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Rosemary (*Rosmarinus officinalis* L.) cultivation studies under Ankara ecological conditions

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ABSTRACT

The composition of 48 essential oil samples, obtained by steam distillation of rosemary (*Rosmarinus oftiicinalis* L.) originated from six different locations of southern Turkey (Izmir, Aydin, Antalya, Mersin, Adana and Hatay) has been analyzed by capillary GC/MS in combination with retention indices. The essential oil yield ranged from 0.35% to 2.08%. Wide variation was observed among the lines regarding their essential oil yield. The highest mean essential oil yield was determined from the Mersin lines with 0.94%. The maximum amount for plant height (16.2 cm), branch per plant (20.48), fresh herb yield (3.34 t/ha), fresh leaf yield and dry leaf yield (0.82 t/ha) was devoted to the lines provided from Antalya province. The essential oil composition of the lines changed from 14.3% to 17.5% camphor, 11.0–21.6% eucalyptol and 10.2–12.5% α-pinene.

1. Introduction

Rosemary (*Rosnmarinus oflicinalis* L.) is a well-known evergreen shrub with a characteristic aromatic smell. It is a member of the important Labiatae family (Lamiaceae), which comprises up to 200 genera and about 3500 species, and it is naturally found in all of the coastal regions of the Mediterranean Sea (do Amaral Franco and da Rocha Afonsa, 1972). Rosemary leaves are a very common spice and its oil is used in fragrance flavor industry aromatherapy (Mizrzhi et al., 1991), antioxidant activity (Tena et al., 1997; Bicchi et al., 2000; Wada et al., 2004), antimiccrobial and antitumour properties (Baratta et al., 1998; Pintore et al., 2002; Almela et al., 2006).

Several studies regarding the chemical composition of the essential oils of *R. officinalis* L. from different geographic origins have been performed and demonstrated some chemical variability (Arnold et al., 1997; Dellacassa et al., 1999; Porte et al., 2000; Diab et al., 2002; Pintore et al., 2002). This study aims at improving lines with high essential oil yield and wide adaptability to Central Anatolian climatic conditions. The same method was performed by the authors in *Sepia officinalis* in which some lines were introduced to Turkish Ministry of Food Agriculture and Livestock as potential varieties. The process is currently being done to evaluate suggested lines. Naturally, some main characters like yield and volatile oil and even some components are of importance as well. In the current study, lack of reference genotype led authors to perform inter-line comparison. For this to be done, it was planned to search for promising lines all over the coastal region of Southern-Western Turkey. Finally, to improve some elite lines, 5–6 years of experiment is needed.

2. Material and methods

2.1. Plant material

Cuttings of natural growing plants were collected from six different provinces (Izmir, Aydin, Antalya, Mersin, Adana and Hatay) located in the western and southern coastal belt of Turkey in May 2012.

2.2. Experimental area

Rooted cuttings from every line were planted in the experimental fields of Ankara University Agronomy Faculty laid on augmented trial technique with three lines per location as references. Ankara has an elevation of 948 m, located at 40 07N Latitude and 032 59E Longitude. It has a typical continental climate; hot, dry sum-

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Table 1
F and LSD values from analysis of variance.

		F value	LSD
Plant height	Blocks	2.31	3.01
	Control vs. lines	9.37[b]	2.30
Number of branches	Blocks	8.14[b]	3.90
	Control vs. lines	6.23[a]	2.98
Fresh herb yield	Blocks	2.20	1.31
	Control vs. lines	9.24	1.00
Dry herb yield	Blocks	2.97	0.48
	Control vs. lines	5.37[a]	0.37
Fresh leaf yield	Blocks	3.02	73.47
	Control vs. lines	12.81[b]	56.11
Dry leaf yield	Blocks	4.89[a]	24.64
	Control vs. lines	10.02[b]	18.81
Essential Oil Yield	Blocks	0.77	0.57
	Control vs. lines	0.89	0.44

Blocks:city of collected material.
[a] 0.01:statistically significant.
[b] 0.05:statistically significant.

mers and cold, snowy winters. The annual average precipitation in Ankara is 382 mm, which is just half the level recorded in the southern coastal region, 650–1300 mm depending on location.

2.3. Isolation of essential oil

Dried and crushed herb material (100 g each) was distilled for 3 h using Clevenger-type apparatus. The yellowish-color essential oils stored at refrigerator until use.

2.4. Analysis of essential oil components

The essential oil was broken down by GC/MS. The analysis was done 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 the carrier gas, at a flow rate of 1 mL min^{-1}. Injector and MS transfer line temperatures were set at 220 and 290 °C, respectively. Column temperature was initially kept at 50 °C for 30 min, then imperceptibly increased to 150 °C at a 3 °C min^{-1} rate, held for 10 min, and finally raised to 250 °C. Diluted samples (1/100 in acetone, v/v) of 1.0 μL were injected automatically and in splitless mode. The identification of chemical compounds obtained from our study was performed by matching their retention times and mass spectra with those obtained from the Flavor2.L, Wiley7n.1, and NIST98.L spectral and literature data.

2.5. Yield and yield components measurements

The plant samples for yield and yield components were taken from 20 plants representing each line during mid June before flowering.

3. Results and discussion

Table 1 reveals *F* and LSD values from variance analysis for rosemary lines grow in Ankara ecology. *F* values for blocks were insignificant for all the traits measured, except for dry leaf yield and number of branch. On the other hand, regarding control vs. lines, this value was significant for all the traits other than fresh herb yield and essential oil yield. Here, essential oil yield was neither significant for blocks nor control vs. lines.

3.1. Plant height

Rosemary height of the plants under investigation presented Antalya samples as the tallest lines (16.2 cm) (Fig. 1). This value is followed by Mersin (14.3 cm) and Aydin (12.7 cm). Meanwhile, Adana was presented as the shortest lines of the all samples. Baytop (1984) and Ceylan (1987) introduce rosemary as a plant ranging from 50–100 cm height and 500–200 cm, respectively. It seems that the extremely short plants average of the current study is first due to the severe cold of the year before (2012) and secondly the week preliminary adaption of the lines to Ankara ecological circumstances. Yet, all the samples originated form coastal belt of Mediterranean region.

3.2. Number of branches per plant

It is evident form Fig. 2 that Antalya samples stood top all other locations' sample regarding branch number. This was followed by Mersin (17.44 branches per plant) and Hatay (13.94 branches per plant). Izmir specimens were characterized as samples with the lowest branch number (10.31). In Kirpik (2005) study, some brilliant lines of Cukorova (Mediterranean coast, Southern Turkey) was evaluated in a two-year trail, resulting in lines with branch numbers ranging between 11.2 and 23.0. In Romany, however, Varban et al., (2007) showed an almost high average of 41–52 branch numbers per plant. Though this gap could be described by plantation dimension 70 × 70 cm in the latter study, but again, this output is outstanding.

3.3. Dry herb yield (t/ha)

Rosemary dry herb yield of six locations ranged between 0.76 to 1.09 t/ha. Followed by Adana (0.95 t/ha) and Mersin (0.90 t/ha), Antalya, again, reached the top with 1.09 t/ha (Fig. 3). The yield of the rosemary herb was in part similar with the earlier observations made by researchers in different parts of Turkey referring to Uysal and Tugrul (2009) in which they yielded 0.97–1.04 t/ha in Antalya region. Contrary to this, the yield of rosemary oil from Bornova (Turkey) was surprisingly as high as two to three fold of which found in current study, reaching to value of 1.77–3.09 t/ha (Sonmez, 2007). This difference may best be explained by ecological conditions from where lines were transferred.

3.4. Dry leaf yield (t/ha)

Antalya exhibited the highest dry leaf yield (0.82 t/ha, Fig. 4). Adana lines grown in Ankara lead to higher dry leaf yield (0.69 t/ha) when compared to those from the four other provinces yielding 0.65, 0.63, 0.62 and 0.55 t/ha for Mersin, Aydin, Izmir and Hatay, respectively. Ozguven et al., yielded the high amount of 6.45 t/ha under Adana ecological conditions. Parallel to this, Kirpik (2005), reported 7.82 t/ha

For the first year after plantation in Cukurova province. This value reached drastically to 22.12 t/ha for the year after. In a two year trial Sonmez (2007) yielded 1.23–2.18 t/ha for 2005–2006 continuous years, respectively. Low leaf-stem ratio, leaves dimensions, relative water content and lines ecological background may lead to huge differences of current study findings with the previous observations.

3.5. Essential oil ratio (%)

The yield of rosemary oil distilled from leaves of plants ranged between 0.71% to 0.94% on dry weight (v/w) basis which is higher in comparison with other values found in some literature (0.27–0.65%, samples from Cukurova, Kırıcı and Inan, 2001; 0.45–0.50%, samples