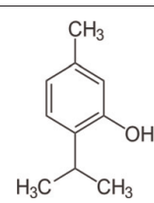
2.3.3 Melissa officinalis *L.*

Son grass (M. officinalis) is a plant belonging to the genus Honeybabagiller, which grows naturally in Turkey. It is a valuable essential oil plant and its leaves are used. The most important components of Calendula essential oil are nerolal (cytral), cytronelal, cytronelol, nerol acetate, isogeraniol, and geranyl acetate. Sage also contains phenolic substances, such as rosmarinic acid, cafleic acid, gallic acid, ramnosid, luteolin, which provide antioxidant properties. Since ancient times, it has been widely used as a sedative, diuretic, diastolic, and analgesic in diseases of the digestive system of people. The antioxidant activity of elderberry flower is related to the cytonellal and nervous components and phenolic components in the essential oil. Some research have used it as an antioxidant, especially as a preservative for high-fat foods. Also due to its high antioxidant capacity, son grass is added to foods with a high-fat content as a protective agent against the oxidation of polyunsaturated fats [12].

Phenolic compounds	**Chemical structure**
Rosmarinic acid	
Caffeic acid	
Luteolin	

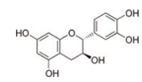
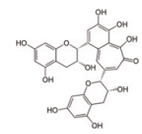
2.3.4 Thyme

Thyme is a valuable essential oil and spice plant from the Lamiaceae family. Especially in essential oils, essential oils containing carvakrol/thymol components are more valuable. The main component of thyme type thyme essential oil is thymol. Especially in Turkey, plants belonging to the genus Origanum are collected and oregano belonging to the genus Origanum is called coral reef. The main component of thyme essential oil is carvakrol. There are also flavonoids hydroxycinnamic acid, hydroxybenzoic acid, rosmarinic acid, apigenin, and luteolin. The antioxidant activity of oregano is mainly due to its essential oils. It is mainly used as an antioxidant to prevent food from spoiling. In terms of human health, herbal tea or essential oil is used for upper throat infections, stomach problems, and antibacterial and antifungal purposes [13].

Essential oil	**Chemical structure**
Karvakrol	
Timol	

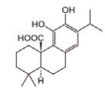
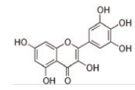
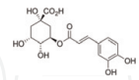
*2.3.5 Green tea (*Camellia sinensis*)*

Green tea is an uncontested type of tea. It is a good source of antioxidants due to the vitamin E in green tea. The highest polyphenols in green tea are catechins and theaflavins. Green tea is rich in flavonoids, including catechins and catechins derivatives. The main catechins in green tea are epigallocatechin gallate (EGCG), epigallocatechin (EGC) and epigallocatechin (EGC), catechins (EC), and epicatechin gallate (ECG). The highest antioxidant effect among catechins. The main flavonols found in green tea are quercetin, kaempferol, myricetin, and rutin. Green tea polyphenols are powerful antioxidants that combine active oxygen and nitrogen substances and indirectly show antioxidant activity by triggering the synthesis of intracellar (endogenous) antioxidant enzymes, such as superoxide dysmutase and glutathione dystase, glutathione-s-reductase, catalase, and kinon reductase. Thanks to these effects, green tea can prevent lipid peroxidation and damage to DNA structure. According to reports, the epigallocatechin gallate in green tea may have a protective effect on neuronal diseases, such as Alzheimer's and Parkinson's by regulating free radical clearing, iron-binding activity, and antioxidant enzymes [14].

Polyphenols	**Chemical structure**
Kateşin	
Theaflavin	

*2.3.6 Likapa (*Vaccinium sp.*)*

Likapa, also known as blueberries, belongs to the family Fundagiller and belongs to the genus blueberries. It is found naturally in my country but is not planted. In our country, blueberries, ligarba, blueberries, morsivit, bush strawberries, and trabzonspor tea are called blueberries in foreign countries. There are four different varieties of natural blueberries in our country, and breeding research is underway well-known species are *Vaccinium myrtillus L.* and *Vaccinium arctostaphylos L*. The parts used are leaves, flowers, and fruits. Phenolic compounds, such as lycapa, chlorogenic acid, kersetin, kaempferol, myrisetin, proantocyanidines, catechins, epicatechin, resveratrol, and anthocyanins have a strong antioxidant capacity as they are a good source of organic acid, tannins, and vitamin C. The fruit does not contain sodium but contains a high percentage of potassium, phosphorus, and calcium. It is a fruit with high nutritional value and strong antioxidant potential, as it contains a high content of anthocyanins, flavonoids, and polyphenol compounds. It has more antioxidant effects than other fruits. In recent years, it has been reported that the consumption of likapa has gradually increased to reduce pathologies associated with oxidative stress [15].

Phenolic compounds	Chemical structure
Kuersetin	
Mirisetin	
Chlorogenic acid	

3. Conclusion

In this study, it was determined that substances and plants containing aromatic structures exhibit high antioxidant activity. Research has shown that there is a positive relationship between the phenol content of medicinal and aromatic plants and their antioxidant capacity. Phenolic compounds are obtained from plants and contain aromatic rings and hydroxyl groups. In this review, information was given about the antioxidant activities and general properties of some aromatic plants, which are becoming increasingly important.

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