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Antioxidants properties of some spices with their chemistry and mechanism of action

Abstract

Herbs and spices are the very best way to add flavor and dimension to a dish without adding fat, salt or calories. In fact, some herbs and spices already include a little something extra, like antioxidants. Antioxidants are substances that slow or prevent the oxidative process in which cells are damaged by free radicals, which can lead to cell dysfunction. These powerful nutrients have been linked to the prevention of heart disease and diabetes, improving immune function and lowering the risk of infection and even some cancers. The bioactive compounds present in spices having antioxidant properties mainly consists of flavonoids, phenolic compounds, sulfur-containing compounds, tannins, alkaloids, phenolic diterpenes, and vitamins. While we hear a lot about the antioxidants found in dark chocolate and red wine, spices like ground cloves, oregano leaves, ginger, cinnamon, turmeric and yellow mustard seed are the real antioxidant stars – delivering a higher concentration of antioxidants per 100g than dark chocolate, wine, even blueberries and whole grain cereal. Plus, they have none of the calories found in chocolate or the drawbacks associated with alcohol consumption.

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Introduction

If we find a common link between oriental traditional medicinal formulations and new age fortified foods, spices seem to be the strongest contender. Spices are flavored, aromatic substances used commonly as condiments and preservatives. Since time immemorial several traditional medicines worldwide have been using a combination of ingredients including spices.[1] The chemical constituents and spices having significant biological properties including antimicrobial, antioxidant, anti-inflammatory, anti-cancerous were well documented in various scientific reports.[2,3] These spices have the potential to be used ass preservatives in many processed due to its antimicrobial and antioxidant properties. In recent years, antioxidant properties of spices are well explored by scientific community due to its natural origin. Antioxidant properties are related to the efficiency of a substance to protect the food substances containing lipids and oils from oxidative deterioration. They controls the rancidity process and retard the formation of toxic oxidation products.[4,5] Due to natural origin of spices and increasing attention towards green consumerism, use of spices as an antioxidant alternative is an emerging research area. For retarding lipid peroxidation, synthetic antioxidants such as butylated hydroxytoluene (BHT) and butylated hydroxyanisole (BHA) have been used widely for many years to retard lipid oxidation, but current concern about the safety of synthetic antioxidants.[6] Oxidative stress is one of the factor in variety of diseases such as cardiovascular disease and also accelerates the aging process. It was found these antioxidant compounds are capable of reducing the oxidative stress. Oxidative stress is caused by high concentration of free radicals in cells and tissues and antioxidant compounds have ability to neutralize these free radicals.

Determination methods of antioxidant capacity in spices

For determining the antioxidant activity, antioxidant efficacy or efficiency of spices and herbs several analytical methods were employed. DPPH (2,2-diphenyl-1-picrylhydrazyl), FRAP (ferric reducing antioxidant power), ORAC (oxygen radical absorbance capacity), total phenolics content, ABTS (2,2 Œ-azino-bis(3-ethylbenzothiazoline- 6-sulphonic acid)), CUPRAC (cupric reducing antioxidant capacity), TRAP (total radical-trapping antioxidant parameter), TEAC (Trolox equivalent antioxidant capacity) are the most frequently used methods.[7] The antioxidant activities and antioxidant capacities of compounds obtained from spices also depends on the analytical methods used. In many cases, solvent extractants and temperature have significant effect on the antioxidant activity of spices.[8,9] Schaich and coworkers have well documented the critical evaluation of various antioxidant assays discussing the concepts and technical limits of assays.[10]

Antioxidant compounds of spices and their mechanism of action

The antioxidant compounds such as flavonoids, polyphenolics, terpenoids, lignans, sulfides, carotenoids, saponins, coumarins, plant sterols, curcumins, and phthalides present in spices are mainly responsible for their antioxidant properties.[11] Table 1 listed the primary antioxidants and the biologically active compounds found in spices and culinary herbs.[12,13] These compounds were largely determined by chromatographic methods. The antioxidant ability of spices are characterized by their ability to prevent free radical formation, remove radicals, repair oxidative damage, eliminate damaged molecules.[14] The most effective antioxidants act via interrupting the free radical chain reactions. These compounds donate H radicals to the free radicals formed during oxidation becoming radicals themselves that are stabilized by the resonance delocalization of the electron within the aromatic ring.[15,16]

The major component responsible for the antioxidant properties of spices are phenolic compounds which are indirectly linked with the efficacy of antioxidant property of spices. More than 425 herbs and spices are investigated for their antioxidant properties by Carlsen and coworkers where Clove has the highest mean antioxidant value, followed by peppermint, allspice, cinnamon, oregano, thyme, sage, rosemary, saffron, and estragon, all dried and ground, with mean values ranging from 44 to 277 mmol/100 g.[17] Many researches were done for investigating the antioxidant potentials which reported the presence of antioxidant properties in predominantly in rosemary, oregano, thyme,

sage, marjoram, basil, coriander and pimento.[18] Eugenol, curcumin, gingerol, carvacrol, thymol, pimento and capsaicin are the major compounds responsible for the antioxidant activity.[3] Figure 1 depicts the chemical structure of antioxidant compounds of some spices.[12] It is not a surprising that spices and herbs are at the top of the list of 100 products with the highest antioxidant content.[19,20] Their antioxidant activities are ten times higher than that of fruit and vegetables. The antioxidant capacities of some spices showed a positive correlation with their corresponding total polyphenol concentrations.[21]

Table 1 List of Antioxidant compounds present in some spices

Spices	Major antioxidant compounds
Clove	Phenolic acids (gallic acid), flavonol glucosides, phenolic volatile oils (eugenol, acetyl eugenol), Tannins
Turmeric	Curcumin, 4-hydroxycinnamoylmethane
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, myristic acidhesperidin fruit,
Rosemary	Carnosol, 12-O-methylcarnosic, rosmanol, caffeic acid, rosmarinic acid, caffeoyl derivatives, phenolic diterpenes (carnosic acid), carnosol, epirosmanol, flavonoids
Sage	Rosmanol, epirosmanol, phenolic acids (rosmarinic acid), phenolic diterpenes (carnosic acid), flavonoids
Thyme	Phenolic acids (gallic acid, caffeic acid, rosmarinic acid), thymol, phenolic diterpenes, flavonoids

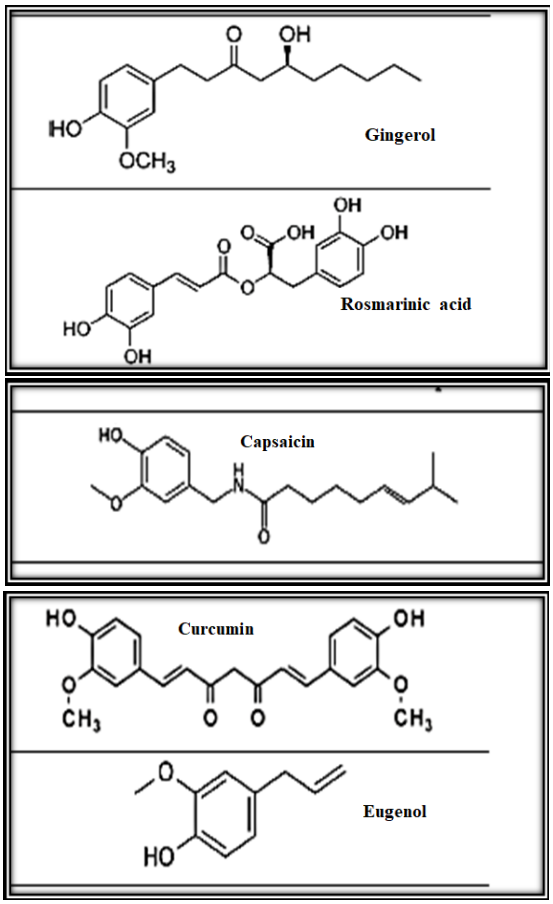

Figure 1 Structure of some Antioxidant constituents present in spices.

Conclusion

There has been well published scientific literature on the antioxidant activities and antioxidant capacities of compounds from spices. Spices as antioxidants will continue to increase as well as research and technology that will develop better ways of growing spices which contain higher amounts of antioxidants. Exploring better ways of isolating active compounds and employment of chemometrics in designing a more effective combination of natural food antioxidants as well as the use of mixture designs to optimize the effectiveness of blended spices or blended antioxidant compounds will continue to increase in the future due to the increasing demand of consumers.

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Conflicts of interest

None.

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