

Isolation and Identification of Ginger Essential Oil

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ABSTRACT: The essential oil of plant material is the fraction isolated by means of several methods such as liquid carbon dioxide, microwaves and low or high pressure distillation employing boiling water or hot steam and is chemically defined as terpenoids namely monoterpene and the oxygenated form. Since these compounds might be employed as flavour contributors due to their chemical nature, it is the aim of this investigation to extract and identify the chemical compounds present in the essential oil of ginger. The essential oil of ginger was extracted and isolated by the application of Clevenger apparatus and the total phenolic compounds responsible for flavouring, preserving and antioxidant activities were determined. The results indicated that Zingiberene belonging to the sesquiterpene was the predominant compound present in the oily fraction. Therefore further investigation concerned with characterisation and applications for particular activities are recommended.

Keywords: Essential Oil, Ginger, Phenolic Compounds

Introduction

Ginger (*Zingiber officinale* Roscoe) is a plant that belongs to the Zingiberaceae family. The plant is indigenous to warm tropical climates, particularly southeastern Asia. It is extensively cultivated in India, China, Africa, Jamaica, Mexico and Hawaii (Evans, 1989). Ginger products, such as the essential oil and oleoresin, are internationally commercialized for use in food and pharmaceutical processing.

The essences due to their chemical nature are volatile at ordinary room temperature and might be called volatile oils, ethereal oils or essential oils. Various techniques have been employed to extract this valuable fraction of the plant material namely by water, steam distillation or application of microwave and liquid carbon dioxide (Sellar, 2001). The essential oils are

composed of monoterpene hydrocarbons, sesquiterpene hydrocarbons and oxygenated monoterpene. Although the latter has the least concentration but is the major contributor to the taste and aroma of food substances (Parthasarathy *et al.*, 2008).

The recovery of the essential oils of ginger depend on variety and origin of the plant as well as the cultivation, humidity at the time of harvest, the methods of extraction and to some extent on the age of the plant (Onyenekwe and Hashimoto, 1999). Although ginger essential oils is yellow, the intensity of colour, aroma and taste varies according to the originated place of cultivation (John and Ferreira, 1997; Purselglove *et al.*, 1981; Guenther, 1975). The chemical composition of essential oils of ginger has been identified and quantified by means of GC-MS or GC with flame ionization detector applications (Sultan *et al.*, 2005; Singh *et al.*, 2008).

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According to Famurewa and Emuekele (2011), sliced oven drying at 50°C (SOD) of fresh ginger has the highest volatile oil, protein, calcium and magnesium (Famurewa et al., 2011). Gurdip Singh et al. (2008) extracted the essential oil of ginger (*Zingiber officinale*) by hydrodistillation method and subjected the oil to GC-MS analysis. Sultan et al. (2005) extracted the essential oil of Thai and Chinese ginger by means of steam hydrodistillation and carried out works concerning the composition of essential oils by GC with flame ionization detector.

The essential oil and oleoresin of ginger are used as a medicine with indications against several problems, such as a cure for swelling, sores and loss of appetite (Nhareetsomchit and Nurshukriyah, 2003), stomach ache, diarrhea, tooth ache, gingivitis arthritis, asthmatic respiratory disorders and motor diseases, also possessing anti-inflammatory activity. Some of these functional properties are generally attributed to the gingerol and shogaol. For instance, gingerols inhibited the growth of *Mycobacterium avium* and *Mycobacterium tuberculosis* (Hiserodt et al., 1998).

The antioxidant activity of ginger essential oil and oleoresins were evaluated against mustard oil using peroxide, anisidine, thiobarbituric acid (TBA), ferric thiocyanate (FTC) and 2, diphenyl-1-picrylhydrazyl (DPPH) radical scavenging methods. They were found to be better antioxidants than butylated hydroxyanisole (BHA) (Gurdip Singh et al., 2008).

Ginger essential oil has shown moderate to good inhibitory effects against some of fungi such as *Aspergillus flavus*, *Aspergillus solani*, *Aspergillus oryzae*, *Aspergillus niger* and *Fusarium moniliforme* (Gurdip Singh et al., 2008).

Manju and Nalini (2005) demonstrated the chemopreventive efficacy of ginger in colon cancer. They investigated the effect of ginger on the initiation and post-initiation stages of 1,2- dimethyl hydrazine (DMH)-

induced colon carcinogenesis in male Wistar rats. The number of tumours, as well as the incidence of cancer, were decreased significantly on treatment with ginger.

Guh et al. (1995) studied the antiplatelet effect of gingerol isolated from *Z. officinale*. Gingerol (0.5–20 µM) concentration dependently inhibited the aggregation and release reaction of arachidonic acid and collagen-induced rabbit platelets, but not those induced by platelet-activating factor U46619 and thrombin. Gingerol (0.5–10 µM) dependently inhibited thromboxane B2 and prostaglandin D2 formation caused by arachidonic acid and completely abolished phosphoinositide breakdown induced by arachidonic acid, but had no effect on that of collagen, PAF or thrombin, even at concentrations as high as 300 µM. In human platelet-rich plasma, gingerol and indomethacin [indometacin] prevented the secondary aggregation and blocked ATP release from platelets induced by ADP (5 µM) and adrenaline [epinephrine] (5 µM), but had no influence on primary aggregation. The highest antiplatelet effect was obtained when platelets were incubated with gingerol for 30 min, and this inhibition was reversible. It is concluded that the antiplatelet action of gingerol is due mainly to the inhibition of thromboxane formation.

Abdel Aziz et al. (2005) reported the potential of different extracts of ginger and its essential oil and concluded that [6]-Gingerol exhibited the maximum activity. At present, it is estimated that about 80% of the world population relies on botanical preparations as medicines to meet their health needs. Herbs and spices are generally considered safe and proved to be effective against certain cases. Fortunately, even long-term consumption of these substances is not known to produce any side effects. In recent years, in view of their beneficial effects, use of ginger and many other spices /herbs as medicine has been gradually increasing in many countries (Langer, 1998). Natural

products and their active principles as sources for new drug discovery and treatment of diseases have attracted the attention in recent years. Rhizome of ginger has been recommended for use as carminative, diaphoretic, anti spasmodic, expectorant, peripheral circulatory stimulant, astringent, appetite stimulant, anti-inflammatory agent, diuretic and digestive aid (Langner *et al.*, 1998; White, 2007). Research works have been carried out concerning the effects of ginger in surgery, chemotherapy and some other illness (Schmid *et al.*, 1994; Visnovsky, 1992; Bliddal *et al.*, 2000).

Therefore the aim of this investigation is to extract the ginger essential oil consumed in Iran and evaluate the extraction recovery and identify the chemical components present in this valuable fraction.

Materials and Methods

Ginger plant does not grow in Iran due to weather condition. Therefore dried rhizomes of ginger (*Zingiber officinale Roscoe*) were purchased from the local market in Tehran and was identified in Tehran University. The samples were grinded, homogenized and made into a fine powder. In order to extract the essential oils, 100 g of the powder was placed in 1 liter conical flask and connected to the Clevenger apparatus. 500 mL of distilled water was added to the flask and heated to the boiling point. The steam in combination with the essential oils were distilled into a graduated cylinder for 5 hours and then separated from aqueous layer. The oil was kept in the refrigerated until required for further analysis (Singh *et al.*, 2008).

Total phenolic content of the extracts was determined using the Folin-Ciocalteu assay. Samples (300 ml) were introduced into the test tubes followed by 1.5 ml of Folin-Ciocalteu's reagent (10 times dilution) and 1.2 ml of sodium carbonate (7.5% w/v). The

tubes were allowed to stand for 30 min before absorbance at 765 nm was measured. Total phenolic content of the extracts were expressed as gallic acid equivalent (GAE) in mg/100 g material (Farang and Bade, 1989; Stoilova *et al.*, 2007; Firestone, 1990). The components of ginger essential oil were identified on the basis of the comparison of their relative retention time (Singh *et al.*, 2005). A Hewlett Packard GC model HP-6890 with 30 meter 5% phenyl dimethyl siloxan (HP-SMS) column equipped with A Hewlett Packard MS model HP-5973.detec was used to identify the chemical constituents (Firestone, 1990).

Results and Discussion

The essential oil accounted for 1.2% of the total weight and the total phenolic compound based on dry weight was 5.9 mg GAE/g. Figure 1 provides information concerned with the chemical analysis of ginger essential oils that was carried out by GC-MS. Table 1 presents the respective retention time and concentrations of compounds present in the extracted oil. Figure 2 shows the chemical structure of some compounds identified by GC-MS. As indicated in Table 1 and Figure 1 Zingiberene is the predominant compound belonging to the sesquiterpene hydrocarbons and constituted approximately 32 % of the total extracted essential oil. The specific aroma of ginger is predominantly related to Zingiberene. The findings are in agreement with previous work carried out by Sultan *et al.* (2005). Totally seventeen compounds were identified in the essential oil examined. The chemical constituents of the essential oils extracted as mentioned in Table 1 belong to sesquiterpene hydrocarbons namely Zingiberene, AR-Curcumene, Beta-Sesquiphellandrene while the oxygenated monoterpene namely Endo-Borneol and Geraniol are present at lower concentrations and have more

contributions to the flavouring characteristics of the oil. The monoterpene hydrocarbons, Camphene and Beta-Phellandrene and sesquiterpene alcohols, Nerolidol and Alpha-Eudesmol are also present in the extracted oil. As indicated earlier the main constituents of the oil belong to the sesquiterpene. Sultan *et al.*, (2005) carried out works concerning the composition of Thai ginger essential oils by GC equipped with Flame Ionization Detector and found that Zingiberene (30.81%) constituted the major fraction of the oil followed by Citral (5.4%), Myrcene (4.6%), 1,8- Cineol (3.9%), α -Pinene (3.6%), β - Phellandrene (2.8%), γ -Terpinene (2.5%) and β -Pinene (0.74%) in respective decreasing order. The Chinese ginger essential oils analysis indicated similar qualitative and quantitative chemical composition. Zingiberene was the major sesquiterpene hydrocarbon of ginger essential oils and this compound was identified and isolated in 1900 (5). Pino and Marbot (2004) identified AR-Curcumene (22.1%), Zingiberene (11.7%), Beta-Bisabolene (11.2%), Candina-1,4 diene (12.5%) in the essential oils of cubian ginger essential oils. Gurdip Singh *et al.*, (2008)

analyzed the chemical composition of ginger (*Z. officinale*) essential oil by GC-MS and five major components were identified; Geraniol (25.9%), α -Zingiberene (9.5%), (E,E)- α -Farnesene (7.6%), Neral (7.6%) and Ar-Curcumene (6.6%). Zingiberene has biological activities such as antifever, antiviral and antigestation (Millar & Notprod, 1998).

Conclusion

Ginger essential oil as mentioned earlier is made of different classes of chemical compounds that might contribute to flavor and taste of the products and if used in the industry for food formulation, due to their chemical nature might contribute other characteristics namely antioxidant and preserving activities to the product. Therefore further investigations concerned with the chemical constituents present in the oil are required to establish the antimicrobial, stabilizing behavior, antiemitting, anticarcinogenic, anti-inflammatory, antiplatelet, anti-ulcer, anticonvulsive and analgesic and cardiovascular properties of the oil as well as to identify the most potent components of the oil concerning the treatments for the above matters.

Table 1. Chemical composition and concentrations of compounds present in the examined ginger essential oil

Compounds	Concentrations (%)	RT (min)
Camphene	0.73	9.13
Beta-Phellandrene	0.93	11.16
Endo- Borneol	0.97	14.79
Geraniol	0.97	17.06
Geranyl Acetate	1.37	19.54
AR-Curcumene	15.88	22.02
Zingiberene	31.79	22.28
Alpha Farnesene	5.71	22.36
Beta-Bisabolene	9.29	22.56
4, 5- Dimethyl-11-Methylene Tricyclo 7	2.35	22.46
Gamma-Cadinene	3.56	22.70
Beta-Sesquiphellandrene	15.57	22.93
Delta-Cadinene	0.64	23.02
Nerolidol	2.01	23.56
7- Alpha-(1-Hydroxyl-1-Methylethyl)	2.00	25.25
Germacrene B	1.10	25.41
Alpha-Eudesmol	3.23	25.92

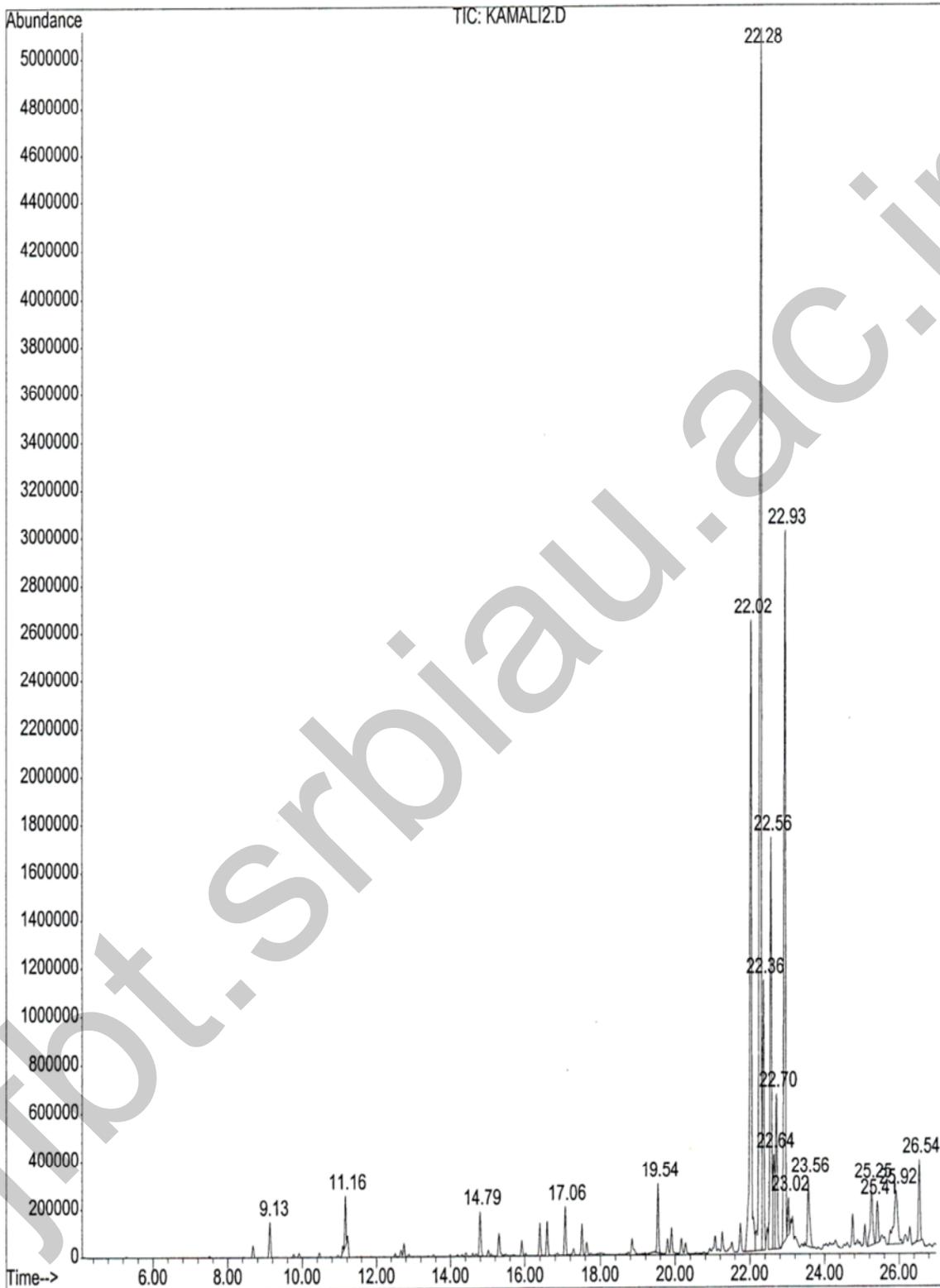


Fig. 1. The GC-MS profile of chemical analysis of ginger essential oil

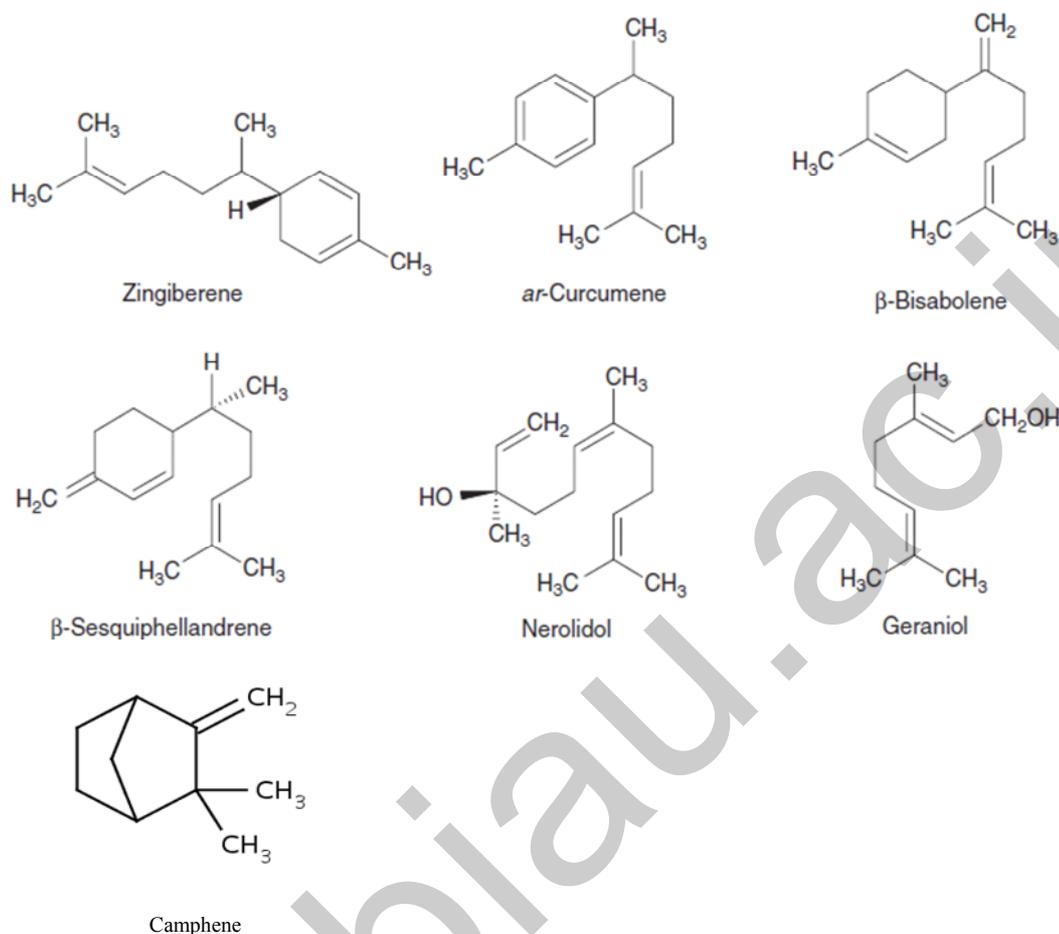


Fig. 2. Chemical structure of some compound in the ginger essential oil

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