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Promising Sources of Antioxidants from Herbs and Spices: A Review

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Abstract: *Herbs and spices are rich sources of potent antioxidants. For over 2000 years, herbs and spices are used in every kind of treatment in TIM (Traditional Indian Medicine) and TCM (Traditional Chinese Medicine), as flavoring, coloring, and fragrance agents. Herbs and spices have various kinds of bioactive constituents which are potential and promising sources of antioxidants. The herb's and spice's history is as old and long as the history of mankind. The antioxidants in herbs and spices are very much effective because they have excellent antioxidant activity. In recent times it is an increase in the interest for the recognition, identification of antioxidants compounds that are well-potentiate and have nominal or very much fewer side effects. This interest in growing and it is under various projects at a global level. This study provides some details on the most popular and most widely used herbs and spices and explains their antioxidant properties. Therefore, using herbs and spices is a safer option than using synthetic antioxidants, which have become prevalent and broadly acceptable by consumers.*

Keywords: Herbs, Spices, antioxidants, promising sources, treatment, constituents

I. INTRODUCTION

Herbs and spices have a parallel history with the history of mankind. People have been using these plants for medicinal purposes since the beginning of time, and herbal knowledge has been passed on for thousands of years. In various parts of the world, there has been a growing interest in the study of traditional plants and their medicinal importance over the last few decades. Plants have been studied for their medicinal properties due to their potent pharmacological activities, low toxicity, and economic viability [1]. Because of the worldwide movement toward using natural ingredients in food and cosmetics, natural antioxidants present in plants are growing in interest. From a protection standpoint, herbs and spices are one of the most effective targets for natural antioxidants [2].This renewed interest in plant-based medicines is largely due to a general perception that green medicine is safer and more dependable than expensive synthetic drugs, many of which can have adverse side effects [3]. This breakthrough could lead to the invention of novel drugs or the advancement of the use of traditional herbal medicines. Many plant spices and herbs have a preservative effect, implying the existence of antioxidative bioactive constituents in their tissues. There is an inverse association between antioxidative status and the prevalence of human diseases like cancer, neurodegenerative disease, aging, and atherosclerosis, according to research [4].Plants produce a substantial amount of antioxidants to protect themselves against the oxidative stress induced by photons and oxygen, so they represent a potent source of the novel compound with antioxidant activity.

ROS (reactive oxygen species) and free radicals are charged molecules that are actively formed by the human body as a result of both enzymatic and non-enzymatic reactions. Oxidative stress is caused by the aggregation of reactive oxygen species (ROS) and free radicals, and it is the pathophysiology of many common human disorders such as atherosclerosis, hypertension, asthma, Alzheimer's disease, and Parkinson's disease. Antioxidants, also known as "free radical scavengers," are compounds that inhibit the action of free radicals and neutralize them, preventing them from causing harm. Hence stability between the ratio of antioxidants and free radicals is necessary for the proper metabolic function [5].Oxidative stress may be caused by a slight change in equilibrium. In recent years, there has been a growing

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concern about the role of natural and synthetic antioxidants for therapeutic uses. They're commonly used in dietary supplements, and their function in the prevention of diseases like cancer, coronary heart disease, aging, and altitude sickness has been studied. Different nutrients that function as antioxidants for cardio defensive action include flavonoids, ascorbic acid, phenolic acids, cysteine, α-tocopherol, anthocyanins, and glutathione [6].Several studies have focused on natural antioxidant sources and their use in food systems to treat a variety of human diseases. BHA (butylated hydroxyanisole) and BHT (butylated hydroxytoluene) are the most commonly used supplemental artificial antioxidants in the diet. They are effective antioxidants, but their effectiveness is steadily compromised due to their volatility and possible carcinogenic activity. To solve this issue, researchers are increasingly looking at natural safe (nontoxic) additives as possible antioxidants [7].

II. ANTIOXIDATIVE COMPOUNDS

The antioxidant activity of herbs and spices is most often due to phenolic acids (gallic, caffeic, protocatechuic, and rosmarinic acids) phenolic diterpenes (carnosol, rosmanol, carnosic acid, and rosmadial), flavonoids (quercetin, kaempferol, catechin, gallate,epicatechin, naringenin, epigallocatechin gallate, and rutin), volatile oils (menthol, eugenol, thymol, carvacrol, safrole, p-cymene, 1,8-cineole, α-terpineol, myristicin, cinnamaldehyde, and piperine) and phenylpropanoids (thymol, carvacrol, eugenol, p-cymene) [8][9]. Some plant pigments (anthocyanin and anthocyanidin) also have an antioxidative activity. Coumarin (warfarins, coriandrin, andsuksdorfin) and alkaloids (colchincine, piperin, hydrastin, and berberin) also give the antioxidative effect [10].

III. CLASSIFICATION OF ANTIOXIDANTS

Antioxidants are naturally occurring or synthetic chemicals that prevent or postpone the initiation of oxidation [11]. Natural antioxidants are in higher demand as a result of safety issues over synthetic antioxidants, as well as a growing market desire for natural ingredients, clean labels, and less use of food additives in food products. Spices and herbs are excellent sources of antioxidants for food safety due to their inherent antioxidant components. Using natural antioxidants from spices and herbs has added benefits. These include their nutritional effects and the ease with which they can be absorbed by the body.

Spices or natural flavors are also be labeled (i.e., clean labels). Synthetic antioxidants, on the other hand, have the potential to cause side effects in humans and do not have additional health benefits. Table 1 depicts the various antioxidant groups, as well as descriptions of each and how they work to prevent lipid oxidation.

Table 1: Different classes of antioxidants

No.	Class of Antioxidants	Function	Examples
1.	Free Radicals Scavengers	Block free radicals by donating a hydrogen atom	Extracts from spices and herbs (rosemary, clove, sage, oregano), BHA(Butylated hydroxyanisole), TBHQ (tert Butylhydroquinone), BHT (Butylated hydroxytoluene), Propyl gallate, Tocopherols
2.	Oxygen Scavenger	React with oxygen	Ascorbic palmitate, Ascorbic acid, Sulphites, Ascorbates, bisulfate, Erythorbic acid,
3.	Chelating agents	Sequester chelate metal ions capable of catalyzing the oxidation	Phosphates, EDTA (Ethylenediaminetetraacetic acid), Citric acid

3.1 Antioxidants from Spices and Herbs

When fats and oils, as well as lipid-containing foods, oxidize, oxidative rancidity grows. This chemical reaction is responsible for the production of off-odors and off-flavors in many foods that makes them rancid, marked by sharp, offensive odors and tastes. These foods may be unhealthy for consumption. Peroxides and hydroperoxides are formed

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when fat or oil in foods reacts with atmospheric oxygen, and carbonyl compounds are produced as secondary oxidation products.

These oxidative rancidity reaction products (alcohols, acids, aldehydes, and ketones) impart the harsh flavors and odors that make foods inedible and cause consumers to avoid them. Several experiments have shown that spices and herbs likesage, rosemary, and oregano have a strong antioxidant function. Caffeic acid, kaempferol, other flavonoids, volatile and essential oils, and coumarins were known as representative components of cumin phenolics [12]. The antioxidant compounds present in spices and herbs are enlisted in Table 2.

Table 2: Antioxidant compounds in spices and herbs

No	Name of Spices/herb	Bioactive constituents	References
1.	Rosemarinus officinalis (Rosemary)	Rosmanol, Rosemarinic Acid, Carnosol, Carnosic acid	[13]
2.	Salvia officinalis(Sage)	Rosmarinic Acid, Rosmanol, Carnosic Acid, Carnosol	[14][15]
3.	Origanum vulgare(Oregano)	Derivatives of Tocopherols, Flavonoids, Phenolic acids	[15]
4.	Thymus vulgaris(Thyme)	Flavonoids, biphehyls, p-cunene-2,3-diol,Carvacrol,Thymol	[16]
5.	Zingiber officinale(Ginger)	Diarylheptanoids, Ginger-related compounds	[17]
6.	Curcuma domestica(Turmeric)	Curcumins	[18]
7.	Satureja hortensis(Summer savory)	Thymbol, Carvacrol, Carnosol, Rosemarinic acid	[16]
8.	Piper nigrum(Black pepper)	Flavonoids,Phenolic amides	[19]
9.	Capsium annum(Red pepper)	Capsaicin	[20]
10.	Capsicum frutescence(Chilli pepper)	Capsaicin, capsaicinol	[21]
11.	Eugenia caryphyllata(Clove)	Gallates, Eugenol	[22]
12.	Marjorana hortensis(Marjoram)	Flavonoids	[23]
13.	Melissa officinalis(Common balm)	Flavonoids	[16]
14.	Glycyrrhiza glabra (Licorice)	Licorice phenolics, Flavonoids	[12]

3.2 Mechanism of Action (Lipid Oxidation)

Lipid oxidation can be divided into three stages: initiation, propagation, and termination (Figure 1). The rancid aroma and off-flavors in foods were caused by hydroperoxides and secondary oxidation products (acids, alcohol, aldehydes, ketones, and so on) [24]. The presence of oxygen and metal ions, humidity, and light are all factors that catalyze lipid oxidation. Oxygen and metal catalysts must be eliminated or sequestered to make them unreactive to avoid, reduce, or slow down the rate of lipid oxidation. Food that is vulnerable to oxidation must be kept at low temperatures and/or kept out of direct sunlight. Antioxidants work by acting at various levels of lipid oxidation, such as initiation, propagation, and termination, to inhibit oxidation [25].

Phenolic compounds are bioactive constituents found in herbs and spices that serve as radical scavengers and metal chelators, respectively. As a result, these compounds have been regarded as promising agents for lipid oxidation protection. One of the quickest ways to reduce fat oxidation is to have the presence of an antioxidant [26]. Mostly antioxidant acts as hydrogen donors to the lipid-free radical formed during the oxidation of lipid and reorganize to a stable conformation [27].

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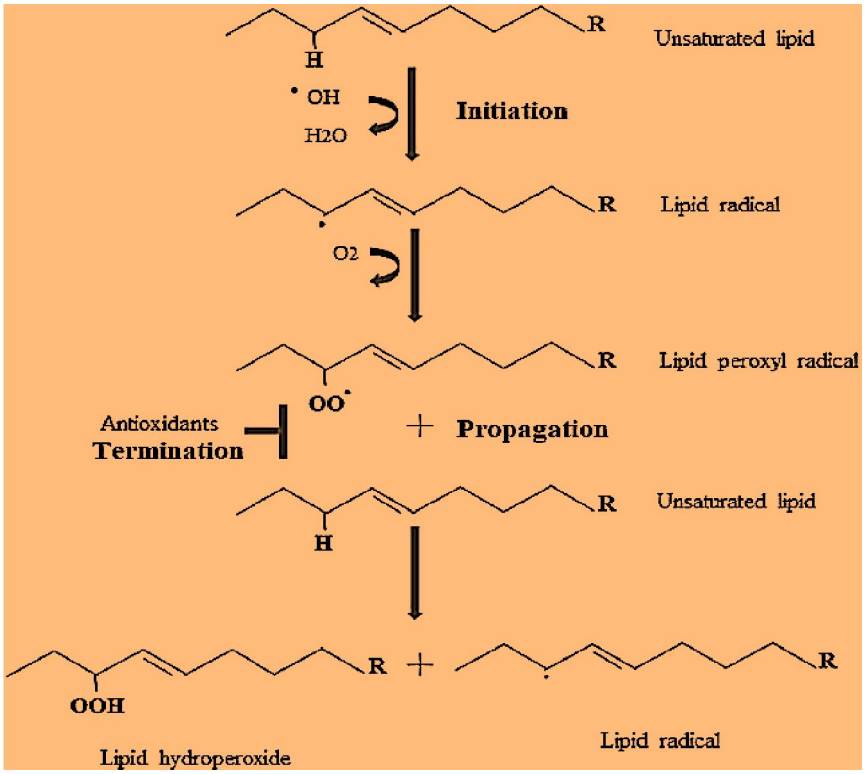

Figure 1: Mechanism of action of Lipid Oxidation

The antioxidant compounds isolated from herbs and spices, as well as their mode of action in inhibiting or slowing the oxidation of fats and oils in foods, are recapitulated in Table 3. The majority of antioxidants present in spices and herbs function by interacting with free radicals formed during the autoxidation initiation period. Others incorporate metal ions to form complexes.

Table 3: Isolated antioxidant compounds from herbs and spices

No	Spices/herb	Plant's part used	Bioactive constituents	Mechanism of Action	Ref
1.	Rosemarinus officinalis (Rosemary)	Leaves	Rosmanol, Rosemarinic Acid, Carnosol, Carnosic acid	Scavenge superoxide radical, lipid antioxidant, and metal chelator	[13] [28]
2.	Salvia officinalis(Sage)	Leaves	Rosmarinic Acid, Rosmanol, Carnosic Acid, Carnosol	Free Radical scavenger	[14] [28]
3.	Origanum vulgare (Oregano)	Leaves	Derivatives of Tocopherols, Flavonoids, Phenolic acids	Free Radical scavenger	[29]
4.	Thymus vulgaris (Thyme)	Leaves	Flavonoids,biphenyls, p-cunene-2,3-diol,Carvacrol,Thymol	Free Radical scavenger	[30]
5.	Zingiber officinale (Ginger)	Roots	Diarylheptanoids,Ginger-related compounds	Free Radical scavenger	[31]
6.	Curcuma	Rhizomes	Curcumins	Free Radical scavenger	[32]

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	domestica (Turmeric)				
7.	Satureja hortensis(Summer savory)	Leaves & Flowering tops	Thymbol, Carvacrol, Carnosol, Rosemarinic acid	-------	[28]
8.	Piper nigrum(Black pepper)	Fruits	Flavonoids, Phenolic amides	Free Radical scavenger	[33]
9.	Capsium annum(Red pepper)	Fruits	Capsaicin	Free Radical scavenger	[33]
10.	Capsicum frutescence(Chili pepper)	Fruits	Capsaicin, capsaicinol	Free Radical scavenger	[33]
11.	Eugenia caryphyllata(Clove)	Flower buds	Gallates, Eugenol	Free Radical scavenger, a metal chelator	[22]
12.	Marjorana hortensis(Marjoram)	Leaves	Flavonoids	Free Radical scavenger	[23]
13.	Melissa officinalis(Common balm)	Leaves	Flavonoids	---------	[16]
14.	Glycyrrhiza glabra (Licorice)	Roots	Licorice phenolics, Flavonoids	----------	[12]

IV. Therapeutic Importance

In vitro studies found that essential oils derived from rosemary, sage, and thyme reduced osteoclast activity and improved bone density [34]. According to Atsumi and Tonosaki, lavender and rosemary essential oils lower cortisol levels and shield the body from oxidative stress [35]. The ethanol extract of rosemary prevented the oxidation of the lipid fraction of minced meatballs during freezer preparation [36].

The antioxidant activities of crude hot water extract of spices (clove, rosemary,thyme, savory, caraway,oregano, basil, cumin, turmeric,coriander, marjoram,fennel, mace) were compared in a sample, and it was discovered that clove, thyme, and rosemary had higher DPPH radical scavenging function. Although marjoram, rosemary, and oregano extracts were found to have higher superoxide radical scavenging activity, turmeric and mace extracts had higher hydroxyl radical scavenging activity. Clove and turmeric had the highest combined phenolic and flavonoid value of these spices [37].

Due to the actions of antioxidative components (catechins, coumarins, terpenes,linalool, and polyphenolic compounds) found in coriander, it has been shown to have gastroprotective activity in cases of gastric mucosal injuries induced by NaCl, ethanol,NaOH, and indomethacin [38].

Based on all reports, it can be concluded that spices have vital medicinal properties and antioxidant function, making them useful for food preservation and reducing peroxidation in biological systems.

V. Conclusion

One of the most significant stimulants for the production of spices and herbal products has been the rise of health consciousness. Since spices and herbs contain a large number of phytochemicals and bioactive ingredients, sources of

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spices and herbal products have gotten a lot of attention. Phytochemicals present in spices and herbs, in particular, have been shown to play an important role in human health and diet due to their wide range of biological activities and health benefits.Many endogenous and exogenous factors cause reactive oxygen species to be formed continuously within our bodies. They have the potential to destroy cellular biomolecules, resulting in a variety of diseases. This is becoming a major concern, and it is critical to discover new ways to protect tissues and organs from oxidative damage caused by free radicals. Many methods have been taken in this direction, with significant results. Natural antioxidants are abundant in traditional spices, herbs, and medicinal plants.Spices and herbs have antioxidant properties that can help to prevent lipid peroxidation. Since many diseases and age-related disorders are connected to oxidative processes in the body, using spices and herbs in one's daily diet may help to lower the risk of disease. Spices and herbs are abundant in several chemical constituents and have good antioxidant properties. Antioxidant activity is not restricted to a particular part or in specific families.Curcumin in rhizomes and monoterpene hydrocarbons can inhibit DNA replication and disrupt DNA bonding, which is thought to prevent the development of cancerous tissues. Many of the herbs and spices mentioned in this study have clinical and medicinal properties and few side effects, but because they are consumed in a consistent quantity as part of a diet, they can have a long-term physiological impact. As a consequence, it is important to standardize the doses that are vital in human treatment.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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