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Composition of Essential Oil in Sweet Fennel (*Foeniculum vulgare* Mill. var. dulce) Lines Originated from Turkey

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This study was carried out to investigate the content and chemical composition of essential oil in 20 sweet fennel lines originated from Turkey. The water-distilled essential oil from dried fruits was analyzed by GC-MS. The essential oil ratios among lines ranged from 1.30 to 4.44 %. The first five components with the highest values in the contents of the essential oil of lines accounted for more than average 98 % of the oil. α-Pinene (0.4 %), myrcene (0.15 %), 3,7-dimethyl-1,3,6-octatriene (0.64 %) and *p*-anisaldehyde (0.95 %) were found below 1 % regarding average values. *trans*-Anethole (79.18-88.17 %), estragole (4.59-6.34 %), limonene (2.18-7.12 %) and α-fenchone (0.97-7.03 %) were found as main constituents.

Key Words: *Foeniculum vulgare* Mill. var. dulce, Sweet fennel, Essential oil, *trans*-Anethole, Estragole, Limonene.

INTRODUCTION

Sweet fennel (*Foeniculum vulgare* Mill. var. dulce, family Apiaceae) is an annual aromatic herb growing wild or cultivated in many regions of the world[1-3]. Sweet fennel is one of the cultivated medicinal and aromatic crops in Turkey. Dried ripe fruit (seed) of fennel is used in folk medicine as a stimulant, diuretic, carminative or sedative and to increase the milk of nursing mothers. In addition, it is recommended to remedy various diseases or sicknesses (indigestion, wind, bronchitis, coughs, sore throat and gum disease, *etc.*)[1,4-6]. Experimentally, it has been shown to increase liver regeneration[2,7]. Essential oil from seeds of fennel has been exhibited to have antioxidant and antibacterial activities and is used in cosmetics, pharmaceuticals, perfumery and as a food additive[8]. It is known that the composition and ratio of essential oil from aromatic plants vary with respect to some factors such as genotype, origin and growing conditions[9,10]. The purpose of this study was to investigate the content and chemical composition of essential oil in 20 sweet fennel lines from Turkey.

EXPERIMENTAL

The study was carried out at the experimental field and laboratories of Field Crops Department, Faculty of Agriculture of Ankara University in 2005. 20 Sweet fennel lines developed by single plant selection method in the department were used as the study material.

100 g of fruits were distilled for 3 h in 500 mL water using a Clevenger-type apparatus to produce oil. The essential oil was analyzed by GC-MS. The analysis was performed using a Hewlett Packard 6890 N GC, equipped with HP-5 MS capillary column (30 m × 0.25 μm) and HP 5973 mass selective detector. For GC-MS detection an electron ionization system with ionization energy of 70 eV was used. Helium was carrier gas, at a flow rate of 1 mL/min. Injector and MS transfer line temperatures were set at 220 and 290 ºC, respectively. Column temperature was initially kept at 50 ºC for 3 min, then gradually increased to 150 ºC at a 3 ºC/min rate, held for 10 min and finally raised to 250 ºC/min. Diluted samples (1/100 in acetone, v/v) of 1.0 μL were injected automatically and in the splitless mode[11]. Individual components were identified by spectrometric analyses using computer library.

RESULTS AND DISCUSSION

The ratios of essential oil ranged from 1.30 % (in line-10) to 4.44 % (in line-7). Similar values were recorded in previous studies[9,12]. The average ratio of essential oil in lines was 2.44 %. Eight lines had higher values than average essential oil ratio (Table-1).

TABLE-1
MAJOR ESSENTIAL OIL CONSTITUENTS IN SWEET FENNEL LINES

Lines	Essential oil ratio (%)	Compounds	RT	(%)
Line-1	2.18	Limonene	12.98	4.16
		α-Fencone	15.81	2.75
		Estragole	21.35	5.39
		p-Anisaldehyde	23.92	0.97
		trans-Anethole	26.06	85.57
		Total	–	98.83
Line-2	2.12	α-Pinene	8.47	0.83
		Limonene	12.99	7.12
		α-Fencone	15.83	5.96
		Estragole	21.34	5.37
		trans-Anethole	25.92	79.18
		Total	–	98.46

Lines	Essential oil ratio (%)	Compounds	RT	(%)
Line-3	3.00	Limonene	12.69	3.03
		α-Fencone	15.43	5.97
		Estragole	20.65	5.74
		p-Anisaldehyde	23.08	1.23
		trans-Anethole	25.03	82.74
		Total	–	98.71
Line-4	2.18	Limonene	12.71	5.35
		α-Fencone	15.38	0.97
		Estragole	20.66	6.34
		p-Anisaldehyde	23.07	1.63
		trans-Anethole	25.03	84.30
		Total	–	98.59
Line-5	2.27	Limonene	12.71	4.03
		α-Fencone	15.44	7.03
		Estragole	20.65	5.59
		p-Anisaldehyde	23.08	1.01
		trans-Anethole	25.02	80.09
		Total	–	97.75
Line-6	2.23	Limonene	12.73	7.07
		α-Fencone	15.42	4.83
		Estragole	20.65	5.66
		p-Anisaldehyde	23.08	1.13
		trans-Anethole	25.05	79.55
		Total	–	98.24
Line-7	4.44	Limonene	12.71	4.33
		α-Fencone	15.41	4.52
		Estragole	20.65	6.21
		p-Anisaldehyde	23.08	1.57
		trans-Anethole	25.06	82.07
		Total	–	98.70
Line-8	1.90	Limonene	12.98	4.19
		3,7-Dimethyl-1,3,6-octatriene	13.48	0.49
		α-Fencone	15.80	1.05
		Estragole	21.34	5.08
		trans-Anethole	26.00	88.17
		Total	–	98.98
Line-9	3.00	Limonene	12.96	2.18
		α-Fencone	15.83	4.38
		Estragole	21.34	5.00
		p-Anisaldehyde	23.93	0.73
		trans-Anethole	26.00	86.99
		Total	–	99.28

Lines	Essential oil ratio (%)	Compounds	RT	(%)
Line-10	1.30	α-Pinene	8.47	0.53
		Limonene	12.97	3.49
		α-Fencone	15.83	5.37
		Estragole	21.33	5.02
		trans-Anethole	25.91	84.47
		Total	–	98.88
Line-11	2.85	Limonene	12.69	4.44
		α-Fencone	15.40	5.59
		Estragole	20.61	4.59
		p-Anisaldehyde	23.07	0.73
		trans-Anethole	24.94	83.08
		Total	–	98.43
Line-12	2.24	Limonene	12.98	5.02
		α-Fencone	15.84	5.79
		Estragole	21.35	6.30
		p-Anisaldehyde	23.93	1.26
		trans-Anethole	25.96	79.68
		Total	–	98.05
Line-13	2.40	Limonene	12.97	2.89
		α-Fencone	15.82	3.35
		Estragole	21.34	4.80
		p-Anisaldehyde	23.93	0.64
		trans-Anethole	26.01	87.20
		Total	–	98.88
Line-14	2.29	Limonene	12.70	4.00
		α-Fencone	15.42	6.12
		Estragole	20.64	5.37
		p-Anisaldehyde	23.08	1.13
		trans-Anethole	25.00	81.97
		Total	–	98.59
Line-15	2.30	Limonene	12.98	3.64
		α-Fencone	15.82	3.59
		Estragole	21.34	4.92
		p-Anisaldehyde	23.92	0.57
		trans-Anethole	26.02	86.17
		Total	–	98.89
Line-16	1.38	Limonene	12.99	5.47
		3,7-Dimethyl-1,3,6-octatriene	13.48	0.60
		α-Fencone	15.83	4.75
		Estragole	21.35	5.22
		trans-Anethole	26.04	81.24
		Total	–	97.28

Lines	Essential oil ratio (%)	Compounds	RT	(%)
Line-17	2.50	Limonene	12.71	6.47
		α-Fencone	15.40	4.72
		Estragole	20.63	4.96
		p-Anisaldehyde	23.08	0.81
		trans-Anethole	24.96	81.96
		Total	–	98.92
Line-18	2.84	Limonene	12.74	6.47
		α-Fencone	15.40	1.81
		Estragole	20.67	6.07
		p-Anisaldehyde	23.08	1.03
		trans-Anethole	25.05	83.15
		Total	–	98.53
Line-19	2.70	Limonene	12.71	3.79
		α-Fencone	15.41	3.61
		Estragole	20.66	6.02
		p-Anisaldehyde	23.08	0.77
		trans-Anethole	25.11	84.42
		Total	–	98.61
Line-20	2.60	Limonene	12.70	2.85
		α-Fencone	15.44	6.05
		Estragole	20.67	6.29
		p-Anisaldehyde	23.08	1.29
		trans-Anethole	25.05	82.02
Average	2.44	Total	–	98.50

The first five components with the highest values in the contents of the essential oil of lines accounted for more than average 98 % of the oil. *trans*-Anethole, estragole, limonene, α-fencone and *p*-anisaldehyde were recorded as five major components for other lines except for line-2, line-8, line-10 and line-16 (Table-1). α-Pinene, myrcene, 3,7-dimethyl-1,3,6-octatriene and *p*-anisaldehyde were found below 1 % regarding average values. *trans*-Anethole (79.18-88.17 %), estragole (4.59-6.34%), limonene (2.18-7.12 %) and α-fenchone (0.97-7.03 %) were found as main constituents. Strehle *et al.*[10] reported that major constituent of sweet fennel oil was *trans*-anethole (84.6 %), followed by relative small amounts of α-fenchone (2.7 %) and limonene (5.1 %). Generally, in sweet fennel oil the anethole content reaches 84-90 %[13-15].

The major differences in the contents of limonene and α-fenchone were recorded among lines. In the essential oil of sweet fennel the fenchone content usually does not exceed 5 %[10,13]. Contrary to that, in line-5, line-14

and line-20, α-fenchone ratios were recorded as 7.03, 6.12 and 6.05 %, respectively. Minimum and maximum limonene contents were obtained from line-9 (2.18 %) and line-2 (7.12 %), respectively. In previous studies, limonene ratios were reported as 3.9-4.4, 3.73 and 5.1 %, respectively[9,10,16].

Based on these results, some differences were observed among lines with respect to the content and main constituents (especially, limonene and α-fenchone) of essential oil. Maximum essential oil ratio was taken from line-7 and maximum *trans*-anethole content was determined in line-8.

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