Original article

Evaluation of phenolic content and antioxidant activity of Iranian caraway in comparison with clove and BHT using model systems and vegetable oil

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Summary Antioxidant activity (AA) of phenolic compounds in methanolic extract of Iranian caraway was compared with clove. Total phenolic content of caraway and clove extracts determined by the Folin-Ciocalteu method, were 13.76 and 243.91 mg g^{-1} dry matter respectively, expressed as tannic acid equivalents, and total flavonoid content of extracts were 2.6 and 5.0 mg g^{-1} dry matter, respectively, expressed as epicatechin equivalents. The extracts were screened for their potency as antioxidant using various *in vitro* models, such as β-carotene–linoleate, ferric thiocyanate, 1,1-diphenyl-2-picryl hydroxyl (DPPH) radical, hydroxyl radical ($^{\bullet}OH$) and reducing power model systems. AA of BHT was also determined in model systems. AA of methanolic extracts at different concentrations of total phenolic content according to β-carotene bleaching and ferric thiocyanate methods expressed as AA (per cent inhibition relative to control) ranged from 82% to 96%.The scavenging effect of both extracts on DPPH and $^{\bullet}OH$ radicals were 23–40% and 3.5–12.7%, respectively, which were comparable with BHT as a synthetic antioxidant. Extracts with high content of total phenolic compounds exhibited also good reducing power.

Keywords Caraway (*Carum carvi* L.), clove (*Eugenia caryophyllata* Tunb.), *in vitro* model systems, natural antioxidants, phenolic compounds.

Introduction

Autoxidation of fats and oils not only lowers the nutritional value of foods, but is also associated with aging, membrane damages, heart diseases, diabetes and cancer in living organisms (Scott, 1997; Hollman, 2001). Addition of antioxidants to food is an effective way for retarding the oxidation of fats.

There are two basic categories of antioxidants, namely, synthetic and natural. The most common synthetic antioxidants used in foods, are compounds with phenolic structures of various degrees of substitution, whereas natural antioxidants are primarily plant phenolic and polyphenolic compounds that may occur in all parts of plants (Velioglu *et al.*, 1998; Shahidi & Naczk, 2004).

Most of the antioxidants in use commercially (e.g., Butylated Hydroxy Toluene (BHT), Butylated Hydroxy Anisol (BHA) and Propyl Gallate (PG)) are synthetic (Allen & Hamilton, 1989). Although largely effective, synthetic antioxidants continue to be scrutinised for their safety as food additives; consequently, there is increasing public interest in the use of natural antioxidants. Extracts from spices, rosemary, thyme and sage are reported to possess antioxidant properties comparable with or greater than BHA and BHT (Kramer, 1985; Pokorny, 1991; Cuvelier *et al.*, 1994).

A major group of phytochemicals in foods are the phenolic compounds, which includes simple phenols, phenyl propanoids, benzoic acid and derivatives, flavonoids, stilbenes, tannins, lignans and lignins. Plant phenolics are multifunctional and can act as reducing agents (free radical terminators), metal chelators and singlet oxygen quenchers (Shahidi & Naczk, 2004). Flavonoids are a class of compounds that have been demonstrated to be potent antioxidants based on their phenolic hydroxyl groups. They are known as primary antioxidants and can delay or inhibit the oxidation of lipids or other molecules by inhibiting the initiation or propagation of oxidative chain reactions (Andlauer & Furst, 1998). Structure–activity relationship studies of flavonoids have shown that the o-dihydroxy structure in the B ring and the 2,3 double bond in conjugation with the 4-oxo function in the C ring (as in flavones) are essential for effective free-radical scavenging activity. The presence of a 3-hydroxyl group in the heterocyclic

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