Journal of Applied Biological Sciences 7 (3): 42-45, 2013
ISSN: 1307-1130, E-ISSN: 2146-0108, www.nobel.gen.tr

Essential Oil Composition of *Elettaria cardamomum* Maton

Ebru KUYUMCU SAVAN* F. Zehra KÜÇÜKBAY

Department of Basic Pharmaceutical Sciences, İnönü University, Malatya, TURKEY

*Corresponding author:

E-mail: ebru.kuyumcu@inonu.edu.tr

Received: October 25, 2013

Accepted: December 17, 2013

Abstract

Cardamom (*Elettaria cardamomum* Maton) is one of the most commonly used spices and is known as "the queen of spices". Cardamom of the Zingiberaceae family is one of the world's very ancient and expensive spices. The aromatic seeds of *Elettaria cardamomum* Maton are used in treatment of various diseases; from asthma to cardiac disorders besides using spices. Hydrodistilled essential oil of Cardamom which obtained using a Clevenger-type apparatus, were analysed by GC and GC-MS. Relative percentage amounts of the separated compounds were calculated from FID chromatograms. n-Alkanes were used as reference points in the calculation of relative retention indices (RRI). Sixty seven compounds were identified, representing 96.9% of the oil. The major components were found to be 1,8-cineole (25.6%), linalool (6.3%), *α*-terpinyl acetate (40.7%).

Keywords: *Elettaria cardamomum*; essential oil; 1,8-cineole; linalool; α-terpinyl acetate

INTRODUCTION

Cardamom (*Elettaria cardamomum* Maton) is one of the most commonly used spices and is known as "the queen of spices" [1]. Cardamom of the Zingiberaceae family is one of the world's very ancient and expensive spices [2]. The plant is valued for its dried fruits [3]. The genus *Elettaria* is one of the few compact and small natural groups, whose origin is evergreen rainforests of South India and Sri Lanka from where it spread to other tropical countries [4]. Also, this leafy perennial herb is originated from India and Sri Lanka and is commonly cultivated in southern India [5].

It is an herbaceous non-perishable perennial crop whose valuable parts, the seeds are useful as powder or whole pulses in spice mixtures like curries, beverages such as tea and coffee, baked foods and confectionaries, meat products, as flavours in biscuits, custards, wines and liqueurs [2]. In the Middle-East, cardamom along with coffee is traditionally used in making of a beverage *Gahwa* [6].

Its aphrodisiac properties make it useful in medicines that fight stress, obesity loss of appetite [2]. It is also used as a perfume [2]. It is an essential ingredient of digestive stimulants and especially functions as warming stimulant to digestion [6]. Furthermore, it is used in medicinal preparations for indigestion and flatulence [6]. It is used to remove fats and as a cure for urinary and skin complaints in Indian Ayurvedic System of medicine [6]. The ancient Egyptians chewed it as a tooth cleaner and can be chewed habitually like nuts to aid in digestion [2]. On the other hand, the seeds of cardamom are used as carminative, stomachic, desiccant, resolvent, digestive and anti-emetic in treatment of gastrointestinal disorders [3, 7]. Its medicinal properties have been described against cardiac disorders, renal and vesicular calculi, dyspepsia, debility, anorexia, asthma, bronchitis, halitosis besides gastrointestinal disorders. The various animal studies have shown its antioxidant, antihypertensive, gastro protective, antispasmodic, antibacterial, antiplatelet aggregation and anticancer properties [8]. Due to the effects of this plant, the objective of this study was to determine the essential oil composition of *Elettaria cardamomum* Maton.

MATERIALS AND METHODS

Plant Material

The plant material of the study was purchased from the local market in Mersin.

Extraction of the essential oil

The dried fruits of the plant were [9], hydrodistilled for 3 h using a Clevenger-type apparatus (Ildam, Turkey). The dried fruits were immersed in water and heated to boiling for 3h according to the *European Pharmacopoeia* after that the essential oil was evaporated together with water vapor and finally collected in condenser. The distillate was isolated and dried over anhydrous sodium sulphate. The oil was stored at 4 ºC until analysis by GC and GC-MS. The percentage yield (%) of the oil calculated on a moisture-free basis was 1.00% for *Elettaria cardamomum* (w/w).

GC/FID and GC/MS analysis conditions

The essential oil was analyzed by GC/FID and GC/MS. GC/FID which was carried out using an Agilent Technologies 6890N Network system. An HP-Innowax column (60 m × 0.25 mm i.d., 0.25 μm film thickness) was used with helium as carrier gas, at a flow rate of 1.7 mL min^{-1}. The oven temperature was initially kept at 60 ºC for 10 min and increased up to 220 ºC at a rate of 4 ºC min, then held at 220 ºC for 10 min and increased up to 240 ºC at a rate of 1 ºC and then held at 240 ºC for 10 min. Split flow was adjusted at 84.9 mL/min. The split ratio was adjusted to 50:1. The injector and flame ionization detection (FID) detector temperatures were 250 ºC.

GC/MS analysis of the essential oil was performed under the conditions with GC (column, oven, temperature, flow rate of the carrier gas) using an Agilent Technologies 6890N Network system gas chromatograph equipped with an Agilent Technologies 5973 inert Mass Selective Detector (Agilent G3180B Two-Ways Splitters with make up gas) system. Also, the same column and operational conditions were applied to GC/FID. Helium was used as carrier gas. MS were taken at 70 eV. The mass range was between m/z 10 and 425.

Identification and quantification of essential oil constituents

Retention indices were calculated by using retention times of *n*-alkanes (C_7 – C_{29}) homologous series that were injected after the essential oil at the same chromatographic conditions according to Van den Dool method [10]. Identification of individual components of the essential oil was performed by computerized matching of the acquired mass spectra with those stored NIST 05/ Wiley 7n/Adams (comparison quality > 90%) mass spectral library of the GC/MS data system and/or by confirmed with the aid of retention indices from published sources [11]. Relative percentage amounts of the separated compounds were calculated from FID chromatograms. The relative concentration of each compound in essential oil was quantified according to the peak area integrated by the analysis program. The individual compounds identified in the essential oil are given in Table 1.

RESULTS AND DISCUSSION

Water-distilled essential oil from aerial fruits of *E. cardamomum* has been analyzed by GC-MS with HP-Innowax column. The resulting components of the oil are shown in Table 1. The chemical characterisation of the essential oil was resulted in the identification of sixty seven compounds, representing 96.9% of the oil. The average yield of the essential oil was 1.00%. The major components were found to be 1,8-cineole (25.6%), linalool (6.4%), *α*-terpinyl acetate (40.7%). Other monoterpenes, such as camphene and carvacrol, are present in less than 0.1% levels.

In this study, the essential oil of cardamom displayed chemical profiles similar to and different from other finding by many researcher, the major compounds found are 1,8-cineole (28.4%), *α*-terpinyl acetate (21.3%) by Menon et al. [1] and *α*-terpinyl acetate (44.3%), 1,8-cineole (10.7%), *α*-terpineol (9.8%), linalool (8.6%) by Singh et al. [12]. In the study of Gopalakrishnan et al., its seeds were extracted with supercritical carbon dioxide at different conditions of pressure, temperature, contact time, and moisture content to estimate the yield and compositional variations. The proportion of major components (1,8-cineole, terpinyl acetate) and minor also showed variations under different conditions of extraction [13]. The variations in essential oil components under different physical factors have been determined by Sultana et al. The oil was characterized by a large number monoterpenes (97.6 %) constituting 1,8-cineole (89.6%), cis-ocimene (3.7%) and α-terpinene (2.2%) as the major components. Except the volatile oil exposed to sunlight, 1,8-cineole was detected in all the oil samples and its amount varied from 29.4% in heated oil to 89.4% in untreated oil. Linalool, thujyl alcohol, limonene-1,2-epoxide, citronellol, trans-pinocarveol, nerol and linalyl acetate were generated when the oil was heated at 110°C. Exposer of the oil with sunlight, enhanced the production of linalyl acetate (17.8%) and borneol (12.1%). 1,4-Cineole, pcymene-8-ol and isoborneol were only detected in UV exposed oil while the 2-heptane was only identified in high amounts in silica gel and alumina treated volatile oils [14]. Singh et al. reported that the essential oil exhibited strong antibacterial activity against the micro-organisms *Staphylococcus aureus*, *Bacillus cereus*, *Escherichia coli* and *Salmonella typhi* at 3000 ppm. And the methanol and ethanol extracts gave the best antifungal activity was against the food-borne fungi *Aspergillus terreus* at 3000 ppm [12]. According to Verma et al., cardamom effectively reduces blood pressure, enhances fibrinolysis and improves antioxidant status, without significantly altering blood lipids and fibrinogen levels stage 1 hypertensive individuals [8], and the study of Khalaf et al. reveals that cardamom has antioxidant activity [15]. According as Kaushik et al., cardamom seems to have significant antibacterial activity and to be very useful in the discovery of novel antibiotic [5].

By comparing our results to literature, oil composition can show similarities and differences. It is well-known, however, that the essential oil identification is highly variable and depends on several factors and experimental conditions such as isolation method of the essential oil, analytical conditions of GC-FID and GC-MS and especially stationary phase conditions which we used HP-Innowax (60 m × 0.25 mm i.d., 0.25 μm film thickness) as a polar column. In our study identification was performed not only by comparison of mass spectra with the database library (comparison quality > 90%), as well as by comparison of retention indices for alkanes C_7 – C_{29} with the ones reported by Adams [9] but also by comparison FID chromatograms.

Table 1. Chemical Composition and Relative Content of the essential oil components of the *E. cardamomum* (yield percentage 1.00%)

Experimental RI[a]	Literature RI[b]	Compound[c]	Composition (%)	Experimental RI[a]	Literature RI[b]	Compound[c]	Composition (%)
1019	1032	*α*-Pinene	1.4	1713	1678	*cis-p*-Mentha-2,8-dien-1-ol	0.1
1023	1076	*α*-Thujene	0.3	1725	1694	Neral	0.1
1067	1076	Camphene	tr	1728	-	1,8-Menthadien-4-ol	tr
1118	1118	*β*-Pinene	0.3	1738	1709	*α*-Terpinyl Acetate	40.7
1135	1132	Sabinene	2.1	1750	1725	Verbenone	0.1
1190	1174	Myrecene	1.4	1756	1733	Neryl acetate	0.4
1212	1188	*α*-Terpinene	0.4	1759	1740	*trans-p*-Menth-2-en-1,8-diol	0.2
1225	1195	Dehydro-1,8-cineole	2.4	1762	1742	*β*-Selinene	0.1
1236	1203	Limonene	1.1	1765	1742	Geranial	0.3
1245	1213	1,8-Cineole	25.6	1771	1751	Carvone	0.2
1282	1246	*cis-β*-Ocimene	0.1	1773	1758	*cis*-Piperitol	0.1
1296	1255	*γ*-Terpinene	0.8	1780	1765	Geranylacetate	0.9
1304	1266	*trans-β*-Ocimene	0.2	1788	1776	Gamma-Cadinene	tr
1327	1280	*p*-Cymene	0.2	1803	1794	*p*-Mentha-1,5-dien-8-ol	0.2
1340	1286	Terpinolene	0.6	1808	1802	Cuminal	tr
1348	1296	Octanal	0.1	1812	1797	Nerol	0.3
1403	1348	6-Methyl-5-hepten-2-one	tr	1820	-	*cis*-8-Methylbicyclo[4.3.0]non-3-ene	tr
1464	1408	1,3,8-*p*-Menthatriene	tr	1841	1845	*trans*-Carveol	0.4
1510	1450	*trans*-Linalool oxide(furanoid)	0.2	1845	1857	Geraniol	1.6
1528	1468	*trans*-1,2-Limonene epoxide	tr	1852	1864	*p*-Cymen-8-ol	0.1
1530	1474	*trans*-Sabinene Hydrate	0.3	1863	1882	*cis*-Carveol	0.1
1537	1478	*cis*-Linalool oxide(furanoid)	0.1	1954	2008	Caryophyllene oxide	0.1
1603	1546	*cis*-4-Decenal	tr	1962	2029	Perilla alcohol	tr
1605	1553	Linalool	6.4	1967	2030	Methyl eugenol	tr
1614	1562	Octanol	tr	1980	2050	*trans*-Nerolidol	0.9
1617	1565	Linalyl acetate	2.0	2027	2113	Cuminol	tr
1622	1571	*trans-p*-Menth-2-en-1-ol	0.2	2071	2186	Eugenol	tr
1633	1586	Pinocarvone	tr	2079	2198	Thymol	tr
1641	1590	Bornyl acetate	tr	2098	2239	Carvacrol	tr
1657	1611	Terpinen-4-ol	2.8	2131	-	Carvone acetate	0.2
1661	1616	Hotrienol	0.1	2173	2349	Geranic acid	0.1
1666	1624	*cis*-Dihydrocarvone	tr	2365	2369	2*E*,6*E*-Farnesol	0.1
1677	1638	*cis-p*-2-Menthen-1-ol	0.2	2908	2931	Hexadecanoic acid	0.3
1704	1670	*trans*-Pinocarveol	tr			**Total**	**96.9**

Note: [a] Retention indices on an HP-Innowax capillary column; tr(trace), relative content < 0.1 %; [b] Identification was based on the comparison of retention indices with those of published data (NIST); [c] Compounds are listed in order of elution from HP-Innowax capillary column. Identification by comparison of mass spectra with the respective data of NIST, Wiley and Adams libraries in total ion current (TIC) and retention indices as calculated according to Kovats for alkanes C_7-C_{29} compared with the ones reported by Adams, as well as the literature.

CONCLUSION

Cardamom is an important spice crop for its dried capsules. The aromatic seeds are used as common spice and flavoring agent, antimicrobial and medicinal properties. The results of this study indicate that cardamom essential oil showed diversity could be a result of the plant chemotypes, climatic conditions, harvesting time and nutritional status. The cardamomis widespread all over the world, and has been used as traditional herbal medicines by local people. Phytochemical investigation of cardamom has revealed that many components are highly bioactive. Therefore, phytochemical, biological and chemical compositional studies of this genus should be intensified.

Acknowledgment

The authors gratefully thank to the Unit of the Scientific Research Projects of İnönü University for its financial support (Project no: 2008/34).

REFERENCES

[1] Menon AN, Chacko S and Narayanan CS. 1999. Free and glycosidically bound volatiles of cardamom (*Elettaria cardamomum* Maton var. *miniscula* Burkill). Flavour Fragrance Journal. 14: 65-68.

[2] Lwasa S and Bwowe F. 2007. Exploring the Economic Potential of Cardamom *(Elettaria cardamomum)* as an alternative and promising income source for Uganda's smallholder farmers. ACSS Science Conference Proceedings. 8: 1317-1321.

[3] Tyagi RK, Goswami R, Sanayaima R, Singh R, Tandon R and Agrawal A. 2009. Micropropagation and slow growth conservation of cardamom (*Elettaria cardamomum* Maton). In Vitro Cellular and Developmental Biology - Plant. 45: 721–729.

[4] Prasath D and Venugopal MN. 2009. Compound inflorescence cardamom (*Elettaria cardamomum* (L.) Maton) in India. Genetic Resources and Crop Evolution. 56: 749–753.

[5] Kaushik P, Goyal P, Chauhan A and Chauhan G. 2010. *In Vitro* Evaluation of Antibacterial Potential of Dry Fruit Extracts of *Elettaria cardamomum* Maton (Chhoti Elaichi). International Journal of Production Research. 9: 287-292.

[6] Josephrajkumar A, Chakrabarty R and Thomas G. 2005. Occurrence of trypsin-like protease in cardamom (*Elettaria cardamomum* Maton). Indian Journal of Biochemistry and Biophysics. 42: 243-245.

[7] Farah AJ, Siddiqui A, Aslam M, Javed K and Jafri MA. 2005. Antiulcerogenic activity of *Ellettaria cardamomum* Maton. and *Amomum subulatum* Roxb. seeds. Indian Journal of Traditional Knowledge. 4: 298-302.

[8] Verma K, Jain V and Katewa SS. 2009. Blood pressure lowering, fibrinolysis enhancing and antioxidant activities of cardamom (*Elettaria cardamomum*). Indian Journal of Biochemistry and Biophysics. 46: 503-506.

[9] Adams RP. 2007. *Identification of Essential Oil Component by Gas Chromatography/ Mass Spectrometry*, (4th ed.). IL: Allured Publishing Co.: Carol Stream.

[10] Van den Dool, H., &Kratz, P.D. 1963. A generalization of the retention index system including linear temperature programmed gas-liquid partition chromatography. Journal of Chromatography. 11: 463-471.

[11] NIST Standard Reference Database Number 69, Eds. P.J. Linstrom and W.G. Mallard, National Institude of Standard and technology, Gaithersburg MD, 20899. http://webbook.nist.gov.

[12] Singh G, Kiran S, Marimuthu P, Isidorov V and Vinogorova V. 2008. Antioxidant and antimicrobial activities of essential oil and various oleoresins of *Elettaria cardamomum* (seeds and pods). Journal of the Science of Food and Agriculture. 88: 280-289.

[13] Gopalakrishnan N and Cadavallur CS. 1991. Supercritical Carbon Dioxide Extraction of Cardamom. Journal of Agricultural and Food Chemistry. 39: 1976-1970.

[14] Sultana S, Ali M, Ansari SH and Bagri P. 2009. Effect of physical factors on the volatile constituents of Elettaria cardamomum fruits. Journal of Essential Oil Bearing Plants. 12(3): 287-292.

[15] Khalaf NA, Shakya AK, Al-Othman A, El-Agbar Z and Farah H. 2008. Antioxidant Activity of Some Common Plants. Turkish Journal of Biology. 32: 51-55.