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An overview of spices and herbs as natural antioxidant sources

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Abstract
Antioxidants are abundant in spices and herbs. Over 2000 years have passed since spices and herbs were used for aroma, colour and flavour. In addition to being used to preserve foods and beverages, they have phytochemicals that have been shown to preserve food and beverages. Spices and herbs contain excellent antioxidant activity, which makes them extremely effective antioxidants. As whole spices or ground herbs, extracts, encapsulated products, or emulsions, spices and herbs have been used as antioxidants. Additionally, spices and herbs are all natural, an appealing quality for consumers, along with their effectiveness as antioxidants. Foods can be controlled by adding spices and herbs to reduce lipid oxidation. Spices and herbs will continue to be effective antioxidants in the future, and possible trends are also discussed.

Keywords: Herbal tea, infusions, medicine, phytochemicals, production

1. Introduction
Many different ways have been found to use herbs and spices. Food has been flavoring and improving its organoleptic properties since ancient times with culinary spices and herbs [1-7] Spices and herbs are also used as food additives, as well as preservatives and medicines. Different countries have extensively studied spice and herb properties due to their high antioxidant capacity. As part of our diet, spices and herbs can also provide natural antioxidants. There are many bioactive compounds found in spices, including flavonoids, phenolics, sulfur-containing compounds, tannins, phenolic diterpenes, alkaloids, vitamins, and others [6, 8, 9]. Different antioxidant activities are demonstrated by these compounds. Free radicals are scavenged by flavonoids, while catalytic metal ions can be rendered inactive by their complexes with flavonoids. The phenolic compounds in herbs and spices such as oregano, sage and rosemary provide excellent antioxidant protection.
Oxidative degradation of lipids and oils in food can be prevented by antioxidants. An antioxidant affects rancidity development, retards toxic products of oxidation, maintains nutritional quality, and extends shelf life of food. The use of synthetic antioxidants as food preservatives is limited because of safety concerns. It has become increasingly popular to consume natural antioxidants in the form of spices and herbs.
Oxidative stress can be reduced by natural antioxidants found in spices. Cells and tissues become oxidatively stressed when free radicals accumulate. There are many factors that can contribute to its occurrence, such as smoking, drugs, radiation, alcoholism, physical exertion and psycho-emotional stress. It is reported that chronic oxidative stress causes a number of diseases, including cancer, heart disease, and accelerated aging. There are several biological components that are susceptible to reaction with malondialdehyde and 4-hydroxynonenal, which are products of secondary lipid oxidation. In addition to mutagenesis and cancer, malondialdehyde has been implicated in both enzymatic and non-enzymatic forms of formation. An antioxidant-rich food is spice and culinary herb. It is therefore possible to use spices to ameliorate or prevent certain health conditions.
Spices were analyzed for their bioactive compounds, flavonoids, and total polyphenols to better understand their antioxidant activity. In this article, various spices are described and their therapeutic effects are summarized. A brief description of other spices and herbs applications is provided in this review.

2. Antioxidant Classification: Classification of antioxidants were represented in Table 1.

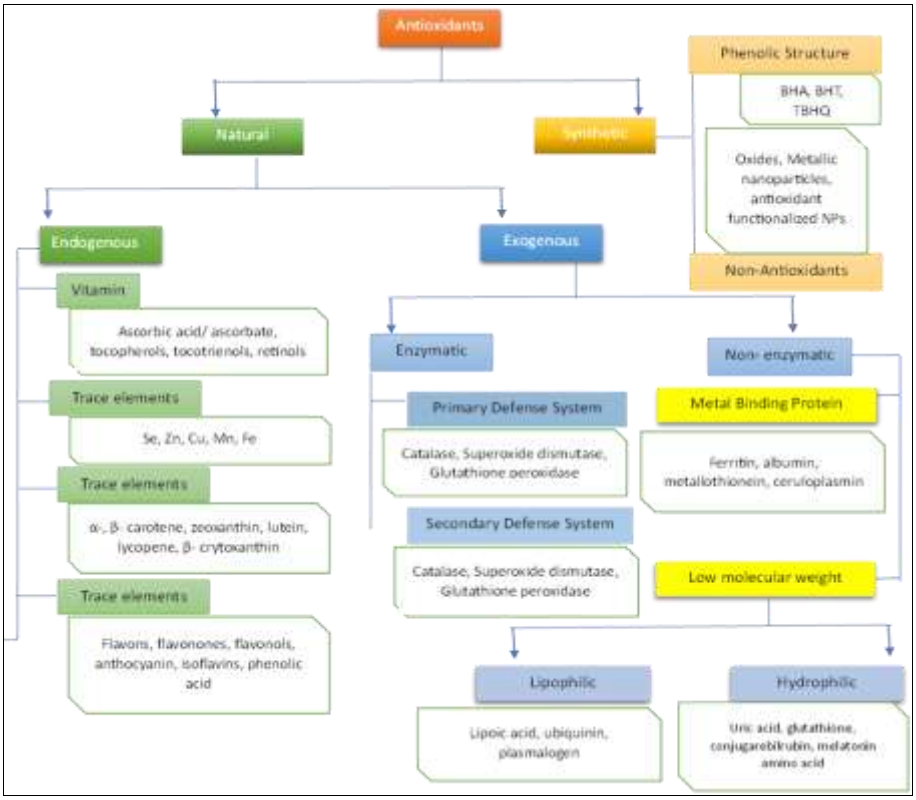

Fig 1: Classification of Antioxidants

3. Spices and herbs: differences and similarities

Herbs are made from leaves of plants, while spices are made from other parts of plants. Depending on the nature of the spice/herb, its flavour/taste, its taxonomy, or where it originates, spices and herbs can be divided into different groups. There are different parts of the plant that produce different spices, as shown in Table 2.

Table 1: Different parts of plant and their spices/herbs

Part of Plant	Spice/ herb	Pictures
Leaves	Basil, oregano, bay leaf, thyme, tarragon	 Basil, oregano, bay leaf, thyme, tarragon
Bark	Cinnamon, cassia	 Cassia, Cinnamon
Seed	Fennel, Fenugreek, Dill mustard	 Dil mustard, Fennel, Fenugreek
Flower/ bud, pistil	Clove, saffron	 Clove, Saffron
Fruits/ berries	Clove, chilli, black paper, all spice	 Black pepper, Allspice, Chilli

Bulbs	Onion, garlic, leek	 Garlic, Onion, Leek
Roots	Ginger, turmeric	 Turmeric, Ginger
Aril	Mace	 Mace

4. The antioxidant properties of spices and herbs

Foods containing lipids or fats undergo oxidative rancidity when they are exposed to oxygen. Many foods develop off-odors and off-flavors due to this chemical reaction, causing their sharp, offensive odours and tastes. There is a possibility that these foods are unfit for consumption. As a secondary oxidation product, carbonyl compounds are produced when fats or oils react with atmospheric oxygen. Consumers reject foods that contain these oxidation products (Aldehydes, acids, ketones, and alcohols) due to their harsh odours and harsh flavours. Researchers have demonstrated that rosemary, sage, oregano, among other herbs and spices, possess high antioxidant activities [10-12]. In addition to caffeic acid and kaempferol, cumin contained volatile and essential oils as well as coumarins [13]. An overview of spice and herb antioxidant compounds can be found in Table 3.

Table 2: Overview of antioxidant compounds of spices and herbs

Spices	Antioxidant compounds
Clove	Phenolic acids (Gallic acid), flavanol glucosides, phenolic volatile oils (Eugenol, acetyl eugenol), tannins
Ginger	Shogoal, gingerol
Mace	Myristphenone
Marjoram	Beta-carotene, beta-sitosterol, caffeic-acid, carvacrol, eugenol, hydroquinone, linalyl-acetate plant 3-17, myrcene, rosmarinic-acid, terpinen-4-ol
Nutmeg	Myristphenone, phenolic volatile oils, phenolic acid (Caffeic acid), flavanols (Catechin)
Oregano	Caffeic acid, p-coumaric acid, rosmarinic acid, caffeoyl derivatives, cavacrol, flavonoids
Red pepper	Beta-carotene fruit, beta-sitosterol plant, caffeic acid campesterol, camphene fruit, capsaicin fruit, capsanthin fruit, chlorogenic-acid fruit, eugenol fruit, gamma-terpinene fruit, hesperidin fruit, myristic acid
Sage	Rosmanol, epirosmanol, phenolic acids (Rosmarinic acid), phenolic diterpenes (Carnosic acid), flavonoids
Sesame seed	Sesaminol, a-tocopherol, sesamol
Turmeric	Curcumin, 4-hydroxycinnamoylmethane
Thyme	Phenolic acids (Gallic acid, caffeic acid, rosmarinic acid), thymol, phenolic diterpenes, flavonoids
Rosemary	Carnosol, 12-0-methylcarnosic, rosmanol, caffeic acid, rosmarinic acid, caffeoyl derivatives, phenolic diterpenes (carnosic acid), carnosol, epirosmanol, flavonoids

5. Determination and Extraction of Antioxidants

5.1. Spices and their antioxidants: extraction techniques

With certain selectivity and sensitivity, extracting active compounds from spices can be accomplished. In addition to solvent-phase extraction, supercritical CO_2 extraction, as well as solid-phase extraction, there are many well-known methods for extracting active components from spices [14].

A spice sample can be extracted more efficiently with different solvents or solvent mixtures. Allwyn Sundar Ray *et al.* [15] have provided a list of solvents used in spice extraction. In addition to ethanol, methanol, acetone, ethyl acetate water, toluene and trichloroacetic acid are used as solvents. A mixture of methanol and water (1:1) and ethanol and water (1:1) are the most commonly used mixture. There was a difference in flavonoids, polyphenols, and tannin concentrations between aqueous and methanolic extracts of cardamon, coriander, and bay leaf [16]. In contrast to methanolic solutions, aqueous solutions contained almost twice the amount of polyphenols. Similarly, cardamon and bay leaf extracts yielded significantly higher polyphenol levels in methanolic extracts. For cardamon, these levels were 2–3 times higher, and for bay leaf, they were 3–10 times higher.

Depending on the extraction temperature, the efficiency of the extraction could be affected. The antioxidant activity of 13 spices has been measured using hot water extraction (80–100 °C) [17]. 3 hours were spent on the extraction. DPPH (diphenyl-1-picrylhydrazyl) was used to measure antioxidant activity. Since such high temperatures may have caused a significant amount of polyphenols to be oxidized, the measurements may not be appropriate. Using different extraction agents (methanol, ethanol, and acetone) at various temperatures (20, 40, and 60 °C), Ereifej *et al.* [18] investigated the effect of these extractants. Three different temperatures were used to determine the degree of total phenolics in cloves. At 60 °C, cloves showed the highest

level of phenolics when ethanol was used as extract ant. When cloves were extracted with acetone at 60 °C, the most total phenolics were found. Using methanol and acetone to extract cloves, the total phenolics were quite similar. Additionally, roasting was observed to influence the antioxidant activity of spices (Clove, cinnamon) [19-21].

5.2. An analysis of the antioxidant capacity of spices using analytical methods

It has been found that spices and herbs have a wide range of antioxidant capacities. There are several methods reported, including ferric-reducing antioxidant power (FRAP), electrochemical and photo chemiluminescent methods, voltametric method, 2, 2-azino-bis (3-ehtyl benzothiazoline-6-sulfonic acid (ABTS) assay, DPPH radical scavenging activity, ORAC and spectrophotometry [22-27]. It was reported recently that a rapid method based on near-infrared spectroscopy could be used to determine the total polyphenol content and antioxidant activity of a Chinese herbal preparation [28]. Fourier Transform Infrared Spectroscopy was used by Lu *et al*. [29] to investigate garlic concentrate's antibacterial effects.

6. Spices and their effects on human health

Many spices are highly effective antiseptics due to their antibacterial, antimicrobial, and antiviral properties. When cloves were used in conjunction with antibiotics, a synergistic effect was observed [30]. Black pepper, garlic, ginger, cloves, Nigella, and black pepper have all been used to treat cancer [31]. Certain cancers may also be treated with aged aqueous-alcoholic extracts of garlic [32].

It has been used for centuries to prevent lipid oxidation and rancidity in food by adding spices to it. According to Dev *et al*. [21], adding clove in roasted form increases the shelf life of cakes. Many foods have been preserved by spices since ancient times. The use of spices has now expanded even further: adding cinnamon to cheese extends its shelf-life; adding various spices to sunflower oil preserves the vitamin E content; various spices prolong the shelf life of meat by inhibiting oxidation of omega-3 fatty acids and sterols in vegetable oils [33, 34].

7. Conclusion

Several studies have shown that spice has high antioxidant activity, which protects people from acute and chronic diseases, in addition to enhancing the color, flavor and aroma of food and drinks. Spices and culinary herbs show a wide range of antioxidant properties in this review. There is already a high level of interest in spices and culinary herbs, and this information will hopefully further fuel that interest. Herbs and spices are certainly valuable ingredients for healthy, nutritious eating, preservatives as well as functional food.

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