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Variation in essential oil composition of coriander (*Coriandrum sativum* L.) varieties cultivated in two different ecologies

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ABSTRACT

Coriander, *Coriandrum sativum* L, is an important medicinal plant belonging to Apiaceae family, which is grown in many parts of Turkey. In this study, essential oil and composition of 6 Turkish coriander cultivars (Gamze, Arslan, Erbaa, Pelmus, Kudret, Gürbüz) were examined in two different (Mardin and Tokat) ecologies. Essential oils were isolated with distillation method in maturated fruits and component composition was determined with gas chromatography–mass spectrometry (GC-MS). Main component was linalool in all cultivar, and it was higher in the conditions of Mardin having a warmer climate in all the cultivars than that of Tokat with temperate climate. Contrary to linalool, α-pinene and neryl acetate contents of all cultivar were higher in Tokat.

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Coriandrum sativum L; ecology; linalool; α-pinene; nerylacetate

Introduction

Genus *Coriander*, belonging to Apiaceae (Umbelliferae) family, is represented with 2 species, *C. sativum* and *C. tordylium* (Fenzl) Bornm in Flora of Turkey (1), and species *C. sativum* contains two varieties (var. *vulgare* and var. *microcarpum*). *C. sativum* var. *vulgare* Alef is known as a coriander with big grain while *C. sativum* L. var. *microcarpum* DC. is known as a coriander with small grain (2–4).

Coriander is an aromatic plant and is known by the names such as 'kişniş, aşotu, kuzbere' (5) in Turkish. It is widely used in many areas mainly food, medicine, perfumery and cosmetic due to the aromatizer and therapeutic properties thereof (6). It is widely cultivated all around the world, and India is the largest producer of coriander. Other producer countries are Russia, Poland, Bulgaria, England, Holland, Morocco, Egypt and Turkey (7–9). In the studies made on varieties of Turkish origin, essential oil ratio was higher in small grained varieties (10, 11).

In addition to being consumed as fresh leaves and herb, full maturated fruits are mainly used as spice or in confectionery items, sauce, meat and dairy products, drink and perfumery industry (12). Moreover, it can also be used for medical purposes due to its appetizing, gas expectorant and digestive properties (13). Its seed and oil have an important commercial value.

Variation of essential oil content and composition in plants depends upon their genetic structure, climatic conditions and agronomic practices (10, 11, 14). Coriander is cultivated in various regions of Turkey. In recent years, increase of the volume of trade has made the production of these plants attractive to the growers. Since qualities of aromatic plants are the mainly important for user and industry, climatic factors and genetic structure of plant have important role on yield and quality of the plants. New coriander cultivar, Gamze, Arslan, Erbaa, Pelmus, Kudret and Gürbüz, were registered recently in Turkey and there aren't any records on comparison of essential oil variation for different environments. Thus, aim of the research is to examine the effects of two different environments (Mardin and Tokat) on oil composition of new Turkish coriander cultivar.

Material and method

Plant material and field studies

In the study, 6 coriander cultivars (Gamze, Arslan, Erbaa, Pelmus, Kudret, Gürbüz) registered in Turkey were used as plant material. Field studies were conducted in two different ecologies. One of these was conducted in Gaziosmanpaşa University, Agricultural Research

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Center Experimental Field in Tokat, Kazova, located Middle Black Sea Region, and the other was conducted in Artuklu University experimental field of Mardin in the Southeastern Anatolia Region of Turkey. In both locations, seeds were sown in the middle of October. In the experiment, the climate has a transition climate property between Continental climate and Mediterranean climate in Mardin. Rainfall amount of the location during plant growing period is insufficient. Summers are hot and winters are cold. Snowy days are maximum 10 days and days below zero are maximum 60 days. Approximately, 100 days are above 30 °C in a year. Climate of Tokat, on the other hand, exhibits a transition property between the climate of the Black Sea region and the Central Anatolia region. It rains in each season of the year in Tokat. In 50 days of the year, the temperature is below 0 °C and 40 days are above +30 °C. Summers are very hot in hollow valleys. Data of precipitation and temperature during active growing and maturation periods of plant (March-July) were summarized in Table 1.

Cultivars were grown in both locations with three replications. Seed were sown during winter periods in both locations. In the experiment, parcel lengths, inter-row (with 6 rows) were arranged as 3 m, 30 cm, respectively. In all rows, distance between two plants was 5 cm. Parcel area was 5.4 (3 × 1.8) m^2. Fifty kilogram pure N and P_2O_5 per hectare fertilizer were given to the parcels. All of the phosphorus fertilizer was given with the sowing while half of the nitrogen fertilizer was given with the sowing and the other half was given in the bolting period. During cultivation, necessary agronomic practices including weed control were made. In total ripening period, all plant of the centre four rows of each parcel were harvested by hand, and fruits were separated from stem for essential oil and chemical analysis.

Isolation of essential oil

Essential oil was isolated using a Clevenger apparatus (15). Distilled water (200 ml) was used for the distillation of full matured fruits (20 g). Distillation time was approximately 4 h at boiling point. The oil phase was separated and dried over anhydrous sodium sulphate and kept in dark glass bottle at 4 °C for analyses.

Table 1. Precipitation and temperature variation of locations.

	Mardin		Tokat	
	Precipitation (g/m^2)	Temperature (°C)	Precipitation (g/m^2)	Temperature (°C)
March	97.3	8.0	41.6	7.4
April	81.0	13.5	54.9	12.5
May	44.6	19.4	59.7	16.5
June	4.7	25.6	38.2	19.9
July	1.3	29.9	10.6	22.3

Note: Turkish state meteorological service, 2014.

GC-MS analysis

Component analysis of essential oil was performed using a Perkin-Elmer GC having automatic Autosampler System equipped Flame ionization detector (FID) and a mass spectrometer-equipped with a BPX-5 apolar capillary column (30 m × 0.25 mm × 0.25 μm film). Helium, at a flow rate of 1.0 mL/minute, was used as carrier gas. Injector and MS transfer temperatures were, respectively, adjusted to be 230 and 250 °C. Oven temperature was programmed from 50 to 150 °C, at rate of 3 °C/min, held isothermal for 10 min and finally raised to 250 °C at 10 °C/min. The mass spectrometer conditions were as follows: transfer line temperature at 250 °C, ion source at 250 °C and the ionization energy at 70 eV. Diluted samples with acetone (1/10 v/v) of 0.1 μL were injected using auto sampler in split mode (5:1). As a result of the analyses, components were defined with the comparison of the retention times of the present standards (linalool, D-limonene and α-pinene) in laboratory and with the comparison of the Mass spectra with the spectra of the components provided in WILLEY and NIST libraries. Linear retention index on SGE-BPX5 capillary column were compared with Relative linear retention index from literature (16–19). The relative peak area percentages of compounds were calculated based on the FID data.

Data analysis

The significance of differences between samples was tested by analysis of variance (ANOVA) and represented by critical value from an *F*-test (*F*) and statistical significance (*p*). Means of essential oil and major components with significant variation were compared bay using Duncan Multi Range Test. The analysis was performed using the SPSS software for Windows™ (version 17, SPSS Inc., Chicago, IL, USA).

Result and discussion

Essential oil content

The ecological variation in the essential oil contents was given in Tables 2 and 3. Variation of mean data of locations in essential oil contents was non-significant statistically and similar mean values were obtained in Mardin with 0.5% and Tokat with 0.5%. Essential oil contents were high in Erbaa, Pelmus and Kudret-K cultivars. While the same value was obtained in both ecologies in Erbaa cultivar, relatively high value was obtained in Pelmus and Kudret-K cultivars in Mardin location. Oil content was less statistically ($p < 0.01$) in Aslan cultivar as compared to other cultivars (Table 3). In this cultivar while essential oil contents was 0.2% in Tokat location, it was 0.3% in Mardin location. In the study, essential oil contents in four

Table 2. Variation of mean, standard deviation and F data in coriander essential oil content and components grown two different ecology.

			Mardin	Tokat	
Components[a]	RI[b]	RI[c]	(Mean ± sd)	(Mean ± sd)	*F* value
α-Pinene	923	919[16]	0.8 ± 0.5[b]	5.1 ± 1.1[a]	72.1**
Camphene	947	942[16]	0.5 ± 0.4	0.2 ± 0.3	1.4 ns
β-Pinene	979	980[16]	0.1 ± 0.0	0.1 ± 0.0	2.7 ns
β –Myrcene	1000	994[16]	0.3 ± 0.2[a]	0.1 ± 0.1[b]	5.7*
p-Cymene	1035	1036[16]	0.9 ± 0.4	0.6 ± 0.3	2.3 ns
Limonene	1041	1039[16]	0.6 ± 0.2[b]	1.1 ± 0.2[a]	9.7*
γ-Terpinene	1069	1068[16]	4.1 ± 1.6	3.0 ± 2.8	0.6 ns
α - Terpinolene	1087	1090[17]	0.1 ± 0.0	0.7 ± 1.7	0.6 ns
Linalool	1109	1110[18]	86.1 ± 4.3[a]	75.8 ± 2.7[b]	24.5**
Camphor	1052	1152[16]	2.4 ± 0.7	2.4 ± 0.3	0.4 ns
Decanal	1192	1189[17]	0.1 ± 0.0	0.1 ± 0.1	0.1 ns
Nerylacetate	1370	1365[19]	2.9 ± 0.8[b]	7.3 ± 2.4[a]	17.6**
Essential oil (%)			0.5 ± 0.1	0.5 ± 0.1	0.3 ns

[a]Components are listed in order of their elution from a SGE-BPX5 capillary column.
[b]Linear retention index on SGE-BPX5 capillary column.
[c]Relative linear retention index from literature (16–19).
*$p < 0.05$; **$p < 0.01$; ns: no significant.

cultivars were higher in Mardin than in Tokat. In Pelmus cultivar, however, essential oil ratios were higher in Tokat location than in Mardin location. In Erbaa cultivar, essential oil ratios did not change according to the ecologies; the same value (0.6%) was obtained in both locations.

In essential oil plants, essential oil changes according to the genetic structure make-up of the crops cultivar, climatic conditions of the region in which it is grown, cultivation practices adopted (10, 11, 14, 20). While Erbaa cultivar is not affected by the regions, the values of the four cultivars (Gamze, Arslan, Kudret-K and Gurbuz) were slightly higher in Mardin.

As per European Pharmacopeia, coriander fruit must have an essential oil concentration higher than 0.03% (21). Essential oil content of coriander varied from 0.2 to 0.6% in the research.

Oil composition

It was observed significant differences between main factor locations for linalool, α-pinene and nerylacetate. It was also tested significant interaction for linalool ($p < 0.05$), nerylacetate ($p < 0.01$) and γ-terpinene ($p < 0.01$). But, mean data between cultivar were unimportant, statistically (Table 3).

Similar to previous studies (4, 10, 11, 20), essential oil of coriander contained linalool, oxygenated monoterpene, as main components. Other compounds were neryl acetate, γ-Terpinene and α-pinene. Variations in these important compounds due to locations were given in Tables 2 and 3. Of these values, linalool, neryl acetate and α-pinene changed significantly ($p < 0.01$) according to the locations while non-significant according to cultivar (Table 3). Mean value of linalool was 86.1% in Mardin, and 75.8% in Tokat (Table 2). Contrary to linalool, nerylacetate and α-pinene contents were higher in Tokat location with 7.3 and 5.1% than that of Mardin with 2.9 and 0.8%, respectively. But, variation of the components in mean of cultivar was non important statistically (Table 3).

Oil composition of the aromatic plants is commonly dependent on the ecological conditions with their genetic structure (14, 20, 22). It is known that climatic factors with cloudy days, lower temperature and high

Table 3. Variation in essential oil content and major components of essential oil of coriander (*Coriandrum sativum* L) according to Location (L) and Cultivar (C).

		Gamze	Arslan	Erbaa	Pelmus	Kudret-K	Gürbüz	Mean[L]
Essential oil	Mardin	0.5	0.3	0.6	0.5	0.6	0.4	0.5[a]
	Tokat	0.4	0.2	0.6	0.6	0.5	0.4	0.5[a]
	Mean[C]	0.5[a]	0.3[b]	0.6[a]	0.6[a]	0.6[a]	0.4[a]	
Factors		L^{NS}		C^{*}		$L \times C^{NS}$		
Linalool	Mardin	82.2	92.1	90.4	86.3	84.1	81.5	86.1[a]
	Tokat	74.7	72.7	78.1	78.4	72.7	77.9	75.8[b]
	Mean[C]	78.5	82.4	84.3	82.4	78.4	79.7	
Factors		L^{**}		C^{NS}		$L \times C^{*}$		
α-Pinene	Mardin	0.3	1.5	0.7	0.7	1.5	0.4	0.9[b]
	Tokat	4.1	5.0	4.6	4.1	6.8	5.8	5.1[a]
	Mean[C]	2.2	3.3	2.7	2.4	4.2	3.1	
Factors		L^{**}		C^{NS}		$L \times C^{NS}$		
Nerylacetate	Mardin	3.6	1.7	2.3	2.8	3.3	3.9	2.9[b]
	Tokat	6.5	5.4	6.6	7.1	12.1	6.1	7.3[a]
	Mean[C]	5.1	3.6	4.5	5.0	7.7	5.0	
Factors		L^{**}		C^{NS}		$L \times C^{**}$		
γ-Terpinene	Mardin	4.2	1.7	3.2	4.3	4.5	6.7	4.1[a]
	Tokat	1.9	7.0	0.1	4.4	0.1	4.8	3.1[a]
	Mean[C]	3.1	4.3	1.7	4.4	2.3	5.8	
Factors		L^{NS}		C^{NS}		$L \times C^{**}$		

*$p < 0.05$;
**$p < 0,01$; NS: not significant.

amount of rainfall may have adverse effect on the accumulation of linalool (23). The earlier reports were in agreement to present results that linalool contents of all cultivar were high in Mardin locations with high temperature (Table 2). In a study by Telci et al. (10), linalool ratios were high in Diyarbakır having a climate similar to Mardin. It may be concluded that that there was a positive correlation between the temperature and linalool content (20).

Of the two locations, maximum linalool was obtained in Arslan and Erbaa cultivars with 92.1 and 90.4%, respectively. Studies with respect to the comparison of the linalool contents in these cultivars are limited (24). In a study made by Inan et al. (13) with the same cultivars in the conditions of Çukurova for two years, linalool ratios varied between 85 and 90%.

Contrary to linalool contents, α-pinene and neryl acetate contents in all cultivar were higher in Tokat location with temperate climate (Table 3). Although there are limited records on the component variation, the changes detected in the composition of coriander essential oil could result from complex chemical modifications of terpenes (25).

In conclusion, linalool, main component of coriander maturated fruits, was higher in all the cultivars in Mardin with warmer climate, the climate was especially more appropriate in order to obtain products with linalool, a highly prices aromatic product.

Disclosure statement

No potential conflict of interest was reported by the authors.

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