Original Article

The Essential Oil Compositions of *Rosmarinus officinalis L.* Cultivated in Konya and Collected from Mersin-Turkey

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ABSTRACT

Purpose: In this research, essential oil (EO) compositions of the dried and fresh aerial parts of *Rosmarinus officinalis* cultivated in the reearch field in Selcuk University Medicinal and Aromatic Plants Department Area in Konya and collected from Mersin was investigated. **Material and Methods:** EO was distilled by using Clevenger type apparatus for 3 h and the chemical compositions were detected in GC-MS. **Results:** Although, the oil yields of the collected rosemary was determined to be 0.4 ml (in fresh) and 0.6 ml (in dried) aerial parts, the yields of the cultivated plants for fresh and dried parts were 0.32 ml (in fresh) and 0.9 ml (in dried), respectively. In this research the differences with respect to composition and components were determined between the cultivated and collected plants. On the other hand, in this study, it was also determined that the EO compositions varied with respect to be fresh or dry of the plant parts. While there were 67 and 55 of EO compositions were observed in the fresh and dried parts of the collected marjoram, respectively; in the cultivated plants there were 46 (in fresh) and 79 (in dried) components detected. **Conclusion:** In this study, it was observed that the major EO compositions were camphor, 1.8-cineole, borneol, α-pinene, linalool, verbenone, bornyl acetate, limonene and camphene. The objective of the study to detect the differences between the EO compositions varied according to be the plant fresh or dry and collected or cultivated.

Key words: Rosemary, *Rosmarinus officinalis*, Oil yield, Essential oil composition, Camphor.

INTRODUCTION

Rosemary (*Rosmarinus officinalis* L.) is an important medicinal and aromatic plant from the family Lamiaceae,[2] which is represented by different names such as Turkish bushard, hasalbal and akpüren. The rosemary plant is 50-100 cm high, with bushes appearing as a perennial plant[3] (Photo 1). Rosemary,[5] which grows wild in places where the Mediterranean climate dominates, has wide use in the world as a medical, aromatic and ornamental plant. In folk medicine, analgesic, anti-inflammatory and treatment of gastrointestinal disturbances are properties attributed to this species.[8,9] It is located in the category of rosemary non-wood products which grow mostly in the southern and western coastal waters in Turkey. It has a production of 172 tons in 2014 and 758 tons in 2013.[1] In addition, the fact that biberia is the only commercial plant in Europe and America where antioxidant use is offered[4] emphasizes the necessity of breeding in our country.

The aim of the study to compare of differences between the essential oil (EO) compositions of the dried and fresh aerial parts of *Rosmarinus officinalis* cultivated in the

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Table 1: Essential oil compositions of dried and fresh aerial parts of the collected and cultivated *Rosmarinus officinalis*

		Collected	Cultivated	Collected	Cultivated	Collected		Cultivated	
RI*	Compounds	Fresh (%)	Fresh (%)	Dried (%)	Dried (%)	Fresh (%)	Dried (%)	Fresh (%)	Dried (%)
805	4-Methyl-1,3-penta diene	0,00	0,00	0,00	0,02	0,00	0,00	0,00	0,02
1010	Tricyclene	0,00	0,00	0,00	0,31	0,00	0,00	0,00	0,31
1030	**α-pinene**	**9,73**	**3,76**	**3,51**	**13,12**	**9,73**	**3,51**	**3,76**	**13,12**
1055	3-hexanone	0,00	0,00	0,00	0,02	0,00	0,00	0,00	0,02
1061	α-fenchone	0,00	0,00	0,45	0,06	0,00	0,45	0,00	0,06
1075	camphene	2,50	1,41	0,84	8,21	2,50	0,84	1,41	8,21
1106	isoamyl alcohol	0,00	0,00	0,00	0,04	0,00	0,00	0,00	0,04
1116	β-pinene	1,46	0,79	0,53	3,84	1,46	0,53	0,79	3,84
1125	sabinene	0,08	0,00	0,00	0,07	0,08	0,00	0,00	0,0
1128	verbenene	0,49	0,00	0,30[\]	0,00	0,49	0,30[\]	0,00	0,00
1129	thuja-2,4 (10)-diene	0,00	0,00	0,00	0,16	0,00	0,00	0,00	0,16
1138	3-penten-2-one	0,00	0,00	0,00	0,03	0,00	0,00	0,00	0,03
1149	delta-3-corene	2,05	0,64	1,14	0,00	2,05	1,14	0,64	0,00
1168	myrcene	1,59	0,87	0,67	4,12	1,59	0,67	0,87	4,12
1170	α-phellandrene	0,38	0,16	0,12	1,19	0,38	0,12	0,16	1,19
1172	pseudolimonene	0,00	0,85	0,00	0,09	0,00	0,00	0,85	0,09
1182	delta-2-carene	0,00	0,00	0,00	0,73	0,00	0,00	0,00	0,73
1202	limonene	3,86	2,96	2,56	3,88	3,86	2,56	2,96	3,88
1209	**1,8-cineole**	**13,79**	**8,29**	9,93	17,64	13,79	9,93	**8,29**	**17,64**
1210	1,5,8-p-menthatriene	0,00	0,00	0,00	0,02[i]	0,00	0,00	0,00	0,02
1212	2E-hexenal	0,00[v]	0,00	0,00	0,04	0,00	0,00	0,00	0,04
1217	cis-ocimene	0,06	0,00	0,00	0,00	0,06	0,00	0,00	0,00
1218	β-ocimene (z)	0,00	0,00	0,00	0,12	0,00	0,00	0,00	0,12
1225	gamma terpinene	0,57	0,62	0,50	0,97	0,57	0,50	0,62	0,97
1228	β-ocimene (E)	0,04	0,00	0,00	0,02	0,04	0,00	0,00	0,02
1230	3-octanone	0,10	0,13	0,00	1,65	0,10	0,00	0,13	1,65

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Table 1: Cont'd.									
1236	β-cymene	0,02	0,00	0,00[i]	0,00[j]	0,02	0,00	0,00	0,00
1237	*o*-cymene	0,00	0,00	0,91	0,00	0,00	0,91	0,00	0,00
1238	camphogen	1,05	0,00	0,00	0,00[j]	1,05	0,00	0,00	0,00
1244	terpinolene	1,45	1,59	1,03	0,68	1,45	1,03	1,59	0,68
1253	amyl vinyl ketone	0,00	0,00	0,00	0,02	0,00	0,00	0,00	0,02
1292	hexenol (3Z)	0,00	0,00	0,00	0,03	0,00	0,00	0,00	0,03
1293	3-hexen-1-ol	0,06	0,00	0,00	0,00	0,06	0,00	0,00	0,00
1294	3-octanol	0,00	0,00	0,00	0,25	0,00	0,00	0,00	0,25
1295	pelargonaldehyde	0,11	0,00	0,00	0,00	0,11	0,00	0,00	0,00
1296	nonanal	0,00	0,00	0,10	0,00	0,00	0,10	0,00	0,00
1299	fenchone	0,02	0,00	0,00	0,03	0,02	0,00	0,00	0,03
1438	α-p-dimethylstyrene	0,14	0,00	0,10	0,00	0,14	0,10	0,00	0,00
1440	para-cymene	0,10	0,39	0,00	1,20	0,10	0,00	0,39	1,20
1442	filifolene	0,18	0,24	0,25	0,00	0,18	0,25	0,24	0,00
1446	1-octen-3-ol	0,23	0,44	0,20	0,28	0,23	0,20	0,44	0,28
1460	cis sabinene hydrate	0,38	0,56	0,00	0,00	0,38	0,00	0,56	0,00
1461	β-terpineol	0,44[\]	0,00	0,00	0,00	0,44	0,00	0,00	0,00
1464	sabinene hydrate	0,00	0,00	0,00	0,30	0,00	0,00	0,00	0,30
1467	trans-linalool oxide	0,00	0,00	0,04	0,00	0,00	0,04	0,00	0,00
1491	α-ylangene	0,09	0,00	0,00	0,03	0,09	0,00	0,00	0,03
1499	α-campholenal	0,00	0,00	0,00	0,02	0,00	0,00	0,00	0,02
1502	α-copaene	0,35	0,00	0,08	0,00	0,35	0,08	0,00	0,00
1511	chrysenthenone	0,50	1,07	0,10	0,00	0,50	0,10	1,07	0,00
1539	**camphor**	**14,48**	**16,24**	17,61	25,78	14,48	17,61	**16,24**	**25,78**
1546	**linalool**	**4,47**	**8,07**	5,92	1,21	4,47	5,92	**8,07**	**1,21**
1550	trans sabinene hydrate	0,00	0,00	0,00	0,19	0,00	0,00	0,00	0,19
1554	3-pinanone	0,00	3,16	0,00	0,00	0,00	0,00	3,16	0,00
1559	pinocamphene	3,07	0,00	3,74	0,20	3,07	3,74	0,00	0,20

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Table 1: Cont'd.									
1563	1-terpineol	0,07	0,00	0,00	0,00	0,07	0,00	0,00	0,00
1566	cis-para-menth-2-en-1-ol	0,00	0,00	0,00	0,17	0,00	0,00	0,00	0,17
1578	isopulegol	0,00	0,00	0,00	0,06	0,00	0,00	0,00	0,06
1581	pinocarvone	0,40	0,42	0,47	0,15\	0,40	0,47	0,42	0,15
1591	**bornyl acetate**	**2,81**	**8,41**	3,03	3,04	2,81	3,03	**8,41**	**3,04**
1603	4-terpineol	0,97	1,34	1,61	0,00	0,97	1,61	1,34	0,00
1604	camphene hydrate	0,00	0,00	0,00	0,05	0,00	0,00	0,00	0,05
1606	trans-caryophyllene	0,00	0,00	2,55	0,00	0,00	2,55	0,00	0,00
1608	caryophyllene	2,53	1,94	0,00	1,27	2,53	0,00	1,94	1,27
1619	α-longipinene	0,19	0,00	0,00	0,00	0,19	0,00	0,00	0,00
1632	trans-para-menth-2-en-1-ol	0,00	0,00	0,00	0,11	0,00	0,00	0,00	0,11
1642	p-tolycarbinol	0,10	0,00	0,00	0,00	0,10	0,00	0,00	0,00
1643	3,6-octadienoic acid	0,00	0,24	0,00	0,02	0,00	0,00	0,24	0,02
1660	pulegone	0,14	0,00	0,00	0,03	0,14	0,00	0,00	0,03
1664	cis-verbenol	0,73	0,00	0,00	0,04	0,73	0,00	0,00	0,04
1667	trans pinocarvone	0,00	0,00	0,00	0,02	0,00	0,00	0,00	0,02
1670	1,3-cycloheptadiene	0,00	0,00	0,79	0,00	0,00	0,79	0,00	0,00
1673	delta-terpineol	0,00	0,00	0,29	0,00	0,00	0,29	0,00	0,00
1675	delta terpineol	0,00	0,17	0,00	0,00	0,00	0,00	0,17	0,00
1677	p-menth-1-en-8-ol	0,22	0,00	0,00	0,00	0,22	0,00	0,00	0,00
1680	α-terpineol	2,24	2,68	0,00	0,25	2,24	0,00	2,68	0,25
1683	α-humulene	0,00	0,27	0,00	0,14	0,00	0,00	0,27	0,14
1686	β-selinene	0,38	0,00	0,54	0,00	0,38	0,54	0,00	0,00
1688	trans-verbenol	0,00	0,00	1,22	0,16	0,00	1,22	0,00	0,16
1689	cis-verbenol	1,23	3,49	0,00	0,00	1,23	0,00	3,49	0,00
1695	4-hydroxy mentha-1,8-diene	0,00	0,00	0,00	0,02	0,00	0,00	0,00	0,02
1698	myrtenyl acetate	0,06	0,00	0,00	0,00	0,06	0,00	0,00	0,00
1700	gamma cadiene	0,00	0,00	0,00	0,03	0,00	0,00	0,00	0,03
1701	linalyl propanoate	0,00	0,00	2,97	0,00	0,00	2,97	0,00	0,00

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Table 1: Cont'd.									
1709	α-terpinene	0,34	0,24	0,25	1,65	0,34	0,25	0,24	1,65
1718	**borneol**	**6,44**	**11,28**	10,47	3,60	6,44	10,47	**11,28**	**3,60**
1731	**verbenone**	**9,61**	6,27	0,14	1,67	9,61	0,14	**6,27**	**1,67**
1733	β-phellandrene	0,00	0,26	0,00	0,00	0,00	0,00	0,26	0,00
1735	α-phellandr	0,00	0,00	0,00	0,04	0,00	0,00	0,00	0,04
1737	β-bisabolene	0,46	0,00	0,00	0,00	0,46	0,00	0,00	0,00
1748	piperitone	0,13	0,00	0,00	0,08	0,13	0,00	0,00	0,08
1749	carvone	0,12	0,21	0,00	0,00	0,12	0,00	0,21	0,00
1754	trans piperitol	0,00	0,00	0,00	0,08	0,00	0,00	0,00	0,08
1763	N-decanol	0,00	0,00	0,00	0,04	0,00	0,00	0,00	0,04
1768	delta cadinene	0,38	0,19	0,42	0,05	0,38	0,42	0,19	0,05
1775	germacrene D	0,13	0,14	0,00	0,00	0,13	0,00	0,14	0,00
1776	nepthalene	0,28	0,00	0,00	0,00	0,28	0,00	0,00	0,00
1784	octa-2,4,6-triene	0,00	0,24	0,00	0,00	0,00	0,00	0,24	0,00
1791	trimethylcyclopentadiene	0,29	0,00	0,15	0,04	0,29	0,15	0,00	0,04
1803	homomyrtenol	0,00	2,31	0,00	0,13	0,00	0,00	2,31	0,13
1821	cis-sabinol	0,00	0,00	0,00	0,04	0,00	0,00	0,00	0,04
1855	cuminol	0,26	0,00	0,00	0,00	0,26	0,00	0,00	0,00
1860	*p*-cymen-8-ol	0,00	0,00	0,38	0,02	0,00	0,38	0,00	0,02
1862	limonene oxide	0,00	2,33	1,61	0,00	0,00	1,61	2,33	0,00
1876	myrtenol	1,44	0,00	0,00	0,12	1,44	0,00	0,00	0,12
1898	α-selinene	0,00	0,19	0,00	0,00	0,00	0,00	0,19	0,00
1934	α-calacorene	0,00	0,00	0,09	0,02	0,00	0,09	0,00	0,02
1947	piperitenone	0,00	0,00	0,00	0,02	0,00	0,00	0,00	0,02
1951	β-gurjunene	0,00	0,00	0,06	0,00	0,00	0,06	0,00	0,00
1952	α-amorphene	0,00	0,13	0,27	0,00	0,00	0,27	0,13	0,00
2007	caryophyllene oxide	0,66	1,11	0,94	0,10	0,66	0,94	1,11	0,10
2022	methyl eugenol	0,15	0,47	0,00	0,03	0,15	0,00	0,47	0,03

Continued...

Table 1: Cont'd.									
2064	cyrptone	0,00	0,00	0,26	0,00	0,00	0,26	0,00	0,00
2074	α-elemene	0,00	0,00	0,06	0,00	0,00	0,06	0,00	0,00
2093	methyl-3-(4-methyl-3-pentenyl)-3-cyclohexenyl ketone	0,00	0,00	0,00	0,02	0,00	0,00	0,00	0,02
2100	6-methyl-3,5-heptadien-2-one	0,00	0,00	0,00	0,05	0,00	0,00	0,00	0,05
2171	delta-3-carene	0,00	0,00	0,00	0,03	0,00	0,00	0,00	0,03
2183	β-cubebene	0,00	0,00	0,08	0,00	0,00	0,08	0,00	0,00
2188	eugenol	0,06	0,00	0,09	0,03	0,06	0,09	0,00	0,03
2196	thymol	0,00	0,00	0,06[j]	0,04	0,00	0,06	0,00	0,04
2199	gamma-cadinene	0,00	0,00	0,09	0,00	0,00	0,09	0,00	0,00
2200	α-cadinol	0,05	0,00	0,13	0,00	0,05	0,13	0,00	0,00
2222	α-bisabolol	0,19	0,10	0,34	0,00	0,19	0,34	0,10	0,00
2228	carvacrol	0,03	0,50	0,14	0,42	0,03	0,14	0,50	0,42
2238	α-eudesmol	0,00	0,05	0,00	0,00	0,00	0,00	0,05	0,00
2252	4-(4-methyl-3-pentenyl)-3-cyclohexenyl propyl ketone	0,00	0,00	0,00	0,15\	0,00	0,00	0,00	0,15\
2353	geranylaceton	1,12	0,00	0,00	0,03	1,12	0,00	0,00	0,03
2378	farnesyl acetone	0,07	0,00	0,16	0,00	0,07	0,16	0,00	0,00
2403	β-caryophyllene epoxide	0,12	0,00	0,00	0,00	0,12	0,00	0,00	0,00
2405	nopinene	0,00	0,00	0,20	0,00	0,00	0,20	0,00	0,00
2440	4-(4-methyl-3-pentenyl)-3-cyclohexenyl penthyl ketone	0,00	0,00	0,00	0,06	0,00	0,00	0,00	0,06
2487	Ar-Abietatriene	0,00	0,00	0,09	0,00[j]	0,00	0,09	0,00	0,00

*Calculation formula of retention indice

Ip=100n+100 [tr(x)-tR(n)]/ [tR(n+1)-tR(n)]

Ip: Retention Indice, n: Carbon atom number of the hydrocarbon eluting before the sample, tr(x): Retention time of sample x (the components of the essential oil), tR(n): Retention time of the hydrocarbon eluting before the sample, tR(n+1): Retention time of the hydrocarbon eluting after the sample

[A-j] Means with no common superscripts within each row are significantly different ($P < 0.01$).

Photo 1: *Rosmarinus officinalis* flowers.

Photo 2: *Rosmarinus officinalis* general view

research field and collected from Mersin was investigated.

MATERIAL AND METHODS

Materials

Plant materials were collected in 2015 from Mersin and Selcuk University, Field Crops Department, Medical

Photo 3: *Rosmarinus officinalis* flowers

Plant Garden. A voucher specimen has been deposited at the KNYA herbarium.

Methods

Dried and fresh aerial parts (branch, leaf and herb) of the collected and cultivated *Rosmarinus officinalis* were subjected to hydrodistillation for 3 h using Clevenger type apparatus to produce essential oil. The EOs were stored at -20 ^{0}C until analyzed. The compositions of *Rosmarinus officinalis* L. (ROE), EOs were identified by The GC-MS analyses.

RESULTS AND DISCUSSION

As a result of the studies done, the volatile oil components of wet and dry specimens of *Rosmarinus officinalis* plant cultivated and from nature were compared (Table 1, Figure 1). Table 1 revelaed that there were significant ($p<0.01$) differences between the dried and fresh aerial parts of the collected and cultivated *Rosmarinus officinalis* with respect to their EO compositions. While, the oil yields of the collected rosmarin was determined to be 0.4 ml (in fresh) and 0.6 ml (in dried) aerial parts, the yields of the cultivated plants for fresh and dried parts

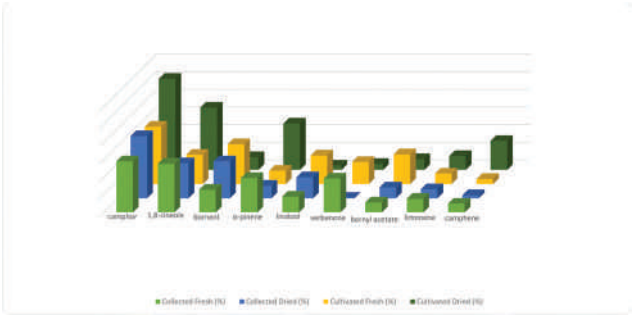

Figure 1: Total major essential oil compositions of the dried and fresh aerial parts of the collected and cultivated *Rosmarinus officinalis*

were 0.32 ml (in fresh) and 0.9 ml (in dried), respectively. Drying of the material made to increase the oil yield both in the collected and cultivated rosmarin. In dried materials, cultivation of the plant had positive effect on the yield. EO composition may vary considerably between aromatic plant species and varieties, and within the same variety from different enviromental areas.[7] Besides EO yields, in this research the differences with respect to composition and components were determined between the cultivated and collected plants. On the other hand, in this study, it was determined that the EO compositions varied with respect to be fresh or dry of the plant parts. While there were 67 and 55 of EO compositions were observed in the fresh and dried parts of the collected rosemary, respectively; in the cultivated plants there were 46 (in fresh) and 79 (in dried) compositions detected. There were differences between the amounts of EO compositions of fresh and dried aerial parts of collected and cultivated *rosmarin*. Although the amounts of EO in the fresh collected rosmarin were higher than the those of cultivated, the rates of EO in dried collected material was lower than the those of cultivated.

According to Table 1, it was observed that the major EO compositions were camphor, 1,8-cineole, borneol, α-pinene, linalool, verbenone, bornyl acetate, limonene and camphene. This compositions were also shown in Figure 1. Furthermore, in the other study, it was observed that the most abundant constituents documented for this oil are again α-pinene, 1,8-cineole, verbenone and camphor.[6] Moreover, in a study, composition of Turkish rosemary and identified 20 compounds, with p-cymene (44%), linalool (21%), γ-terpinene (17%), β-pinene (3.6%), α-pinene (2.8%), 1,8-cineole (2.6%), and thymol (1.8%) being the main constituents (20). Moreover, in the other study, it was determined that the major constituents of the oil were described as 1,8-cineole (27.23%), α-pinene (19.43%), camphor (14.26%), camphene (11.52%) and β-pinene (6.71%).

CONCLUSION

The results of this study demonstrate that the aim of the study to compare of differences between the EO compounds and compositions varied according to be the plant fresh or dry and collected or cultivated. It was observed that camphor, and 1.8-cineole were the major EO contents.

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CONFLICT OF INTEREST

Authors declare that there is no conflict of interest.

ABBREVIATONS USED

EO: Essential oil; GC-MS: Gas Chromatography-Mass Spectrophotometry h: hours; ml: milliliter; ROE: *Rosmarinus officinalis* L. Essential oil; RI: Retention Indices.

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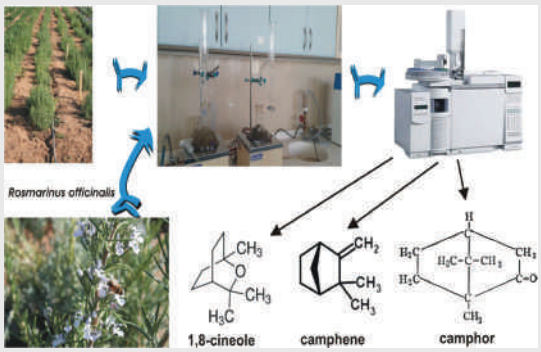
PICTORIAL ABSTRACT



SUMMARY

- Rosemary (*Rosmarinus officinalis* L.) is an important medicinal and aromatic plant from the family Lamiaceae, which is represented by different names such as Turkish bushard, hasalbal and akpüren. In folk medicine, analgesic, anti-inflammatory and treatment of gastrointestinal disturbances are properties attributed to this species
- The aim of the study to compare of differences between the essential oil (EO) compositions of the dried and fresh aerial parts of *Rosmarinus officinalis* cultivated in the research field and collected from Mersin was investigated.
- Our study was observed that the major EO compositions were camphor, 1,8-cineole, borneol, α-pinene, linalool, verbenone, bornyl acetate, limonene and camphene.

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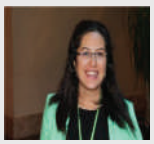

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