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Spices and herbs: Natural sources of antioxidants – a mini review

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ABSTRACT

Spices and herbs are rich sources of powerful antioxidants. Spices and herbs have been used for flavour, colour and aroma for more than 2000 years. They have also been used for preservation of foods and beverages primarily due to their phytochemicals. The antioxidants in spices and herbs are very effective because they possess excellent antioxidant activity. The spices and herbs have been used as antioxidants as whole or ground spice/herb, extracts, encapsulated or as emulsions. Aside from their efficacy as antioxidants, spices and herbs are classified as all natural, an attractive quality for consumers. Thus, spices and herbs may be used as a means to control lipid oxidation in foods. Furthermore, the future of spices and herbs as effective antioxidants is discussed and expected trends are summarized.

Contents

1. Introduction

Antioxidants are substances that prevent oxidation of other compounds. One of the classic definitions of oxidation is combination of an element or compound with oxygen, hence the term oxidation. It comes from the French word *oxider*. The word *oxide* was coined by Guyton de Morveau and Antoine Lavoisier, both French chemists, from *oxy*gene and ac*ide* in 1787 (Online Etymology Dictionary, © 2010 Douglas Harper). These

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two words were combined to form the word *oxide*. Oxidation and reduction occur side by side and thus the reaction is known as a *redox* reaction. Oxidation therefore means gain of oxygen while reduction is loss of oxygen. The meaning of *oxide* has different meanings depending on the areas of science.

Lipid oxidation is a deleterious chemical reaction that occurs in foods that renders them inedible. This brings about development of rancid flavour and rancid aroma that makes the foods unpalatable and unacceptable. Oxidative rancidity is a major cause of food quality deterioration and product rejection and can lead to the formation of undesirable off-flavours and off-odours as well as harmful compounds (Decker, Elias, & McClements, 2010). In addition to product quality loss due to development of rancid flavour, changes in colour and texture and consumer acceptance, there is also nutritive quality losses due to degradation of essential fatty acids and vitamins. As mentioned above, there are health risks associated with lipid or oil oxidation due to the formation of toxic compounds when fats and oil undergo oxidative degradation. These oxidation products can cause damage in living organisms as well as mutagenesis and carcinogenesis (e.g., lipid peroxide, malondialdehyde or MDA).

To prevent food degradation due to oxidation, employment of antioxidants has become a necessity for food products which are sensitive to this type of chemical change. Phenolic compounds, ascorbic acid, carotenoids, some protein-based compounds, Maillard reaction products, phopholipids and sterols are the natural antioxidants found in foods (Choe & Min, 2009). Thus, food phenolics render antioxidant activity mainly due to their role as reducing agents, hydrogen donors, and singlet oxygen quenchers. Some phenolics also have the ability to chelate metal ions which act as catalysts in oxidation reactions. Flavonoids are natural polyhydroxylated aromatic compounds that are widely distributed in plants (e.g., fruits, vegetables, spices and herbs). Flavonoids have the ability to scavenge free radicals, including hydroxyl, peroxyl and superoxide radicals and can form complexes with catalytic metal ions rendering them inactive. It has also been found that flavonoids can inhibit lipoxygenase and cyclooxygenase enzymes, the enzymes responsible for development of oxidative rancidity in foods. Spices and herbs are excellent sources of antioxidants and have a long history of safe usage. More than 5000 years ago, the ancient Egyptians used spices and herbs in their food, for medicinal purposes and for mummification in which they used a blend of spices such as cumin, cinnamon and onion, among others.

Spices and herbs are rich sources of phytochemicals (Shan, Cai, Sun, & Corke, 2005; Srinivasan, 2014; Surh, 2002; Zheng & Wang, 2001). Phytochemicals are a large group of bioactives derived from plants which have potential protective effects against diseases. This group consists of flavonoids and other phenolic compounds, carotenoids, plant sterols, glucosinolates and other sulphur-containing compounds. There are more than 6000 known flavonoids (Jaganath & Crozier, 2010). Phenolic compounds have various functions in the plant such as structural, defence, as attractants for pollinators and seed-dispersing animals. Plants also produce these substances to protect themselves against UV light for their survival and for adaptation to their environment. Several studies have demonstrated that spices and herbs such as rosemary, sage, oregano with their high content of phenolic compounds serve as strong antioxidants (Cuvelier, Berset, & Richard, 1994; Pizzale, Bortolomeazzi, Vichi, Uberegger, & Conte, 2002; Zheng & Wang, 2001). Principal component and hierarchical cluster analysis were employed to classify different spices based on in vitro antioxidant activity and individual polyphenolic antioxidants compounds (Hossain, Patras, Barry-Ryan, Martin-Diana, & Brunton, 2011). The classification was achieved based on global antioxidant activity assays such as 2,2-diphenyl-1-picrylhydrazyl (DPPH), oxygen radical absorbance capacity (ORAC), ferric reducing antioxidant power (FRAP), microsomal lipid peroxidation (MLP) and 2,2′-azinobis(3-ethylbenzothiazoline-6-sulphonic acid) (ABTS), levels of different polyphenolic compounds (gallic acid, carnosol, carnosic acid, caffeic acid, rosmarinic acid, luteolin-7-*O*-glucoside, apigenin-7-*O*-glucoside) and total phenols. These tests were applied on rosemary, oregano, marjoram, sage, basil, thyme, fennel, celery, cumin and parsley, and rosemary showed the highest antioxidant activity measured by the DPPH assay whereas oregano had the highest activity in terms of the ORAC test. Clove extracts were found to possess antioxidant activity comparable to synthetic antioxidants against DPPH radicals and formation of peroxides (Ivanovic, Dmitrijevic-Brankovic, Misic, Ristic, & Zizovic, 2013). Combining 0.6 and 5% of oregano extract with the clove extracts improved their antioxidant activity (Ivanovic et al., 2013) with respect to the extract from pure clove. This study showed the great potential of supercritical clove extract as a natural functional ingredient and as an antioxidant to reduce undesirable flavour notes especially in combination with oregano extracts (Ivanovic et al., 2013).

2. Classification of antioxidants

Antioxidants are compounds that inhibit or delay onset of oxidation and may be classified as natural or synthetic (Shahidi & Zhong, 2010). There is an increasing demand for natural antioxidants due to safety concerns for synthetic antioxidants, in addition to increasing consumer preference for natural products, clean label and less usage of food additives in food products. Due to their natural antioxidant components, spices and herbs are great sources of antioxidants for food preservation. There are additional advantages of using natural antioxidants from spices and herbs. These include their health benefits and that they can be readily assimilated by the body. They can also be labeled as spices or natural flavours (i.e., clean labels). Synthetic antioxidants on the other hand may cause adverse effects in humans and may not contribute additional nutritional benefits. Table 1 shows the different classes of antioxidants, examples of each and how they function in inhibiting lipid oxidation.

3. Differences between spices and herbs

Spices come from different parts of a plant other than the leaves while herbs come from leaves of a plant. Spices and herbs can be classified into various groups based on flavour/taste, taxonomy or part of the plant where they came from. Based on flavour, spices and herbs can be classified into 4 groups: hot