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Comparison of Essential Oils and Secretion Structures of *Rosa damascena* Mill. Grown in Iğdır and Isparta (Turkey)

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Abstract

The paper aims to compare the chemical compositions of essential oils and anatomical properties of secretory structures differences between *R. damascena* which is cultivated in Iğdır and Isparta (EOI1, EOI2, and EOIg). GC/ MS and GC-FID were utilized for essential oils analysis. Nonadecane (31.0%), heneicosane (21.1%), citronellol (16.8%), and 1-nonadecene (6.2%) were primal constituents of EOI1. Nonadecane (29.3%), heneicosane (17.6%), citronellol (18.6%), 1- and nonadecene (5.4%) were primal constituents of EOI2. Heneicosane (15.2%), nonadecane (14.1%), γ-muurolene (13.0%), citronellol (7.8%), and tricosane (8.5%) were primal constituents of EOIg. Both Isparta and Iğdır sepal cross-section anatomies glandular and non-glandular trichomes were observed.

Keywords: Rosa damascena, Iğdır, Isparta, essential oil, anatomy

1. INTRODUCTION

Rosa L. species is known as one of the most popular types of ornamental plants with its pleasant smell and beautiful appearance, belonging to the Rosoideae subfamily, which is in the Rosaceae family. The genus *Rosa* has 200 species and more than 18,000 varieties. The rose plant is one of the most cultivated ornamental plants in the world today. The history of the rose, which is considered the queen of flowers, dates back to prehistoric times. Rose is an important ornamental plant with economic, cultural and symbolic value. In addition to being used as a garden plant, roses also have economic importance in terms of their petals, which are a natural source of fragrance, colour and sweetener. The rose

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plant originated mostly in Western Asia and partly in Europe. It is widely seen in European and Middle Eastern countries, especially Iran, Afghanistan and Turkey. It is grown in Bulgaria, Russia, Egypt, France, India and Morocco. It has been reported by many botanists that around 200 rose species have been described in the world. The most important and most used of these rose species are Isparta rose (*Rosa damascena* Mill.) and rosehip (*Rosa canina* L.) [1].

The natural distribution area of *R. damascena*, whose homeland is Iran, is the Northern Hemisphere, and it is cultivated in France, Lebanon, India, Russia, China, Morocco, Mexico, Italy and other European countries, especially in Turkey and Bulgaria. *R. damascena* is a plant with very thorny, and pink flowers, which is formed by the hybridization of *R. gallica* L. and *R. phoenicia* Boiss. [2].

R. damascena (Rosaceae) is known as "Yağ gülü, Yağlık gül, Isparta gülü, Reçellik gül, Pembe gül, Katmer gül, Yalınkat gül, Şam gülü, Güla Muhammedi, Peygamber kokusu, Ölü gülü, Kazanlık gül" in Turkey. It is the only type of rose cultivated for industrial purposes. It is accepted that rose oil helps to relieve the pain, sadness and stress caused by mental problems, helps to provide mental balance and facilitates the birth psychologically during childbirth. In the Ottoman period, the essential oil obtained by fermenting (sourcing) different rose flowers by steam distillation (retort system) was called "sega oil" and this oil was used as an elixir in the treatment of many diseases (pharyngitis, tonsillitis, etc. in the treatment of throat and respiratory tract diseases). It is known that the scent of rose is used in the treatment of psychiatric and neurological disorders through aromatherapy. In the research, it has been determined that the child of the mother who has used rose oil since birth is more advanced than her peers in distinguishing odours. Memory-enhancing effects in other living things it has been experienced. It is believed that those who are busy with roses strengthen their memories. Rose oil has been used for solving skin problems since it is known as an accelerator of new tissue formation and wound healing since ancient times. Massage can be done by adding rose oil to fixed oils. It is added to the water in the aroma diffuser as one drop per square meter of room area in the aromatherapy lamp and can be used by inhalation [3].

Approximately 15.000 tons of rose flowers are produced annually worldwide, and Turkey ranks first among the essential countries producing rose flowers. According to the 2014 Rose Flower Report data, it has been determined that Turkey's rose flower planted area is 2.200 ha, its production is 6.750 tons and its yield is 4.250 kg ha^{-1}. The report also states that Turkey exported 3.443 kg of rose oil with a total return of $13.961,163 in 2014 is reported. 50% of the world's rose oil demand is met by Turkey, 40% by Bulgaria and the remaining 10% from other countries such as Iran, India, Morocco and Afghanistan [4].

The paper aims to compare the chemical compositions of essential oils and anatomical properties of secretory structures differences between *R. damascena* which is cultivated in Iğdır and Isparta.

2. MATERIALS AND METHODS

2.1. Plant materials and obtaining essential oils

Isparta samples were collected in May 2022 and they were identified by authors Assoc. Prof. Dr Songul Karakaya (Department of Pharmaceutical Botany) and Asst. Prof. Dr Hafize Yuca (Department of Pharmacognosy). Fresh flowers of *Rosa damascena* were obtained from two different regions of Isparta. The crushed dried flowers (300 g and 300 g) of *R. damascena* from Isparta (EOI1 and EOI2) were placed in hydrodistillation for 3 h through a Clevenger-type apparatus in reference to the method suggested at the European Pharmacopoeia.

In November 2020, 1500 red rose (qızıl gül) seedlings grown in gardens in Iğdır were planted in the field. The roses grown in the field at the foot of Mount Ağrı (850 m, Karakoyunlu district, Zülfikar village, latitude: 39.9849, longitude: 44.1597) were collected in May 2022. The crushed fresh flowers (750 kg) of *Rosa damascena* from Iğdır (EOIg) were placed in a copper boiler and hydrodistillated for 2 h. 60 mL of rose oil and 1125 L rose water were obtained in reference to the method suggested at the European Pharmacopoeia. Voucher specimens have been stored at Atatürk University, Biodiversity Application and Research Center with the numbers of EOI1, EOI2, and EOIg AUEF 1397, 1398, and 1399, respectively

Isparta roses were taken from two different regions to fully understand the difference or similarity of the content of the rose grown in Iğdır with Isparta roses.

Obtained oils were dried over anhydrous sodium sulfate and held in sealed vials at +4°C temperature in the dark up to the analysis.

2.2. GC-FID and GC-MS analyses of essential oils

GC/MS and GC analysis were established with Agilent 5975 GC-MSD and Agilent 6890N GC systems, in turn. An Innowax FSC column (60 m x 0.25 mm, 0.25 μm film thickness) in helium (0.8 mL/min) was taken as the carrier gas. The GC oven temperature for 10 minutes was 60°C and programmed to 220°C at a rate of 4°C/min and was 220°C for 10 minutes at a rate of 240°C at a rate of 1°C/min. The division proportion was set to 40:1. The injector temperature was 250°C. Mass spectra were enlisted at 70 eV and the mass range was m/z 35 to 450. The FID detector temperature was 300°C. To get the same elution order as GC/MS, a contemporaneous automated injection was carried on a replicate of the same column, applying the same operating conditions. Relative percent sums of partitioned compounds were calculated from the FID chromatograms.

2.3. Microscopic Analysis

For anatomical properties of secretory structures, sections were made manually from the flower of *Rosa damascena* from Isparta and Iğdır (EOI1, EOI2, and EOIg). Plants materials were fixed in 70% alcohol. Sartur and tusche reagents were used. Images were registered with a Zeiss 51425 camera engaged to a light microscope (Zeiss 415500-1800-000, Carl Zeiss Microscopy, GmbH Konigsallee 9-21, 37081 Gottingen GERMANY). An average of 8-12 samples were used for the sections. In this study, only where the essential oils are produced in the plant and their chemical similarities and differences were tried to be revealed.

3. RESULTS

The colour of the EOI1, EOI2, and EOIg were yellow, yellow and greenish and the essential oil % yields were 0.001, 0.001, and 0.008 w/v, respectively. A total of 33, 26, and 32 compounds found 99.1%, 97.5%, and 87.6% of the essential oils were identified in the EOI1, EOI2, and EOIg. Nonadecane (31.0%), heneicosane (21.1%), citronellol (16.8%), 1-nonadecene (6.2%), and tricosane (5.2%) were the main constituents of the EOI1. Nonadecane (29.3%), heneicosane (17.6%), citronellol (18.6%), 1-nonadecene (5.4%), and tricosane (4.1%) were the main constituents of the EOI2. Heneicosane (15.2%), nonadecane (14.1%), γ-muurolene (13.0%), citronellol (7.8%), tricosane (8.5%), and (2E,6Z)-farnesol (5.5%) were the main constituents of the EOIg. The chemical compositions of essential oils were given in Table 1.

Both Isparta and Iğdır sepal cross-section anatomies glandular and non-glandular trichomes were observed (Figures 1-2).

Table 1 The chemical compositions of essential oils

RRI	Component	EOI1 %	EOI2 %	EOIg %
1362	*cis*-Rose oxide	-	0.3	-
1377	*trans*-Rose oxide	-	0.1	-
1500	Pentadecane	0.1	0.2	0.5
1544	α-Guaijane	0.3	0.9	-
1600	Hexadecane	tr	tr	0.1
1612	*β*-Caryophyllene	0.6	1.5	2.3
1661	Alloaromadendrene	-	-	0.4
1668	Citronellyl acetate	tr	0.3	1.2
1687	*α*-Humulene	0.4	0.8	1.0
1700	Heptadecane	-	-	1.7
1704	γ-Muurolene	-	-	13.0
1726	Germacrene D	3.4	2.5	-
1730	*δ*- Guaijane	1.3	4.0	-
1772	Citronellol	16.8	18.6	7.8
1808	Nerol	tr	tr	1.3
1857	Geraniol	0.4	0.5	2.0
1800	Octadecane	0.9	1.0	0.7
1852	1-Octadecene	-	-	tr
1900	Nonadecane	31.0	29.3	14.1
1915	1-Nonadecene	6.2	5.4	1.4
1937	Phenylethyl alcohol	-	tr	-
1973	1-Dodecanol	-	-	0.2
2000	Eicosane	5.0	3.0	3.0
2016	9-Eicosene	0.4	2.1	tr
2050	(*E*)-Nerolidol		tr	0.1
2071	Humulene epoxide II	-	0.4	-
2096	Elemol	-	-	tr
2100	Heneicosane	21.1	17.6	15.2
2185	*β*- Eudesmol	-	-	0.2
2200	Docosane	0.9	-	0.5
2209	Citronellyl caprylate	tr	tr	-
2214	Phenylethy tiglate		0.7	-
2250	γ-Eudesmol		-	0.4
2278	(*2E,6E*)-Farnesal	-	-	tr
2300	Tricosane	5.2	4.1	8.5
2330	(*2E,6Z*)-Farnesol	-	-	5.5
2337	9- Tricosene	0.7	0.5	-
2369	(*2E,6E*)-Farnesol	-	-	4.3
2396	Citronellyl nonanoate	0.5	0.4	-
2400	Tetracosane	0.4	0.3	0.4
2500	Pentacosane	1.7	1.2	1.8
2512	Citronellyl benzoate	0.4	0.3	-
2600	Hexacosane	-	0.5	-
2700	Heptacosane	1.4	-	tr
2931	Hexadecanoic acid	-	1.0	tr
	Total	**99.1**	**97.5**	**87.6**

RRI Relative retention indices calculated against n-alkanes
% calculated from FID data, tr for Trace (< 0.1 %)

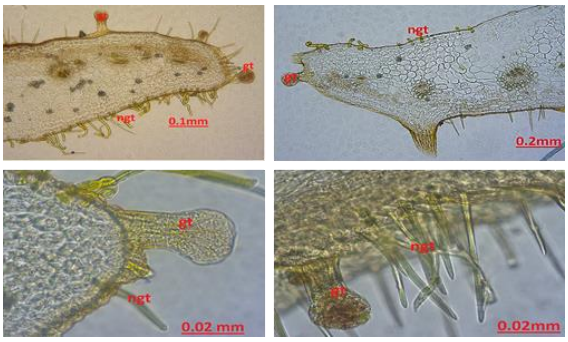

Figure 1 *Rosa damascena* (Isparta) sepal cross-section anatomy; gt: glandular trichome, ngt: non-glandular trichome with Sartur reagent

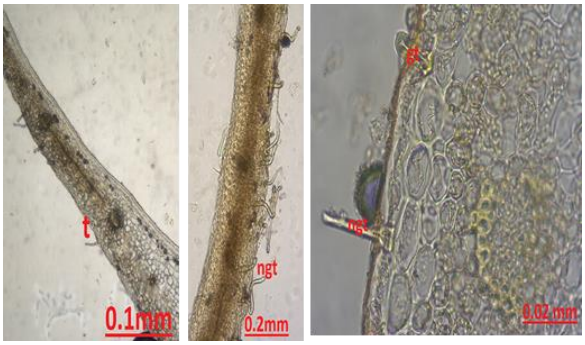

Figure 2 *Rosa damascena* (Iğdır) sepal cross-section anatomy; t: trichome, gt: glandular *trichome, ngt: non-glandular trichome with Sartur reagent*

Secretory structures were found in Isparta and Iğdır petal adaxial surface anatomies (Figures 3-4). The presence of essential oils in papillae was also seen in Isparta and Iğdır petal adaxial surface anatomies with tusche reagent (Figures 3-4).

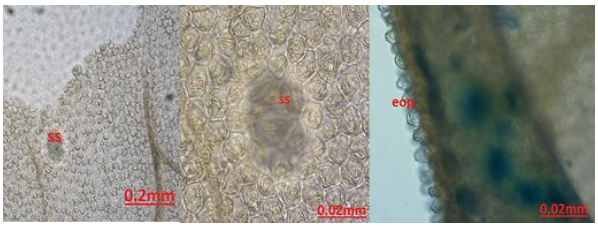

Figure 3 *Rosa damascena* (Isparta) petal adaxial surface anatomy; ss: secretory structure, eop: essential oil in papillae with Sartur and tusche reagents-glandular *trichome with Sartur reagent*

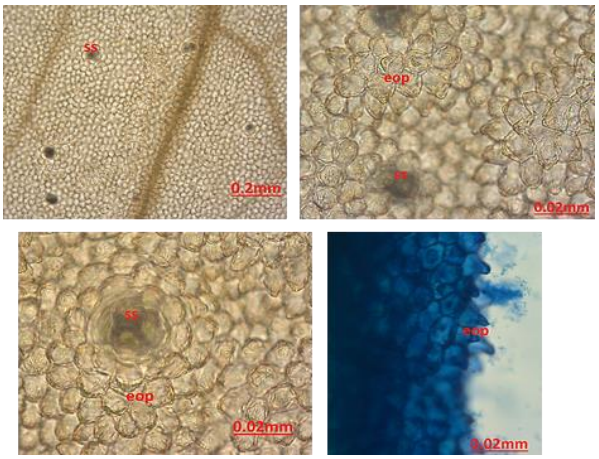

Figure 4 *Rosa damascena* (Iğdır) petal adaxial surface anatomy; ss: secretory structure, eop: essential oil in papillae with Sartur and tusche reagents

4. DISCUSSION

The rose oil's basic character is dependent on geraniol (9 to 24%) and citronellol (31 to 44%). It is changed by nerol (5 to 11%) and farnesol (0.2 to 1.4%). If farnesol content is higher, it causes to the potent floral character. Nerol adds both rosaceous character and freshness. In cases when the geraniol content is low, the freshness of nerol manifests itself as a bit citrusy. However, when geraniol content is high, the mixture of geraniol, farnesol, citronellol, and nerol results in a potent, sweet, fresh, and floral character. The rose oil's other characteristic constituents are geranyl acetate, citronellyl formate, nonanal, eugenol, methyl eugenol, cis-rose oxide, citronellyl acetate, α-terpineol, linalool, and phenylethyl alcohol. The other natural compounds of rose oil are stearoptenes (mainly nonadecane). If they are present, they cause the solidification of rose oil at room temperature and when cooled [5]. In our study, the geraniol content of EOIg (2.0%) was higher than others while the citronellol content of EOI2 is the highest one (18.6%). Farnesol and nerol had only been found in EOIg. Therefore, the floral, rosaceous and fresh scents are more dominant in this sample. The nonadecane contents were higher in Isparta samples (EOI1 and EOI2), so they can solidify more easily than the Iğdır sample (EOIg).

There are many studies on the essential oil the content of *Rosa damascena*. In a study about content of rose oil obtained from roses cultivated in Turkey, citronellol (30.9 to 43.9%), geraniol (9.3 to 14.1%), nonadecane (8.3 to 14.7%), and nerol (5.2 to 7.6%) were found as major compounds [6]. For Bulgarian two rose oil samples, the main compounds were found as citronellol (30.24-31.15%), geraniol (20.62-21.24%), *n*-heneicosane (8.79-9.05%), and *n*-nonadecane (8.51-8.77%) [7]. For Iranian rose oil, according to the GC-MS results, citronellol (14.5-47.5%), nonadecane (10.5-40.5%), geraniol (5.5-18%), and henicosane (7-14%) were the major compounds [8]. Our research when compared to the previous studies, the major compounds were similar, but the nonadecane and heneicosane were found as higher than geraniol and citronellol in all samples.

When previous anatomy studies were evaluated, as, in our study, glandular and non-glandular trichomes were observed in sepals [9, 10]. The glandular trichomes in the Isparta samples were more numerous than in the Iğdır sample (Figures 1, and 2). In other studies, it was observed that papillae from the adaxial surface of the petals had residue of dried secretion as in our study [11, 12, 13]. To our knowledge, it is the first time that the secretory structures were shown clearly in all samples. Additionally, they were figured on the Iğdır sample more than others (Figures 3, and 4).

5. CONCLUSION

The results of original comparable research on essential oils components of Isparta and Iğdır samples. Their secretory structures are not different, they differ only in their size and number. The essential oil is also similar in content, but there is variation in quantities. These essential oils could be used in cosmetics, perfumery, pharmacy and industry owing to their chemical compositions.

The Declaration of Conflict of Interest/ Common Interest

The authors have declared no conflict of interest.

Authors' Contribution

Concept: H.Y, E.T, A.C., S.K., B.D., A.K., Z.G., Design: H.Y, S.K., Data Collection or Processing: H.Y, E.T, A.C., S.K., B.D., A.K., Analysis or Interpretation H.Y, E.T, A.C., S.K., B.D., Literature Search: H.Y, S.K., B.D., Writing: H.Y, S.K., B.D., A.K.

The Declaration of Ethics Committee Approval

This study does not require ethics committee permission or any special permission

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The Declaration of Research and Publication Ethics

The authors of the paper declare that they comply with the scientific, ethical and quotation rules of SAUJS in all processes of the paper and that they do not make any falsification of the data collected. In addition, they declare that Sakarya University Journal of Science and its editorial board have no responsibility for any ethical violations that may be encountered, and that this study has not been evaluated in any academic publication environment other than Sakarya University Journal of Science.

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