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Full Length Research Paper

Extraction of cinnamon essential oil and identification of its chemical compounds

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The essential oils is present in many plants particularly spices, it contain numbers of chemical compounds with different chemical structures. Due to this functional groupings that these compounds posses, they might act and exhibit different properties namely antimicrobial, stabilizing and flavouring properties. The objective of this work is to isolate the oily fraction from cinnamon bark (*Cinnamomum zeylanicum)* and identify the chemical constituents and compounds present in this fraction. The oil was isolated by the application of Clevenger apparatus. The extraction efficiency was determined and total phenolic compounds were measured by Folin Ciocalteau method. The chemical compounds were identified by the application of gas chromatography/mass spectrometry (GC/MS). The oil and total phenolic compounds constituted 1.3% and 5.77 mg/g of the substance, respectively. The results indicated that Cinnamaldehyde was the predominant constituent in the isolated oil. Therefore, due to different chemical components present in the cinnamon essential oil, further investigation concerned with properties, activities and application of this essential oil to replace the medicines or as supplement in diseases, kinds of cancers and chemo therapy is recommended.

Key words: Essential oil, cinnamon, cinnamaldehyde.

INTRODUCTION

The essential oil due to their aroma and flavor, chemical structure, availability and the fact that they are immiscible with water are regarded as valuable substances not only used by themselves but might be employed as an ingredient in many food formulations and products. Due to the fact that extracted essential oil from the original substances is composed of many chemical compounds with different chemical structures and functional groupings, therefore some of them might be regarded as valuable components and might exhibit antioxidant potency. The fact that they are volatile at ordinary temperature in the presence of air, they are regarded and might be named volatile oils, ethereal oils or essential oils (Sellar, 2001). Production technology is an effective factor to improve the overall yield and quality of essential oil. The traditional technologies pertaining to essential oil processing are of great significance and are still being used in many parts of the globe. Water distillation, water and steam distillation, steam distillation, cohobation, maceration and enfleurage are the most traditional and commonly used methods (Handa et al., 2008). Among these methods the most popular economical method to extract and isolate the valuable fraction is by steam distillation (Farag and Bade, 1989; Suhaj, 2000). With technological advancement, new techniques have been developed which may not necessarily be widely used for commercial production of essential oils but are considered valuable in certain situations, such as the production of costly essential oils in a natural state without any alteration of their thermo sensitive components or the extraction of essential oils for micro-analysis.

These techniques are as follows, head space trapping techniques included static head space technique, vacuum head space technique and dynamic head space technique, solid phase micro-extraction (SPME),

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supercritical fluid extraction (SFE), phytosol (phytol) extraction, protoplast technique, simultaneous distillation extraction (SDE), solvent free microwave extraction (SFMF), controlled instantaneous decomposition (CID), thermo micro distillation, micro distillation, molecular spinning band distillation and membrane extraction (Handa et al., 2008). Among the spices, cinnamon is known as the oldest and most popular spice to be used for years (Lee and Balick, 2005). Cinnamon is an herbal plant that has been used for various purposes as forms of dietary intake, oriental medicine and CAMS (Wijesekera, 1978). The essential oil generally terpenoids in structure is distributed all over the tree but the oil is mainly extracted from the bark and leaves. The availability of the oil might depend on many factors namely location, season, time of harvest and the age of tree (Peter, 2001; Parthasarathy et al., 2008).

The concentration of the essential oil in the cinnamon is between 0.4 to 2.8% consisted of cinnamaldehyde , cinnamyl acetate, caryophyllene, linalool, eugenal, benzaldehyde, 4-terpineol and some minor other (Parthasarathy et al., 2008; Wijesekera, 1978; Angmor et al., 1972). Krishnamorthy et al. (1996) worked on two varieties of cinnamon called Navashree and Nithyasree and reported high and predominant concentrations of cinnamaldehyde and eugenol in barks and leaves of these two varieties of cinnamon (Krishnamorthy et al., 1996). Research works concerned with cinnamon essential oil and physical chemical characteristics of the oil concerned with its application to product in pharmaceutical, food, perfumery industries have been studied by many scientists. In recent research works apart from antioxidant and antimicrobial properties, the effect of antitumor activity of cinnamon in animals have been investigated (Cabello et al., 2009; El-Baroty et al., 2010; Kwon et al., 2010). The aim of this research work is to extract the essential oil from cinnamon consumed in Iran and subject to further analysis concerned with qualitative and quantitative measurements of compounds present in the oil.

MATERIALS AND METHODS

Cinnamon barks (*Cinnamomum.zeylanicum)* were purchased from an open market in Tehran and were identified by Agricultural and Natural Resources Research Institute of Tehran province. It is worth to mention that due to some factors namely climate, cinnamon tree is not planted in Iran therefore the skins which were bought for the examinations were imported from other countries like India. The barks were grinded made into a fine powder in order to extract the oil. The oil was extracted by the application of Clevenger apparatus for 5 h and finally the oil was isolated and kept in a dark glass in the refrigerator until required for further analysis. Total phenolic compounds were measured by the application of Folin-Ciocalteau method in duplicate order (Singh et al., 2008). The chemical compounds present in the oil were identified and quantified by the application of Hewlett Packard Gas chromatography (GC) model HP-6890 equipped with HP-5MS capillary column (5% phenyl dimethyl siloxan) and Hewlett Packard Mass model HP-5973 (Firestone, 1990; Stoilova et al., 2007).

RESULTS AND DISCUSSION

The oily fraction isolated from cinnamon had a pale yellowish to greenish appearance with a strong aroma. The essential oil accounted for 1.3% of the total weight and the total phenolic compound based on dry weight was 5.7 mg/g which is in agreement with the findings of El-Baroty et al. (2010) who reported that the yield of cinnamon oil by is hydrodistillation method. Bernard et al. (1989) studied the composition of volatiles from cinnamon bark by two methods; namely direct distillation and extraction using TTE (1, 1, 2-trichloro-1, 2, 2-trifluoroethane) followed by hydrodistillation and was reported that the extraction yield of volatile oil was 0.98 to 1.1% and differences were observed in composition of both oils. The TTE extract had a higher cinnamaldehyde content compared with the direct hydrodistillation oil. Therefore It is understood that geographical position, cultivation, variety of cinnamon, harvesting time and extraction method affect the actual yield of the essential oil (Bernard et al., 1989). Jayawardena and Smith (2010) extracted essential oils of cinnamon bark or leaves at 200°C with water under pressure and isolated it from the aqueous solution using a solid phase extraction cartridge and were then examined by GC-MS. Using superheated water extraction, cinnamon bark oil with over 80% cinnamaldehyde and cinnamon leaf oil containing up to 98% eugenol were obtained.

Alternative solvent extraction methods were also studied but led to emulsion formation apparently because of the presence of cellulose breakdown products. They concluded that superheated water extraction offers a cheap, environmentally friendly technique with a shorter extraction time than hydrodistillation and yielded higher quality oil with a higher proportion of eugenol than hydrodistillation. Baseri et al. (2010) compared SFE of essential oils from commercial cinnamon bark with essential oils that were obtained by hydrodistillation. Effects of operating parameters (pressure, temperature and extraction time of SFE) on the extraction yield and the composition of the extracted volatile oil were studied. Moreover, in the hydrodistillation process, the effect of the pH of the solvent on the concentration of cinnamaldehyde in the extracted volatile oil was studied. The maximum yield of extract in the SFE process was about 7.8% at 70°C and 240 bar. The maximum concentration of cinnamaldehyde in the SFE process was obtained at 70°C and 160 bar, and the maximum concentration of this component in hydrodistillation was achieved at pH = 4.1. Figure 1 presents the GC-MS profile of the chemical constituents of cinnamon essential oil. Table 1 presents the chemical constituents with their relative retention times and respective concentrations of

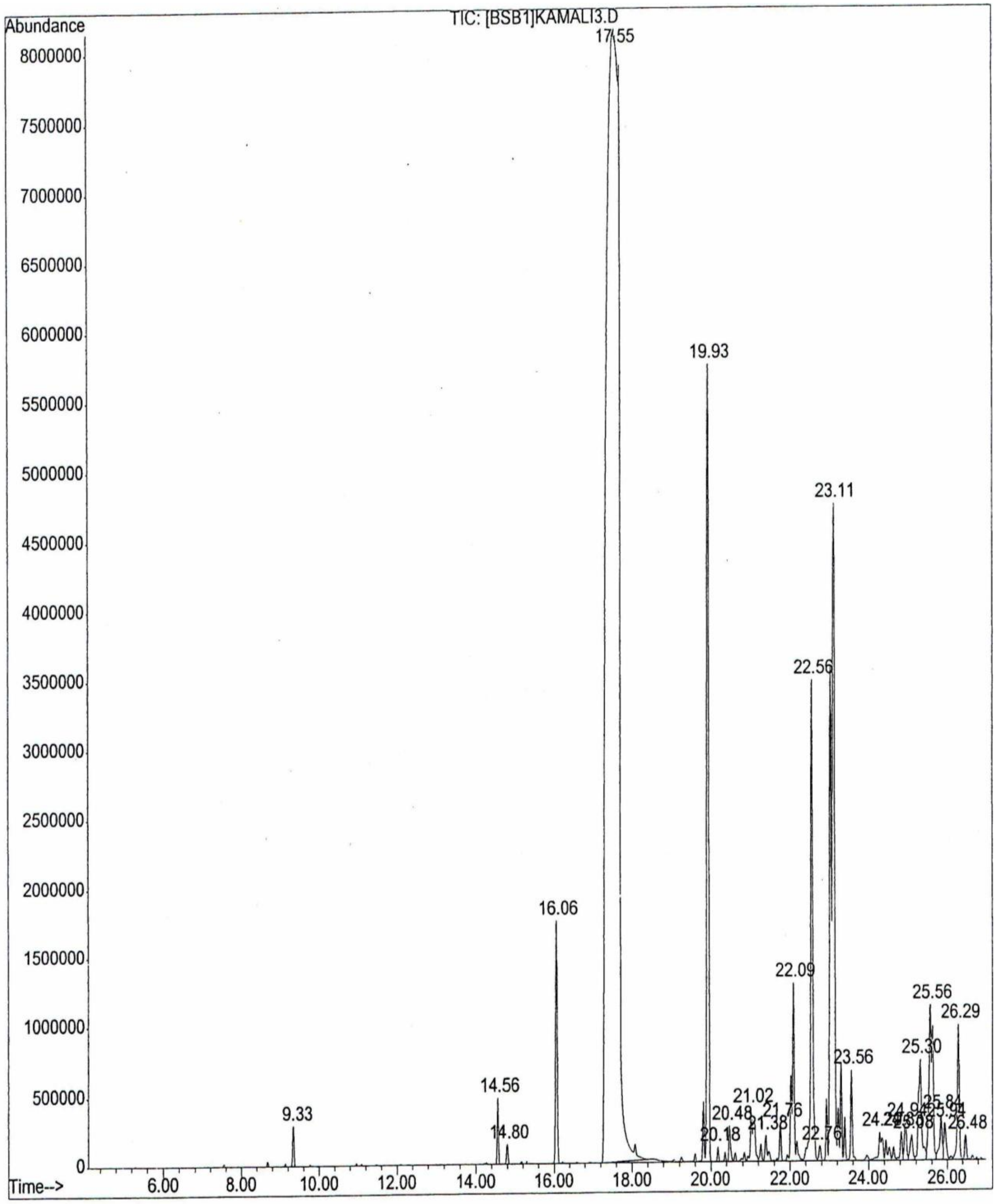

Figure 1. The GC-MS profile of the chemical constituents of cinnamon essential oil.

the compounds present in the essential oil. Figure 2 shows the structures of some of the compounds present in the extracted oil.

Nineteen compounds were identified and quantified in cinnamon. Cinnamic aldehyde (62.09%) followed by para methoxy cinnamic aldehyde (11.56%), alpha-copaene

Table 1. Chemical constituents and concentrations of compounds present in the cinnamon essential oil.

Compound	Concentration (%)	RT (min)
Benzaldehyde	0.23	9.33
Benzenepropanal	0.41	14.56
Borneol	0.12	14.8
2-propenal,3- phenyl (Trans-cinnamaldedehyde)	1.65	16.06
Cinnamic aldehyde	62.09	17.55
Alpha-copaene	6.98	19.93
Beta-elemene	0.08	20.18
Beta-caryphyllene	0.89	21.02
Coumarin	0.41	21.38
Alpha-humulene	0.28	21.76
Alpha-amorphene	1.98	22.09
Alpha-Muurolene	4.32	22.56
Para methoxy cinnamic aldehyde	11.56	23.11
1, 5, 8, 8- Tetramethyl- cycloundeca-5	0.24	24.83
Hinesol	0.36	24.94
6-Methoxy-1-acetonaphthone	0.28	25.08
T-cadinol	2.47	25.56
10-Alpha-cadinol	0.51	25.84
1,4-Dimethyl-7-(1-methylethyl) azule	1.2	26.29

Retention time.

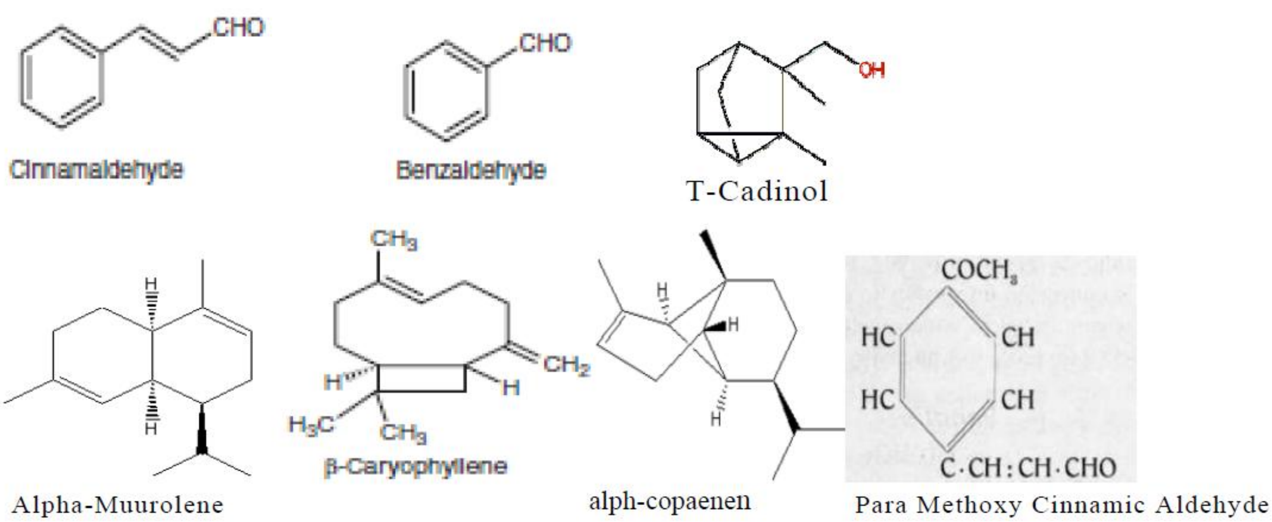

Figure 2. The structures of some of the compounds present in the cinnamon essential oil.

(6.98%) and alpha-muurolene (4.32%) were the major constituents of the oil. The concentration of cinnamadehyde and its derivatives reflects the value of the product in term of commerce and trade (Koroch et al., 2007). The ground spice is used for flavoring baked products. The bark and leaf oil are used in the manufacture of perfumes, soaps and toothpastes and also as a flavoring agent for liquors and in dentifrices. Besides these, cinnamon has a broad spectrum of medicinal and pharmacological application (Parthasarathy et al., 2008). Cinnamon possesses various biological activities such as antioxidant, antimicrobial, antidiabetic and antiallergic. For many centuries, cinnamon and its essential oil have been used as preservatives in food, due to the antioxidant property of cinnamon. *In vivo* lipid peroxidation causes tissue damage, which can lead to inflammatory diseases. Phenolic coumpounds, such as hydroxyl cinnamaldehyde and hydroxy cinnamic acid, present in the cinnamon extract, act as scavengers of peroxide radicals and prevent oxidative damages. Therefore the essential oil and possibly various extracts from cinnamon might be employed to retard autoxidation chain reactions in oils and fats (Wu et al., 1994).

Cinnamon is reported to possess anti-inflammatory activity (Kirtikar and Basu, 1984). The ethanolic extrac (70%) of cinnamtion was effective on acute anflammation in mice (Kubo et al., 1996). An herbal ophthalmic preparation, called Opthacare containing 0.5% cinnamon was found to be effective as an anti-inflammatory in rabbits (Mitra et al., 2000). Cinnamon extract has anti-diabetic effect. Cinnamon is reported to reduce the blood glucose level in non-insulin-dependent diabetics. Therapeutic studies have proved the potential of cinnamaldehyde and hydroxycinnamic acid as anti-diabetic agents. Cinnamaldehyde inhibits aldose reductase, a key enzyme involved in the polyol pathway. This enzyme catalyses the conversation of glucose to sorbitol in insulin-insensitive tissues in diabetic patients. This leads to accumulation of sorbitol in chronic complications of diabetes, such as cataract neuropathy and retinopathy. Aldose-reductase inhibitors prevent conversation of glucose to sorbitol, thereby preventing several diabetic complications (Lee, 2002). A decoction of dried twigs of cinnamon can produce an antipyretic effect in mice. Studies conducted in anaesthetized dogs and guinea pigs indicated that cinnamaldehyde or sodium cinnamate, also produced the hypothermic and antipyretic effects.

It also causes a hypotensive effect, which is due mainly to vasodilation of peripheral vessels. Cinnamaldehyde produced an analgestic effect in mice (Wang, 1985). Nephritis is an autoimmune diseases caused by activation of the complement system. Cinnamon cortex and cinnamon oil inhibited complement formation *in vitro*. Cinncassiol C1 and its glucoside, the cinncassiols C2 and C3 and cincassiol D1 and its glucoside were reported to possess anticomplementary activity. A water-soluble polysaccharide isolated from the cinnamon extract showed complement system activity (Tang and Eisenbrand, 1992). 2-Hydroxycinnamaldehyde and 2-benzyloxy cinnamaldehyde isolated from the stem bark of cinnamon possessed immunomodulatory effects (Koh et al., 1999). Cinnamon oil and extracts possess various antimicrobial activities against several bacteria, fungi, etc.

Cinnamon oil showed an inhibitory effect against the Gram-positive bacteria Bacillus cereus, *Micrococcus luteus*, *Staphylococcus aureus* and *Enterococcus faecalis*, Gram-negative bacteria *Alcaligens faecalis*, *Enterobacter cloacae*, *Escherichia coli* and *Pseudomonas aeruginosa*, the fungi *Aspergillus niger* and *Rhizopus oligosporus* and the yeast *Candida albicans* (Chao et al., 2000). Aqueous extract from cinnamon inhibited the replication of the influenza virus (Mancini et al., 1999). Cinnamaldehyde, cinnamic acid, cinnamyl alcohol and eugenol possessed antibacterial, astringent, carminative and stomachic effects (Lee and Ahn, 1998). Cinnamon oil exhibited fumigant toxicity to adults of *Acanthoscelides oblectus* and inhibited its reproduction through ovicidal and larvicidal action. Both cinnamaldehyde and cinnamyl alcohol showed ovicidal and larvicidal activity (Roger and Hamraoui, 1994). Cinnamon oil possessed strong nematicidal activity against the male, female and juveniles of pinewood nematode Bursaphelenchus xylophilus. Cinnamyl acetate, the active ingredient in the oil at a concentration of 32.81 Mg/l resulted in 50% mortality of nematodes (Park et al., 2005).

Conclusion

The essential oil of cinnamon might be employed to promote the quality of food in term of preservation, stabilization and the last but not the least the flavoring contribution as an ingredient to some food products. Due to different chemical components present in the cinnamon essential oil and the mechanism and the pathway, they behave in respect of antioxidant, antimicrobial, antiinflammation, antidiabetic and antitumor properties and activities, its application to replace the related medicines or as supplement in diseases, kinds of cancers and chemo therapy might be suggested.

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