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ScienceDirect
Food Chemistry 110 (2008) 501–503
FOOD CHEMISTRY
www.elsevier.com/locate/foodchem

Comparative essential oil composition of flowers, leaves and stems of basil (*Ocimum basilicum* L.) used as herb

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Received 16 November 2007; received in revised form 31 January 2008; accepted 10 February 2008

Abstract

The chemical composition of flower, leaves and stems from basil (*Ocimum basilicum* L.) have been examined by GC and GC–MS. The identified components constituting 99.03%, 95.04% and 97.66% of the flower, leaves and stem oils, respectively. The main constituents of the essential oil of flower, leaves and stem oils, respectively, were estragole (58.26%, 52.60% and 15.91%) and limonene (19.41%, 13.64% and 2.40%) and *p*-cymene (0.38%, 2.32% and 2.40%). Dill apiole (50.07%) was identified as the highest main constituent for stem. Estragole (15.91%), apiole (9.48) and *exo*-fenchyle acetate (6.14%) followed in order to decreasing them. Minor qualitative and major quantitative variations for some compounds of essential oils were determined with respect to different parts of *O. basilicum*. It was reported that the chemical composition of different parts oils of basil are very variable. It is known that specific estragole chemotypes are also known.

Keywords: Basil; *O. basilicum*; Lamiaceae; Essential oil; Estragol; Dillapiole

1. Introduction

Basil (*Ocimum basilicum* L.; Lamiaceae family) grows in several regions all over the world (Akgül, 1993; Baritaux, Richard, Touche, & Derbesy, 1992; Özcan & Chalchat, 2002). Basil is called as ‘‘fesleğen’’ or ‘‘reyhan’’ in Turkish (Akgül, 1993). It is herbaceous, 20–60 cm length and white-purple flowering plant which comes from India and Iran. Basil is one of the species used for the commercial seasoning. It is commonly known that the presence of essential oils and their composition determine the specific aroma of plants and the flavour of the condiments (Akgül, 1989; Marotti, Piccaglia, & Giovanelli, 1996; Martins et al. 1999; Sanda, Koba, Nambo, & Gase, 1998). Fresh and dried basil is widely used in the Mediterranean kitchen such as tomato product, vegetables, salads pizza, meat, soups and marine foods (Akgül, 1989; Akgül, 1993; Heath, 1981; Machale, Niranjan, & Pangarkar, 1997; Özcan & Chalchat, 2002; Simon, Quin, & Murray, 1990). Also, basil is well known as a plant of a folk medicinal value and as such is accepted officially in a number of countries (Heath, 1981; Lawrence, 1985). The leaves of basil is used in pharmacy for diuretic and stimulating properties, in perfumes compositions (Baritaux et al., 1992; Baytop, 1984; Khatri, Nasır, Saleem, & Noor, 1995). Martins et al. (1999) reported that basil oil is beneficial for the alleviation of mental fatigue, colds, spasms, rhinitis, and as a first aid treatment for wasp stings and snake bites. Chemical compositions of the essential oils of *O. basilicum* have previously been established (Akgül, 1989; Özcan & Chalchat, 2002). Available information indicates that the essential oil of stems of *O. basilicum* have not been studied before. As part of a program of chemical investigation on essential oil of Turkey native basil, we report the essential oil constituents of flower, leaves and stem of *O. basilicum*.

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doi:10.1016/j.foodchem.2008.02.018

2. Materials and methods

2.1. Plant materials

Aerial parts of *O. basilicum* at flowering stage were collected from Mersin province (Büyükeceli-Gülnar) in August 2005 at the sea level. The flowers, leaves and stem were separated by hand from other one other. Samples were dried at the shade. Plant was identified and authenticated by a plant taxonomist. Voucher specimen was kept at the Herbarium of the Department of Food Engineering, University of Selcuk.

2.2. Recovery of the essential oils

Dried aerial parts (flowers, leaves and stems) of the plants (200 g) were separately ground and submitted to hydrodistillation for 4 h using a clevenger-type apparatus and the oils obtained were dried over anhydrous sodium sulfate. The essential oils for flowers, leaves and stems were light yellow with yield of 0.5%, 1.0% and 0.05% v/w, respectively, on dry basis.

2.3. Identification of components

For identification of components, analytical Hp 5890 gas chromatograph equipped with FID (GC) was performed a DELSI 121 C apparatus fitted with a flame ionization detector and a CP WAX 51 fused silica column (25 m × 0.3 mm; 0.25 μm film thickness). Temperature was programmed from 50 °C for 5 min and programmed to reach 220 °C at the rate of 3 °C/min. ACP WAX 51 fused silica WCOT column (60 m × 0.3 mm) for GC/MS was used with helium as carrier gas. For GC/MS a CPWAX 52 fused silica CB column (50 m × 0.25 mm) was used with helium as carrier gas (flow rate 1 ml/min) and coupled to a HP mass spectrometer: ionization energy 70 eV. Temperature programming was from 50–240 °C at the rate 3 °C/min. The samples were injected at injector temperature 240 °C. The components were identified by comparing linear Kovats indices (KI), their retention times (RT) and mass spectra with those obtained from the authentic samples and/or the MS library.

The percentage composition of the essential oils was computed from 6C peak areas without correction factors. Qualitative analysis was based on a comparison of retention times and mass spectra with corresponding data in the literature (Adams, 2001).

3. Results and discussion

The essential oils exhibited light yellow colour and typical basil odour. The yields of the essential oil of flowers, leaves and stems from *O. basilicum* were 0.5%, 1.0% and 0.05% (v/w), respectively. Essential oil yields of three parts were found as different amounts. In this study, a total of 24, 28 and 36 compounds were established, which account for about 99.03%, 95.04% and 97.66% of the essential oils of *O. basilicum*, respectively. The components identified in the essential oils of all parts of *O. basilicum* are listed in Table 1 in order of their experimental retention times and retention indices.

Table 1
Volation oil composition of flower, leaves and stems of *O. basilicum* (%)

RT	RI	Parts			
		Compounds	Flower	Leaves	Stem
10.53	928	α-Thujene	0.03	0.05	0.09
10.77	935	α-Pinene	0.62	0.46	0.10
11.29	950	Camphene	0.18	0.11	–[a]
12.18	975	Sabinene	0.03	0.07	0.09
12.28	978	β-Pinene	0.03	0.05	0.08
12.81	991	Myrcene	1.28	0.81	0.26
13.30	1006	α-Phellendrene	4.37	4.15	1.66
13.45	1012	δ-3-Carene	0.04	–	–
13.99	1028	*p*-Cymene	0.38	2.32	1.66
14.23	1031	Limonene + β-phellandrene	19.41	–	–
14.21	1034	Limonene	–	13.64	2.40
14.22	1035	1,8-Cineole	–	–	1.04
14.42	1040	(*Z*)-β-Ocimene	1.59	0.31	0.07
14.74	1050	(*E*)-β-Ocimene	0.08	–	–
15.09	1061	γ-Terpinene	0.10	0.17	0.51
16.18	1093	Fenchone	10.10	5.70	0.36
16.57	1107	2-Ethylbutanoate 3-methylbutyle	–	0.07	–
17.14	1125	Mentha-2,8-dien-1-ol *trans*	–	0.08	–
16.43	1102	Isoamyle isovalerate	0.07	–	–
17.62	1142	Limonene oxide	–	0.06	–
16.58	1107	Linalool	0.03	–	0.32
18.26	1162	*Trans*-non-2-enol	–	–	0.17
18.85	1182	Terpinen-4-ol	–	–	0.19
17.86	1149	Camphre	0.19	0.16	–
19.79	1213	Estragole	58.26	52.60	15.91
20.16	1226	*Endo*-fenchyle acetate	0.61	1.30	0.31
20.54	1233	*Exo*-fenchyle acetate	1.15	10.99	6.14
21.94	1290	Bornyle acetate + *trans*-anethole	–	–	0.20
23.85	1356	Eugenol	–	–	0.12
22.72	1314	(*E*,*E*)-Decan-2,4-dienal	–	–	0.29
23.62	1352	α-Terpinyl acetate	–	–	0.38
21.94	1289	*Trans*-anethole	0.23	0.55	0.10
22.25	1300	Carvacrole	–	0.30	–
24.38	1381	α-Copaene	–	0.08	–
25.01	1406	Methyle eugenol	0.03	0.18	0.06
25.46	1423	β-Caryophyllene	–	0.08	0.51
27.26	1496	β-Dihydro aparofuran	–	–	0.64
28.71	1537	Kessane	–	–	1.21
28.81	1557	Elemicine	–	–	0.30
29.13	1578	(*Z*)-Isoelemicine	–	–	0.23
29.54	1596	Caryophyllene oxide	–	–	1.55
30.11	1621	1,2-Epoxyhumulene	–	–	0.10
30.75	1622	Dill apiole	–	–	50.07
31.81	1681	Apiole	–	–	9.48
26.20	1453	α-Humulene	–	–	0.08
27.05	1484	Germacrene D	0.19	0.47	0.07
28.01	1520	δ-Cadinene	–	0.11	–
28.01	1528	Cyclobazzanene	0.03	–	–
30.78	1642	Phenyl ethyl hexanote	–	0.10	–
31.91	1703	β-Sinensal	–	0.07	–
38.63	2041	(*Z*)-Falcarinol	–	–	0.91
Total			99.03	95.04	97.66

[a] Not identified.

The major components of different parts of *O. basilicum* were estragole, α-phellendrere, limonene, fenchone. The main constituents of flower oil were estragole (58.26%), fenchone (10.1%), limonene + β-phellandrene (19.41%) and α-phellandrene (4.37%), while estragole (52.60%), limonene (13.64%), *exo*-fenchyle acetate (10.99%), fenchone (5.70%), α-phellandrene (4.15%) and *endo*-fenchyle acetate (1.30%) were established as the main components of basil leaves. Dill apiole (50.07%), estragole (15.91%), *exo*-fenchyle acetate (6.14%), limonene (2.4%), α-phellandrene (1.66%), *p*-cymene (1.66%), caryophyllene oxide (1.55%), kessane (1.21%) and apiole (9.48%). As seen, dill apiole was identified as the highest main constituent for stem. Whereas, flower and leave oils were found rich in estragole constituent. The monoterpenic hydrocarbons were found to be low in all sample oils. Also, the amounts of oxygenated compounds such as 1,8-cineole, linalool in oils were found to be low. But, all the oils consisted of monoterpenic hydrocarbons, oxygenated monoterpenes and sesquiterpenes .

A few reports on the essential oil of this species from different or similar origins have been published previously. The oil obtained from air dried parts (flower and leaves) of *O. basilicum* with Turkish origin contained methyl eugenol (78.016%), and α-cubebene (6.17%) (Özcan & Chalchat, 2002). It was previously reported that the oil of leaves of *O. basilicum* contained linalool (69%), eugenol (10%), (*E*)-α-bergamotene (3%) and thymol (2%) (Keita, Vincent, Schmit, & Belanger, 2000). Linalool (45.7%), eugenol (13.4%), methyl eugenol (9.57%) and fenchyl alcohol (3.64%) were reported to be the main components of the previously analyses materials (basil leaves) (Akgül, 1989). Khatri et al. (1995) found estragole (87.3%), linalool (5.4%), methyl eugenol (1.5%), β-caryophyllene (2.4%), α-pinene (1.0%), β-pinene (0.8%), limonene (0.5%) and camphene (0.2%) in sweet basil oil. Marotti et al. (1996) reported the presence of linalool, estragole and eugenol as main components of *O. basilicum*. In other study, the major compounds reported were linalool and estragole in basil oil (Lachowichz et al., 1996). Our results were generally different according to literature findings as concerns the major compounds. The observed differences may be probably due to genetic factors, different chemotypes and the nutritional status of the plants as well as other factors that can influence the oil composition. At the same time, results indicated that the oil of Turkish basil belonged to estragole rich type.

Acknowledgement

This work was supported by Selçuk University Scientific Research Project (S.U.-BAP, Konya-Turkey).

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