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Extraction and identification of chemical and molecular compounds of *Rosa damascene* Mill) essence in different genotypes cultivated in some provinces of Iran

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Abstract: The *Rosa damascena* Mill. is cultivated in different parts of Iran. For evaluation of its essence, the experiment was carried out on 50 accessions during 2014-17 using randomized complete blocks design with three replications. Results showed that the essence of Kermanshah11 (0.412 g), Yazd 1 (0.400 g), Isfahan 4 (0.364 g), Lorestan 1 (0.361 g), Kermanshah 2 (0.350 g) and Isfahan 3 (0.331 g) accessions had a higher amount of essence. Strong positive correlation coefficients ($p \leq 0.01$) were found between essence of citronellol- n-eicosan (0.845), citronellol- n-heneicosane (0.879), n-nonadecane-geraniol (0.883), n-heneicosane-geraniol (0.842), n-heneicosane- geraniol (0.850), n-eicosane- geraniol (0.885), n-nonadecane- geraniol (0.930). Comparing the years, the accessions of Isfahan 5, Arak 1, Kordestan 1, West Azarbaijan 1, Tehran 1, Arak1, Fars 1 and Zanjan1 had the highest citronellol, geraniol, geraniol, n-tetradecanal, n-nonadecane, n-eicosane, n-pentacosane, n-heneicosane, respectively.

Key words: *Rosa damascena*; Essence; Accession.

Introduction

Rosa damascena (Damask Rose) is one of the most valuable plant species in many countries worldwide, particularly Iran, Bulgaria, Turkey, India, the United States, the United Kingdom and Japan. These species were one of the most important roses in the ancient time for ornamental production through essence and attractive scents as well as medicinal properties of flowers and fruits (1, 2). Furthermore, the flowers of Damask rose were used for depression treatment by rose water in Iran and Europe (3)

Today, the essence of this rose is more important because of its market-oriented nature. Infect the perfume is originated from a paraffin component of rose that is perchance and exported by high price in Iran (4, 5).

The flowers of *Damask rose* are used in various industries such as pharmaceuticals, food and decorative (3, 6). According to Tucker & Maciarello (1988) (7), four species of roses are used to extract rose essence:

1) *Rosa damascene* Mill.
2) *Rosa centifolia* L.
3) *Rosa moschata* Herrm.
4) *Rosa gallica* L.

The essence of the rose is in the upper part of the petals and inside the cells. Microchemical reagents, such as acid 1 to 200, indicate that the essence completes the entire space of the cell as a discoloration material. This essence is prepared from the petals of the plant mainly the genus of *centifolia, moschata and alba,* but the high-quality essence only obtained from the main species *Damascena* (8, 9).

The essence of liquid Damask rose is mainly colorless but rarely is also yellowish, greenish or slightly dark. The specific gravity is 0.830 to 0.871 at 20 °C. Physically is sensitive to heat. the Damask rose is a liquid form, particularly when heated, while it is crystallized shells when gradually cold to freezing from <15°C and typically freezing come out at 12 °C. Overall, this essence becomes a sticky liquid at 25 °C. However, no change in essence quality followed by a change in its temperature (10).

The essence must be kept in a capped container, away from light and stored in a cool place due to its volatile nature at high temperature and less degree of solubility in a cold place (11, 12).

The essence of Damask rose has solid and liquid forms (13-15) as described as follow:

a). *Stearoptene:* is the solid, crystalline and odorless with a melting point of 33 °C; and

b). *Oleoptene;* the liquid part that is fragrant and strong flavor with a little sweet taste.

The *oleoptene* comprises the following chemical components (16):

1- Geraniol with formula C10H180 (45 to 75 %).
2- Citronellol with formula C12H200 (20 to 40 %).
3- Farnesol with formula $C_{15}H_{26}O$
4- Nerol with formula $C_{10}H_{18}0$
5- Linalol with formula $C_{10}H_{18}0$
6- Citral with formula $C_{10}H_{16}O$
7- Eugenol with formula $C_{10}H_{12}0_2$
8- Ald-Nonylique and other components
8- Ald-Nonylique and other components

Geraniol has been discovered in palm oil or rose palm oil. The geraniol and citronellol, are a mild and

very pleasant liquid and odor (4, 5, 17).

The amount of essence of the flower (petals part) was found at about 0.03% (4).

Oil composition and amount of essences depend on factors like different stages of flowering, different flower components and various harvesting periods. Several experiments to assess the effects of some environmental factors including harvesting dates, fermentation time on the amount and composition of the essence of Damask rose. The different flowering times have significant effects on the amount and composition of essence and the highest amount of oil (0.04%) was obtained from the harvest after 24 months (from planting) (18-20).

Oily essence of rose that is obtained has a sweet aroma, and *(oleoptene*) containing geraniol and citronellol (16, 21). The aromatic petals with a relatively high amount of volatile oils have the main ingredient, geraniol, tannins, glucosides and colorants that escape with water vapor and solvents and these aromatic roses are currently produced in Bulgaria and limited in Anatolia Turkey (15, 22).

Tabai-Oghdai et al. (2004), reported significant differences between the seven genotypes of Damask rose in the western regions of Iran (5).

Tabai-Oghdai et al. (2005) analyzed the chemical properties of rose in six provinces of Iran in terms of essence yield and flower components in different seasons of the year. The result showed that there were defenses for amounts and chemical composition of the essence. Furthermore, comparing the years showed that, Yazd and Isfahan samples had the highest level of the extracted essence of petal, while Yazd's sample had the highest yield of the essence in different years. The genotypes were reported different flower components (23).

Oghdai et al. (2003) compared 40 accessions of Damask rose in different parts of Iran (28 sampling sites within 13 areas), the result showed that there was a significant variation among genotypes for the most traits studied (flowers weigh, flower diameter, number of petals, number of stamen and oil content) (24).

Sefidkon et al. (2006) evaluated four different extraction methods including two distillation methods (distillation with water and distillation with water plus steam) and two extraction methods (extraction by hexane solvent and extraction by petroleum ethyl solvent). The results showed that the efficiency of the concretion was higher than the essence and extract (25).

The present research was conducted to evaluate the chemical and molecular compounds and yield of *Rosa damascena* essence collecting in different parts of Iran.

Materials and Methods

The experiment was conducted at the Mehregan station of Kermanshah Agricultural and Natural Resources Research Center, locating at 34°19' latitude; 47°79' longitude and 1270 m above sea level. The studied traits were the amount of essence and the chemical and molecular composition of the essence.

Fifty accessions of *Rosa damascena* collected from different provinces of Iran (Table 1) and were analyzed during 2013-17.

The plants were planted in a completely randomized block design (RCBD) with 3 replications, no toxins and pesticides were used during the experiment and were controlled through physical and mechanical methods. The contaminated branches were manual removed and burnt outside. Weed control carried out also regularly at the proper time.

Table 1. Characteristics of the experimental locations of *Rosa damascene* accessions. Where Az. (Azarbaijan).

Accession code	Name of accession	Accession code	Name of accession
1	East Az. 1	26	Lorestan 1
2	West Az. 1	28	Arak 1
3	Ardabil 1	29	Hormozgan 1
4	Isfahan 9	30	Hamadan 1
5	Isfahan 10	31	Yazd 1
6	Ilam 1	32	Yazd 2
7	Tehran 1	33	Isfahan 1
8	Charmahal 1	34	Isfahan 2
9	Khorasan 1	35	Isfahan 3
10	Ghom 1	36	Isfahan 4
11	Khuzestan 1	37	Isfahan 5
12	Zanjan 1	38	Isfahan 6
13	Semnan 1	39	Isfahan 7
14	Semnan 2	40	Isfahan 8
15	Baluchestan 1	41	Kermanshah 2
16	Fars 1	42	Kermanshah 3
17	Fars 2	43	Kermanshah 4
18	Ghazvin 1	44	Kermanshah 6
19	Kordestan 1	45	Kermanshah 7
20	Kerman 1	46	Kermanshah 8
21	Khermanshah 1	47	Kermanshah 9
22	Kohkolyae 1	48	Kermanshah 10
23	Khorassan 2	49	Kermanshah 11
25	Guilan 1	50	Kermanshah 12

The extraction of essence from the rose flower was done by water distillation and using Jaimand-Rezaee design device (26). Thus, 400 g of each petal samples were collected in the early morning, then essence was extracted on the same day.

After device adjusting and settings, pouring a mixture of boiling water and petals up to 2/3 of the pot extraction process of the essence was started through a gentle flame. After 2 hours of boiling the petal, the device was turned off and when the liquid was cold, about 4-5 ml of diethyl ether was added. A mix of the ether and the essence was poured into the glass containers that previously was weighed and placed in the refrigerator to freeze the essence. The container cap was slowly opened to completely separate the ether. The essence was weighted with the container and it would be ready for injection into the gas chromatography (GC) device.

Gas Chromatography (GC) Device Settings

The initial temperature was 60 °C, slowly reaches up to a final temperature of 285°C and then stopped at this temperature for 3 minutes and the type of carrier gas is helium, set at a pressure of 0.5 kg/cm^2.

Analysis by gas chromatograph attached to the mass spectrometer (GC / MS)

The detection of the spectra by their inhibition parameters and the injection of normal hydrocarbons (C7-C25) under the same condition was investigated by injecting the essence that was extracted using a computer program. The comparison of spectra of each compound was made with various sources using mass spectrometry of standard compounds, and information available in the GC / MS device library.

Statistical analysis of the data was done using SPSS software and the mean data were compared using Duncan's multiple range tests. SPSS software was used to determine the correlation coefficient of the compounds and the clustering of the accession.

Results

The highest amounts of extracted essences weight of 400 g petal were found in Kermanshah11 (0.412 g), Yazd 1 (0.400 g), Isfahan 4 (0.364 g), Lorestan 1 (0.361 g), Kermanshah 2 (0.350 g) and Isfahan 3 (0.331 g) accessions, respectively. Then Kermanshah11 accession had the highest amount (Table 2). Details of some compounds for some locations are shown in the Tables 3-5 for 2015-2017, respectively.

Correlation coefficient

After four years of planting, the essence extracted and analyzed in 2016. The results of the correlation coefficient of essential compounds are given in Table 6. The statistical analysis revealed the strong and significant correlations for all analyzed compounds ($P<0.5$).

Also, according to Table 7 for 2017 samples, the correlation coefficient with the highest correlation coefficient ($P<0.1$) was related to nonadecane and citronellol compounds (0.65), citronellol and n-heneicosane (0.7), citronellol and n-tericosane (0.63), n-nonadecane and geraniol (0.6) and geraniol and n-nonadecane (0 72), geraniol and n-henicosane (0.71). Some chemical components had a negative correlation, that increase in the amount of one caused a decrease of another.

Cluster analysis

The clustering analysis explored that there were following sub-clusters: Sub-cluster accessions of Kermanshah 7, Arak 1, Lorestan 1 with respective 19, 1 and 8 clustering number; sub-cluster accessions of Kermanshah 3, Kermanshah 6 and Khorasan 10 with respective 20, 3 and 10 clustering number; sub-cluster accessions of Khorasan 2, Tabriz 2 and Kermanshah 1 with respective 2, 11 and 7 clustering number; sub-cluster accessions of Kurdistan 1, Yazd 2, Ardabil 1 and Yazd with respective 12, 13, 18 and 15 clustering number; sub-cluster accessions of Tehran 1, Tehran 1 (2^{nd} replication) and Lorestan (2^{nd} replication) with respective 17, 9 and 5 clustering number; and sub-cluster accessions of Arak 1 (2^{nd} replication) with clustering number 22 (Figures 1-4).

According to Figures 1 to 4 obtained from clustering the highest difference was observed among the accessions of Tehran 1 accession (replications 1 and 2) and Lorestan 1 (replications 1) and Arak 1 (replications 2) with other accessions. Arak 1 (replication 2) showed

Table 2. Mean comparison of essences of 400 g petal sample in *Rosa damascene* accessions.

Amount of essence	Name of accession	Amount of essence	Name of accession
0.361 a- d	Lorestan 1	0.197 f - m	East Az.1
0.161 g – m	Arak 1	0.200 e -m	West Az. 1
0.121 g - m	Hormozgan 1	0.283 b - f	Ardabil 1
0.22 d -m	Hamadan 1	0.167 g - m	Isfahan 9
0.4 00 n	Yazd 1	0.152 h - n	Isfahan 10
0.332 a -d	Yazd 2	0.256 b - i	Ilam 1
0.113 m - n	Isfahan 1	0.137 I - n	Tehran 1
0.132j - n	Isfahan 2	0.174 g - m	Charmahal 1
0.331 a -d	Isfahan 3	0.257 b -i	Khorasan 1
0.364 a -d	Isfahan 4	0.144 I - n	Ghom 1
0.175g -m	Isfahan 5	0.164 g - m	Khozestan 1
0.18 3g -m	Isfahan 6	0.212 e -m	Zanjan 1
0.248 b -i	Isfahan 7	0.116 l - m	Semnan 1
0.193 f -m	Isfahan 8	0.274 b -h	Semnan 2
0.350 a -c	Kermanshah 2	0.319 a - d	Baluchestan 1
0.200 f -m	Kermanshah 3	0.238 c -l	Fars 1
0.162 g - m	Kermanshah 4	0.252 b -i	Fars 2
0.209 e - m	Kermanshah 5	0.198 f - m	Ghazvin 1
0.197 f -m	Kermanshah 6	0.197 f -m	Kurdistan 1
0.174 g - m	Kermanshah 7	0.306 a - d	Kerman 1
0.210 e -m	Kermanshah 8	0.117 k -m	Kermanshah 1
0.107 m -n	Kermanshah 9	0.131 j -n	Kohkolyae 1
0.250 b –i	Kermanshah 10	0.164 g -m	Khorasan 2
0.412 a	Kermanshah 11	0.239 c -k	Guilan 1

Table 3. Chemical composition of the essence extracted from samples in *Rosa damascene* accessions in 2015 (%). Where Az. (Azarbaijan)

Compounds name	Kermanshah 7	Khorasan 2	Kermanshah 3	Fars 1	Lorestan 1	Yazd 1	Kermanshah 1	East Az. 1	West Az. 1
n-pinene	0.3	0.4	1.7	0.3	0.2	0.0	0.6	0.0	0.9
trans-dihydro-rose oxide	0.0	0.0	0.5	0.0	1.5	0.4	0.0	0.0	0.0
citronellol	43.6	17.4	36.2	12.8	3.8	36.7	22.0	6.6	21.6
geraniol	19.3	19.3	24.9	2.8	2.1	18.8	7.5	1.9	10.2
myrcene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
n-phellandrene	0.0	0.6	0.8	0.0	0.0	0.0	0.7	0.0	0.0
n-3-carene	0.0	0.0	0.9	0.0	0.0	0.0	0.5	0.0	0.0
n-undecanol	1.8	0.5	1.1	0.0	0.0	0.0	1.0	0.0	1.9
n-cadinene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.9	1.0
n-tetradecanal	1.4	1.5	2.1	0 .0	2.6	0.0	0.0	3.3	2.2
occidentalol acetate	0.0	0.0	0.0	0.0	2.6	1.6	2.5	1.4	0.0
n-heptadecane	2.7	4.9	1.3	2.2	0.0	3.3	2.1	0.0	8.4
n-pentadecane	0.0	0.0	0.0	5.0	0.4	0.0	0.0	0.0	0.0
isoamyldodecanoate	3.0	0.8	3.0	3.0	9.0	3.5	5.2	4.6	1.3
n-nonadecane	13.7	15.5	14.8	0.0	39.8	17.1	31.4	45.5	15.8
n-eicosane	1.5	1.9	1.0	7.0	3.8	2.0	3.0	2.5	2.6
n-heneicosane	7.0	13.0	4.3	3.1	21.0	9.7	15.9	18.6	15.0
n-tricosane	0.0	0.0	2.0	5.8	0.0	0.0	0.0	0.0	0.0
n-tetracosane	0.0	10.9	0.0	5.5	9.5	0.0	0.0	0.0	7.3
n-pentacosane	0.3	4.1	0.0	47.0	0.8	0.0	0.0	2.0	1.3

Compounds name	Kurdistan 1	Yazd 2	Isfahan 10	Yazd 1	Kermanshah 3	Tehran 1	Ardabil 1	Arak 1	Kermanshah 6	Isfahan 5
n-pinene	0.9	0.3	0.0	0.0	0.5	0.0	0.5	0.0	0.4	0.0
trans-dihydro-rose oxide	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9
citronellol	21.7	19.2	41.0	38.4	34.8	1.7	9.0	48.8	34.6	57.6
geraniol	10.2	11.3	8.0	12.9	19.9	0.6	5.7	19.4	23.0	17.5
octadecanol	1.9	1.4	0.0	0.5	0.0	0.0	0.0	2.0	0.0	1.2
n-gurjunrne	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
citronellylpropanoate	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
n-cadinene	1.0	0.0	0.0	0.0	0.0	4.0	0.0	0.0	0.0	0.0
citronellylpentanoate	0.5	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0
n-tetradecanal	2.2	3.0	0.0	2.2	2.1	0.9	2.0	0.0	0.0	1.4
occidentalol acetate	0.0	0.0	3.4	0.0	0.0	3.3	0.0	1.0	2.2	1.5
n-heptadecane	8.5	4.1	0.5	1.4	1.6	1.4	8.3	2.5	2.4	0.0
isoamyldodecanoate	1.3	4.5	0.0	2.9	2.8	0.0	0.9	0.0	0.0	2.3
n-hexadecanol	15.8	29.7	3.0	24.3	21.0	5.3	20.5	2.0	3.0	9.6
n-nonadecane	0.0	0.0	24.6	0.0	0.0	47.2	0 .0	11.7	19.8	0.0
n-eicosane	2.6	2.6	1.6	2.2	1.6	3.9	4.2	1.5	1.6	0.7
n-heneicosane	15.0	14.4	9.5	11.3	8.3	19.6	27.3	6.4	8.2	2.8
n-tricosane	0.0	0.0	0.0	0.0	0.0	0.0	3.3	0.0	0.0	0.0
n-tetracosane	7.3	1.6	0.0	0.0	0.0	0.0	6.5	0.0	0.0	0.0
n-pentacosane	1.3	0.0	3.6	0.0	2.0	4.9	1.4	0.0	0.0	0.0

Table 4. Chemical composition of the essence extracted from samples in *Rosa damascene* accessions in 2016 (%).

Compounds name	Ghazvin 1	Khorasan 1	Isfahan 1	Kermanshah 11	Isfahan 2	Ardabil 1	Kermanshah 10	Semnan 2	Kermanshah 6	Kermanshah 4	Lorestan 1	Kermanshah 9
dihydro-linalool	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.0	0.4	0.0	0.0	0.0
citronellol	14.9	23.6	23.3	24.7	13.5	19.5	12.3	4.5	27.5	10.4	14.4	1.5
geraniol	9.4	13.1	9.5	14.4	8.6	10.8	7.1	2.4	3.9	3.6	7.7	0 .0
geranioll	17.4	19.32	16.8	22.0	19.0	20.0	12.9	7.8	5.7	6.6	15.1	0.7
citronellyl acetate	0.4	0.3	0.3	0.3	0.0	0.3	0.4	0.0	0.0	0.0	0.3	0.0
n-undecanol	3.5	0.6	0.8	1.0	1.3	2.0	1.8	0.9	0.0	0.4	1.3	0.3
n-pentadecane	0.6	0.0	0.5	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
n-heptadecane	2.2	1.6	3.0	2.3	1.7	0.7	2.7	5.1	4.4	5.2	2.7	5.6
methyl tetradecanoate	5.9	1.7	1.0	1.3	2.8	5.9	2.4	1.2	0.5	2.4	2.4	0.8
n-hexadecanol	2.9	4.0	4.3	3.2	5.6	1.6	7.7	7.1	5.6	11.3	2.7	12.4
n-nonadecane	17.7	18.4	21.3	15.4	22.5	11.5	26.6	43.1	31.1	35.1	28.7	45.7
1-eicosene	1.0	0.4	0.2	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
n-eicosane	2.2	2.0	2.0	1.4	2.5	2.3	2.7	3.4	2.4	2.9	2.8	4.0
n-heneicosane	11.8	9.7	11.2	7.6	13.6	13.5	14.7	18.1	12.4	15.9	15.4	19.7
n-tricosane	9.2	3.2	3.0	2.2	4.1	8.1	4.6	4.5	3.4	3.5	4.6	5.5

Table 5. Chemical composition of the essence extracted from samples in *Rosa damascene* accessions in 2017 (%). Where Az. (Azarbaijan).

Compounds name	Isfahan 4	Isfahan 7	Hamadan 1	Arak 1	Isfahan 6	Kurdistan 1	Kermanshah 7	Kermanshah 8	Charmahal 1	West Az. 1	Isfahan 10	Isfahan 3
dihydro-linalool	0.0	0.5	0.6	0.0	0.8	0.2	0.3	0.0	0.3	0.3	0.5	0.3
citronellol	8.8	15.8	22.8	1.7	23.3	14.5	20.0	6.7	18.4	20.1	26.6	16.2
geraniol	2.1	10.1	10.0	0.7	15.7	11.7	10.7	1.0	3.9	12.6	13.1	9.5
geranioll	3.2	20.9	20.4	2.6	25.8	28.8	25.2	6.2	21.5	25.6	17.0	19.7
citronellyl acetate	0.2	0.2	0.4	0.0	0.2	0.2	0.5	0.6	0.5	0.8	0.7	0.4
n-undecanol	0.7	1.0	1.7	0.3	0.9	3.0	1.0	0.0	1.2	1.1	0.3	1.6
n-pentadecane	0.6	0.3	0.4	0.2	0.3	0.2	0.5	0.5	0.5	0.0	0.3	0.3
n-heptadecane	5.8	2.7	3.1	4.1	2.5	1.3	2.9	5.4	3.6	1.0	2.6	2.7
methyl tetradecanoate	2.3	2.0	1.6	3.6	0.7	5.4	1.1	0.9	1.7	4.6	0.4	0.7
n-hexadecanol	9.6	4.4	4.7	8.3	3.4	1.4	4.2	13.0	7.1	1.6	5.4	5.4
n-nonadecane	41.1	22.8	20.2	42.7	15.5	10.2	18.4	37.4	23.5	10.7	20.1	24.7
n-eicosane	3.2	2.0	1.6	3.9	1.2	1.5	1.7	3.3	2.0	2.0	1.5	2.3
n-heneicosane	16.5	10.6	7.8	22.8	6.0	10.2	9.6	17.2	10.3	11.4	8.8	11.3
n-tricosane	4.0	2.7	2.3	6.7	1.3	8.4	2.8	5.0	2.5	5.6	1.8	3.1

Table 5. Chemical composition of the essence extracted from samples in *Rosa damascene* accessions in 2017 (%) (continue).

Compounds name	Kermanshah 1	Kermanshah 3	Fars 2	Kermanshah 10	Zanjan 1	Hamadan 1	Isfahan 2	Isfahan 8	Semnan 1	Isfahan 10	Isfahan 4
dihydro-linalool	0.4	0.3	0.0	0.0	0.4	0.4	0.2	0.3	0.3	0.5	0.4
citronellol	21.3	20.1	0.0	19.0	21.5	23.3	16.5	21.8	28.2	19.7	22.6
geraniol	12.9	9.0	0.0	4.4	6.6	11.6	4.9	10.2	12.7	10.6	6.5
geranioll	22.2	17.5	0.0	6.2	17.0	17.3	12.2	16.3	24.0	19.0	12.9
citronellyl acetate	0.6	0.4	0.0	0.3	0.3	0.6	0.3	0.5	0.3	0.3	0.2
n-undecanol	0.6	1.1	0.0	0.3	0.8	0.0	1.0	0.5	0.4	1.3	0.5
n-pentadecane	0.3	0.3	0.0	0.4	0.0	0.0	0.6	0.3	0.0	0.0	0.3
citronellylpentanoate	0.0	0.0	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
n-heptadecane	2.6	3.0	2.5	2.8	1.8	2.2	4.2	3	1.4	2.0	3.0
methyl tetradecanoate	1.4	1.9	1.5	0.5	3.1	0.5	1.1	0.5	2.2	3.3	1.7
n-hexadecanol	4.2	5.4	5.9	8.7	5.6	3.7	8.3	4.5	2.7	5.0	6.4
n-nonadecane	20.0	24.2	50.3	30.0	22.8	23.8	30.0	25.5	16.3	20.3	25.4
n-eicosane	1.6	2.0	3.2	3.0	2.3	2.0	2.7	2.0	1.4	2.0	2.2
n-heneicosane	8.2	10.2	25.7	16.6	10.9	10.2	12.0	10.6	6.8	10.3	11.6
n-tricosane	1.8	2.3	4.3	5.0	3.1	2.9	3.0	2.6	1.6	2.7	3.2
dihydro-linalool	0.4	5.2	0.4	0.3	6.8	0.0	0.7	1.0	0.9	0.6	0.0
citronellol	52.4	37.5	16.3	2.2	9.9	5.5	14.5	16.1	10.7	18.2	1.1
geraniol	7.9	9.2	9.4	0.5	5.5	1.4	3.6	4.9	4.4	3.7	0.0
Geranioll	18.0	26.2	18.1	0.6	8.6	2.8	29.8	40.8	11.2	19.3	0.0
Nerylformate	0.0	1.0	0.5	0.0	0.5	0.0	0.0	1.0	0.0	0.0	0.0
Undecanal	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.0
citronellyl acetate	0.8	0.0	0.6	0.0	0.0	0.0	0.8	1.0	0.5	1.1	0.0
n-undecanol	0.9	0.0	2.9	0.5	0.0	0.0	2.0	4.5	2.4	1.3	0.0
a-cadinene	0.0	1.4	0.0	0.0	3.8	0.0	0.0	1.0	0.0	0.0	0.0
n-tridecanol	0.0	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.6
n-tetradecanal	0.0	0.0	0.0	1.5	0.4	2.1	2.0	34.3	2.8	2.6	1.1
n-heptadecane	1.0	0.7	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
methyl tetradecanoate	1.2	0.7	6.0	2.0.	0.0	2.0	5.5	8.0	8.4	4.5	2.8
n-hexadecanol	2.4	1.8	9.7	6.8	2.5	7.6	7.3	0.6	10.4	9.4	7.3
n-nonadecane	8.6	6.9	17.4	32.1	12	29.4	15.6	5.0	25.0	19.8	51.7
n-eicosane	0.8	0.7	1.6	5.0	3.7	4.4	1.6	1.3	2.4	2.0	3.0
n-heneicosane	3.8	3.9	7.9	31.4	21	29.8	8.1	5.9	11.2	0.7	22
n-tricosane	0.0	0.0	2.3	13.9	12.9	11.6	3.2	3.0	4.5	3.3	3.5

Table 5. Chemical composition of the essence extracted from samples in *Rosa damascene* accessions in 2017 (%) (continue).

Compounds name	Isfahan 10	Arak 1	Semnan 2	Semnan 1	Zanjan 1	Khorasan 1	East Az. 1	Fars 1	Ghazvin 1	Isfahan 6
dihydro-linalool	0.7	1.2	2.6	2.2	0 .0	1.1	0.4	0.7	0.4	9.4
citronellol	25.8	37.3	8.5	16.7	5.5	49.2	5.5	11.7	6.5	0 .0
geraniol	2.8	2.5	2.8	5.4	0.8	2.8	1.2	7.9	1.9	0.0
Geranioll	32.6	14.2	4.8	7.8	1.9	17.0	3.2	19.2	3.1	0.0
Nerylformate	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.4	0.0	0.3
citronellyl acetate	1.5	1.5	0.5	0.3	0.0	1.0	0.7	0.9	0.0	0.0
n-undecanol	1.9	0.9	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.6
a-cadinene	0.0	1.4	1.6	6.2	0.0	1.6	0.0	0.7	0.0	15
n-pentadecane	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2
n-heptadecane	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.3	0.9	0.0
methyl tetradecanoate	3.0	1.8	2.8	0.4	2.3	1.5	4.2	0.7	3.0	1.0
n-hexadecanol	9.2	7.3	10.4	7.1	3.2	4.5	13.0.	3.3	8.0	6.5
n-nonadecane	12.2	13.2	35.7	18	35	9.3	36.5	14.1	44	19.3
n-eicosane	1.5	1.6	2.9	2.5	4.9	1.0	3.1	2.3	2.6	2.8
n-heneicosane	8.6	7.5	13.5	15.7	31.3	5.0	17.5	17.7	18	22.6
n-docosane	0.2	0.0	0.4	0.5	0.7	0.0	0.3	0.6	0.3	0.5
n-tricosane	2.9	3.1	4.5	7.5	11	0.0	5.6	8.1	3.2	8.5

Table 5. Chemical composition of the essence extracted from samples in *Rosa damascene* accessions in 2017 (%) (continue).

Compounds name	Kermanshah 1	Kurdistan 1	Kerman 1	Kermanshah 6	Kermanshah 12	Kermanshah 4	Kermanshah 3	Kermanshah 8	Kermanshah 9	Kermanshah 3
dihydro-linalool	1.0	0.4	0.9	1.0	1.4	5.7	0.6	2.3	1.1	1.0
citronellol	8.5	11.3	11.7	32.8	4.3	3.7	23.9	19.3	54.8	7.8
geraniol	1.1	5.0	0.3	2.8	0.4	0.5	5.6	4.0	6.0.	3.8
geranioll	1.8	40.7	2.0	20.5	0.6	3.0	20.7	4.6	14.8	12.5
citronellyl acetate	0.3	1.0	0.6	0.5	0.6	0.5	0.7	1.0	1.1	0.0
n-undecanol	0.5	2.2	0.4	0.8	0.0	0.0	2.2	1.0	1.4	1.5
a-cadinene	0.9	0.0	1.8	0.5	0.4	5.5	0.8	2.7	0.0	0.0
n-tetradecanal	3.4	1.0	3.2	0.0	3.7	0.8	1.8	3.0	0.8	5.5
n-pentadecane	0.0	0.0	0.0	0.3	0.0	0.6	0.4	0.4	1.4	0.0
n-heptadecane	0.0	1.0	0.0	1.5	0.0	0.4	0.0	0.0	0.0	0.0
methyl tetradecanoate	1.0	6.1	0.0	3.0	0.8	0.7	4.3	4.9	1.7	3.0
n-hexadecanol	9.8	1.2	14.3	7.3	11.0	3.1	10.0	7.9	2.3	12.2
n-nonadecane	39.0	11.7	31.8	12.2	37.9	15.6	13.4	24.4	5.5	28.3
n-eicosane	3.7	1.5	3.1	1.4	3.2	13.2	1.4	2.2	2.1	3.6
n-heneicosane	19.7	8.5	17.6	7.4	21.8	28.1	7.2	11.9	2.8	12.3
n-docosane	0.4	0.0	0.4	0.0	0.4	2.0	0.0	0.0	0.0	0.3
n-tricosane	5.0	4.6	6.3	3.0	6.0	8.9	2.3	3.9	0.0	3.4

Table 5. Chemical composition of the essence extracted from samples in *Rosa damascene* accessions in 2017 (%) (continue).

Compounds name	Isfahan 5	Isfahan 8	Isfahan 1	Kohkyloyeh 1	Isfahan 7	Guilan 1	Kermanshah 1	Hormozgan 1	Yazd 2	Lorestan 1
dihydro-linalool	0.8	0.7	0.4	0.3	0.7	0.7	0.4	0.7	1.8	1.1
citronellol	47.0	19.6	1.0	14.8	14.4	20.4	18.6	46.5	13	30.4
geraniol	0.9	3.5	0.3	0.8	4.0	2.8	5.0	0.9	4.4	1.5
geranioll	5.1	28.7	1.0	5.8	27.6	31.7	25.8	9.1	7.2	8.6
citronellyl acetate	2.6	2.5	0.0	1.1	1.0	1.4	0.4	1.0	0.6	1.2
n-undecanol	0.4	1.6	0.4	0.8	1.6	2.8	0.0	0.0	0.0	0.8
a-cadinene	0.0	0.0	1.2	0.0	0.0	0.8	0.0	0.0	0.9	0.9
n-heptadecane	0.0	0.0	1.8	0.0	0.0.	0.0	0.0	0.0	0.0	0.0
methyl tetradecanoate	0.7	5.6	8.3	2.6	4.7	3.6	3.4	0 .0	2.4	2.4
n-hexadecanol	8.0	5.0	8.8	13.2	6.6	4.3	6.6	5.1	5.0	7.5
n-nonadecane	16.6	14.3	38.7	16.9	17.8	14.6	20.5	15.5	24.9	20.4
n-eicosane	1.6	1.6	5.4	2.0	1.8	1.5	1.7	1.8	3.1	1.9
n-heneicosane	7.8	7.8	21.7	19.0	9.1	6.9	8.0	9.4	20.0	9.3
n-docosane	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0
n-tricosane	2.3	2.8	4.0	10.3	3.1	3.0	2.4	3.0	7.8	3.3

Table 5. Chemical composition of the essence extracted from samples in *Rosa damascene* accessions in 2017 (%) (continue).

Compounds name	Ghom 1	Ilam 1	Fars 2	Charmahal 1	Isfahan 1	Ardabil 1
Dihydro-linalool	0.4	0.6	0.3	0.7	0.2	0.0
citronellol	14.4	20.5	0.3	7.9	18.7	5.3
geraniol	7.3	3.6	0.0	5.2	3.7	1.7
geranioll	13.7	32.7	0.0	20.9	30.4	3.0
Citronellyl acetate	0.5	0.7	0.0	0.8	0.5	0.3
n-undecanol	0.0	2.0	0.0	2.3	2.6	0.0
a-cadinene	0.0	0.0	0.0	1.2	0.0	0.0
n-tetradecanal	1.3	1.9	3.0	1.5	1.3	2.1
n-pentadecane	0.0	0.0	0.0	1.0	0.0	0.0
n-heptadecane	0.0	0.0	0.0	3.8	0.0	0.0
Methyl tetadecanoate	4.8	3.8	1.2	19.2	5.1	3.2
n-hexadecanol	3.8	5.6	11.1	1.4	0.8	10.9
n-nonadecane	22.0	13.6	36.9	11.6	11.9	30.4
n- eicossene	2.8	1.4	4.5	2.0	1.7	4.3
n-heneicosane	17.5	6.9	27.0	9.0	11.0	25.4
n-docosane	0.0	0.0	0.0	0.0	0.4	0.7
n-tricosane	7.5	2.6	11.3	4.1	7.1	9.2

Table 6. Correlation coefficients for chemical composition in *Rosa damascene* accessions in 2016 .

Composition	dihydro-linalool	citronellol	geraniol	geranioll	citronellyl acetate	n-undecanol	n-pentadecane	n-heptadecane	methyl tetradecanoate	n-hexadecanol	n-nonadecane	n-eicosane	n-heneicosane
citronellol	0.567	1.000											
geraniol	0.496	0.733											
geranioll	0.519	0.660	0.872										
citronellyl acetate	0.344	0.481	0.472	0.511									
n-undecanol	0.065	0.012	0.278	0.481	0.057								
n-pentadecane	-0.080	0.034	-0.056	0.026	0.279	0.150							
n-heptadecane	-0.345	-0.526	**-0.709***	**-0.727***	-0.333	-0.397	0.367						
methyl tetradecanoate	-0.089	-0.158	0.064	0.245	-0.073	0.706	-0.208	-0.434					
n-hexadecanol	-0.378	-0.591	**-0.769***	**-0.775***	-0.298	-0.448	0.238	0.843	-0.368				
n-nonadecane	-0.498	**-0.771***	**-0.883****	**-0.930****	-0.515	-0.500	-0.011	0.779	-0.344	0.772			
n-eicosane	**-0.621***	**-0.845****	**-0.891****	**-0.885****	-0.502	-0.270	-0.097	0.648	-0.010	0.740	0.872		
n-heneicosane	**-0.620***	**-0.879****	**-0.842****	-0.850	-0.527	-0.244	-0.179	0.480	0.071	0.580	0.850	0.923	
n-tricosane	-0.436	-0.503	-0.273	-0.213	-0.220	0.534	-0.064	-0.059	0.737	-0.001	0.084	0.441	0.496

Table 7. Correlation coefficients for chemical composition in *Rosa damascene* accessions in 2017.

Composition	dihydro-linalool	citronellol	geraniol	geranioll	nerylformate	undecanal	citronellyl acetate	n-undecanol	a-cadinene	n-tridecanol	n-tetradecanal	n-heptadecane	methyltetradecanoate	n-hexadecanol	n-nonadecane	n-eicosane	n-heneicosane	n-docosane
citronellol	0.02																	
geraniol	0.19	0.32																
Geranioll	-0.10	0.31	0.54															
Nerylformate	0.38	0.20	0.47	0.31														
Undecanal	0.45	-0.08	0.13	-0.07	0.24													
citronellyl acetate	-0.18	0.52	0.04	0.39	-0.09	-0.18												
n-undecanol	-0.22	0.13	0.33	0.73	0.21	-0.13	0.37											
a-cadinene	0.85	-0.08	0.04	-0.22	0.19	0.16	-0.18	-0.17										
n-tridecanol	0.04	-0.25	-0.01	-0.06	-0.01	0.44	-0.29	-0.07	-0.05									
n-tetradecanal	-0.04	-0.09	0.05	0.27	0.48	-0.03	0.04	0.51	-0.03	-0.11								
n-heptadecane	-0.09	-0.01	0.28	0.10	0.09	-0.07	-0.08	0.22	-0.04	0.04	-0.12							
methyl tetradecanoate	-0.29	-0.21	0.18	0.35	-0.05	-0.16	0.09	0.57	-0.21	0.11	0.19	0.60						
n-hexadecanol	-0.23	-0.31	-0.46	-0.50	-0.37	-0.18	-0.05	-0.23	-0.09	-0.10	-0.15	-0.17	-0.19					
n-nonadecane	-0.19	**-0.65***	**-0.60***	**-0.72***	-0.39	-0.13	-0.49	-0.50	-0.08	0.05	-0.13	-0.11	-0.13	0.57				
n-eicosane	0.29	-0.52	-0.44	-0.53	-0.21	0.08	-0.38	-0.39	0.24	0.11	-0.07	-0.07	-0.18	0.07	0.37			
n-heneicosane	0.18	**-0.70***	-0.53	**-0.71***	-0.21	0.13	-0.58	-0.56	0.22	0.24	-0.12	-0.17	-0.26	0.22	0.66	0.72		
n-docosane	0.39	-0.33	-0.22	-0.31	-0.10	-0.08	-0.20	-0.32	0.38	-0.05	-0.07	-0.14	-0.28	-0.02	0.17	0.77	0.50	
n-tricosane	0.22	**-0.63***	-0.34	-0.48	-0.15	0.33	-0.45	-0.39	0.22	0.38	-0.08	-0.23	-0.22	0.10	0.34	0.56	0.86	0.37

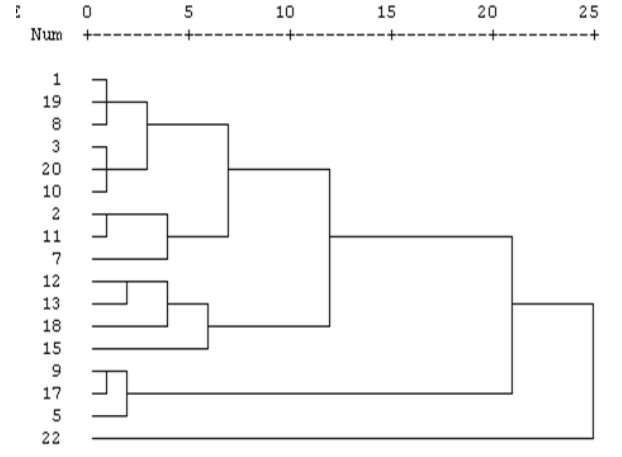

Figure 1. Clustering the chemical composition of the essence extracted from the in *Rosa damascene* accessions in 2015.

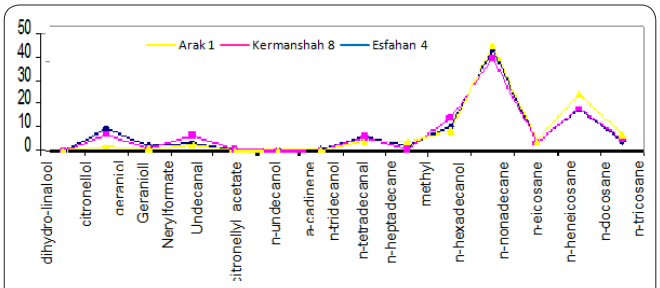

Figure 3. Compare accessions percentage in *Rosa damascene* among Arak 1, Kermanshah 8 and Isfahan 4.

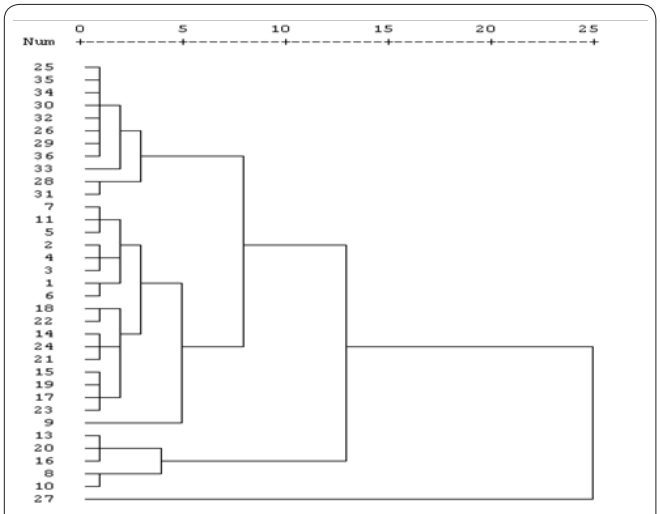

Figure 2. Clustering the chemical composition of the essence extracted from the in *Rosa damascene* accessions in 2016.

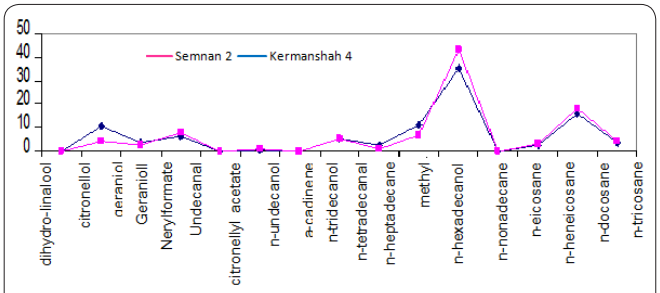

Figure 4. Compare accessions percentage between the in *Rosa damascene* accessions of Semnan 2 and Kermanshah 4.

the lowest percentage of similarity with the other genotypes. It seems that accessions of Tehran 1 (replication 1 and 2) and Lorestan 1 (replication 1) have the highest levels of n-nonadecane (39.8, 45.5 and 47.2%) and n-henicosane (21, 18.6 and 19.6%), respectively, which is showing a low percentage of similarity with the other accessions (Table 3). The Arak1 (replication 2), which showed the greatest difference in clustering with the other accessions, had the highest level of geraniol (33.5%), octadecanol (9.7%), n-eicosane (28.3%) and n-tricosane (10.9%) compared to the other of the accessions.

Comparing the clustering data of genotypic in 2016, the highest percentage of similarity was observed among the accessions with the numbers 25, 35, 34, 30, 32, 26, 29 and 36. So that the lowest percentage of similarities it was observed in accessions with the numbers 13 (Isfahan 4), 20 (Kermanshah 8) and 16 (Arak 1), respectively; Also accessions with numbers 8 (Semnan 2) and 10 (Kermanshah 4) in the cluster have the least similarity to the other accessions and were in a sub-cluster. The rate of henicosane in Semnan 2 and Kermanshah 4 was 18.1 and 15.9%, respectively, and the rate of n-nonadecane 5.1 and 5.2%, n-heptadicane 43.1% and geraniol 7.8 and 6.4% respectively (Table 4). According to Figures 3 and 4, accessions with numbers 8 and 10 showed the highest percentage of similarity among themselves as one group. The amount of nonadecane for Isfahan 4 (41.1%), Arak 1 (24.7%) and Kermanshah 8 (37.4%); also the rate of hexadecane in Isfahan 4 (9.6%), Arak 1 (8.3%) and Kermanshah 8 (8.3%) and the rate of henicosane in Isfahan 4 (16.5%), Arak 1 (22.8%) and Kermanshah 8 (17.2%), which makes these extras superior to others (Table 4). The accessions of Fars 2, shown in cluster 27, which has the lowest percentage of similarity with other accessions, has the highest nonadecane (50.3%), which itself is the reason for the differentiation of these accessions compared to the others (Table 4).

The clustering analysis for results of 2017 explored that highest level of similarity was obtained within three sub-cluster indicating the highest percentage of similarity among them, hence; lower similarity was found for Kermanshah 4 (Code No. 27), Tehran 1 (Code No. 11) and Charmahal 1 (Code No. 45).

It seems that accession Kermanshah4 has the highest amount of nonadecane (15.6%), n-nonadecane (13.2%), n-henicosane (28.1%). Furthermore, the Tehran1 was the highest rate of nonadecane (51.7%), henicosane (22%) and accessionCharmahal1(19.2%). methyl tetradecanol are among the other accessions that have been distinguished among its subcluster (Figure 5).

High and low levels of essence components

The height and low levels of essence components were as: The high and low levels of transdihdrorozaxide were 0.4 (Lorestan 1) and 1.5 (Yazd 2) %. The respective height and low values of citronellol were 1.7 to 57.6% for Isfahan 5 and Tehran 1, respectively. Geraniol ranged from 0.6 (Arak 1) to 33.5 (Tehran 1) %. The high and low value of n-undecanol was 0.5 (Tabriz 2) and 1.9 (Khorasan) 2%, respectively. The n- tertadecanol ranged from 0.9 to 3.3% in Tehran1, respectively. The occidentalol acetate ranged from 1 (Isfahan 10) to 3.4 (Arak 1) %. The n-heptadicans was ranged from 0.5 (Lorestan1) to 8.5 (Isfahan 10) %. The isoamyl dodecanoate with amplitude 0.8 to 9 % was highest in Lorestan1 and

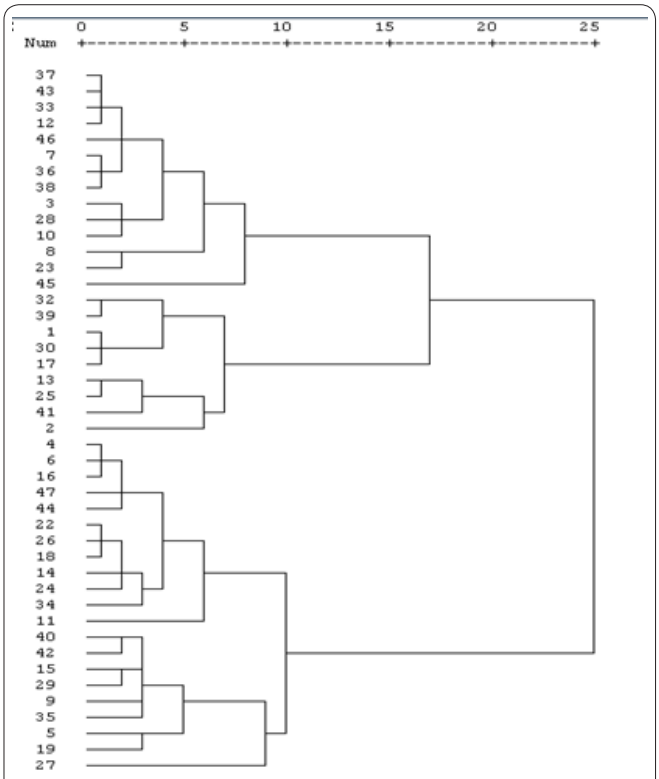

Figure 5. Clustering the chemical composition of the essence for collected in *Rosa damascene* accessions in 2017.

lowest in Khorasan 2. The n-nonadicane with a range of 3.2 to 47.2 % (in Tehran 1 and Arak 1, respectively. The n-eicosane was with a range of 0.6 (Arak 1) to 28.3 (Lorestan 1) %. The high and low n-henicosane were 2.3 (Ardebil 1) to 27.3(Arak 1) %. The n-tericosane was ranged from 2 to 10.9% (respectively in Kermanshah 3 and Arak 1). The n-tetracosane was ranged from 1.6 (Yazd 2) to 10.9 (Khorasan 2). The n-pentacosane with a range of 0.3 to 47 was the highest in Fars 1 and the lowest in Kermanshah 7.

In the second year (2016), the main chemical compounds in the essence of *Rosa damascena*in different area of the country (Table 4), including citronellol with a range of 1.5 to 28.2 percent, were highest in Semnan 1 and the lowest in Kermanshah 9, geraniolwith range of 0.7 to 24 percent was highest in Semnan 1 and the lowest in Arak 1, geraniol with a range of 0.7 to 28.8 percent was highest in Kurdistan 1 and the lowest in Kermanshah 9, n-heptadicanol with the ranges of 0.5 to 5.8 percent was the highest in Tehran 1 and the lowest in Isfahan 4, Methyl Tetradecanoate with a range of 0.4 to 5.9 percent was highest in Isfahan 4 and lowest in Tehran 1, hexadecanol with a range of 1.4 to 13 percent was highest in Kermanshah 8 and the lowest in Kurdistan 1, n-nonadicanol with a range of 10.2 to 50.3 percent was highest in Fars 2 and the lowest in Kurdistan 1, n-eicozan with a range of 1.2 to 4 percent was highest in Kermanshah 9 and the lowest in Isfahan 6, n-heneicosanewith a range of 6 to 25.7 %, highest in Fars 2 and lowest in Isfahan 6 and n-tericosan with a range 1.3 to 9.2 % was highest in Qazvin and lowest in Isfahan 6.

Discussion

The presence of genetic diversity is important to improve the quality and quantity of traits, while genotypic diversity increases the range of superior cultivars and cultivation zone (27-29). Increasing the yield of flowers and enhancing the quantity of essence is largely dependent on the improvement, and production of high yielding cultivars with high qualitative and quantitative characteristics through genetic variation (30).

Based on the statistical analysis, we found that there were significant differences between the accessions for studied variables. Greater genetic diversity indicated the greater chances for accession heterosis in relation to contents and composition of essence (30). Variation in the flowers of Damask Rose accessions has been reported for various traits such as essence, flower components, flower yield, and chemical composition of essence (31-33).

In the clustering of the accessions, based on the active materials present in them in 2015, the extra essences with high similarity were found in Arak 1 (replication 2), while other extras showed a lower similarity level containing the highest geraniol (33.5%), octadecanol (9.7%), n-eicosane (3.28%) and n-tricosane (10.9%). Also, accession of Tehran 1 (replications 1 and 2) and Lorestan 1 (replication 1) have the highest nonadecane with 39.8, 45.5 and 47.2% respectively, and n-henicosane with 21, 18.6 and 19.6% respectively. They can be introduced this year as a superior accession.

In 2016, clustering, it was shown that Fars 2 has the lowest percentage of similarity which has the highest amount of nonadecane (50.3%). Isfahan 4, Kermanshah 8, Kermanshah 4, Arak 1 and Semnan 2 showed the lowest similarity ratio to the other accessions and adversely the highest similarity whitens themselves. Based on the clustering of accessions in 2017, Kermanshah 4, Tehran 1 and Charmahal 1 explored lower similarity in their subclusters due to the highest nonadecane (15.6%), n-eicosane (13.2%), n- henicosane (28.1%) in Kermanshah 4. As well Tehran 1 has the highest concentration of nonadecane (51.7%), henicosane (22.0%). and Charmahal1 with 19.2% methyl tetradecanol were found the other accessions.

As presented in the results, the highest correlation was related to most of the chemical components of essences. The correlation coefficient in one year is different from that of the next year. In the second year, the correlation coefficient was with relatively less significant effects among the compounds including n-nonadecane and citronellol (0.65), citronellol and n-henicosane (0.70), citronellol and n- tricosane (0.63), n-nonadecane and geraniol (0.60), geraniol and n-nonadecane (0.72), geraniol and n-henicosane (0.71) ($p<0.05$).

It might be due to the heterogeneity of sample or genotypic interaction with a proven climate hindering the production of the essence and its composition (34). The effective compounds in the essence and their effects on each other can fluctuate from one year to the next. Different researchers have achieved similar results in this regard mainly relate to local meteorological and topographical characteristics such as minimum and maximum rainfall, dry months, hill slope direction and elevation (7, 35).

There is often a good match between genetic variation and geographical diversity. Researchers from different countries have identified the most important components of *Rosa damascena* essence as citronellol,

geraniol, geranium, nanodecane, hexadecanol, n-tricosane, n-eicosane and linalool. It is due to different components of the essence. The compounds might be the same in every sample, but the content might be varying between samples and genotypes (33, 36, 37).

Investigating the compositions of the essence of *R. damascena* in three regions of India were in the first sample of alpha-pinene (7.1%), in the second sample, the compound of terpinene-4 (3.1%), and in the third sample compound of linalool (6-7%) as the main components. By studying different sources and reports it can be seeming, that essences are different in terms of the amount and type of compounds. Researches that have been carried out on the essence of different *R. damascena* have shown that different vegetation conditions or different methods of getting essence have a very different effect on the amount of essence composition. Thus determining the proper location for growth is very important to produce the primary material (38-40).

Based on the comparison Tables 4 and 5, the mean number of the essence content in Kermanshah 12 (0.412 g), Isfahan4 (0.364g), Lorestan1 (0.361g), Kermanshah2 (0.350g), Yazd2 (0.332g), Isfahan3 (0.331g), Baluchistan1 (0.319g) and Kerman1 (0.306g) had the highest amount of essence in 300 g petals, respectively. Furthermore, in the first year (2015), the results showed that the highest and lowest important chemical compounds of *Rosa damascena* including beta-pan were found in Kermanshah3(0.2 -1.7%) and Lorestan1, respectively.

According to Table 3, in the first year of 2015, in the essence of accession of Rosa *damascena*, the chemical composition of citronelol, geraniol, n-heptadicanol, isoamyl dodecanoate, n-nonadicane, n-eicosane, n-henicosane, n-tericosane, n-tetracosane and n-pentacosane were highest.

Also, in the second year (2016), according to Table 4, the chemical composition of citronellol, geraniol, n-nonadicane, n-henicosane, n-hexadcanol and n-tericosane had the highest rate.

In the third year (2017), the most important chemical compounds in the essence of *Rosa damascena* flowers in different regions of the country (Table 5), including citronellol with a range of 0.3 to 54.8%, were highest in Kermanshah 9 and the lowest in Fars 2, geraniol with the range from 3 to 7.9% was highest in Fars 1 and the lowest in Isfahan 1, geraniol with the range of 0.6 to 40.7%, the highest was in Kurdistan 1 and the lowest in Kermanshah 12, Tetradecanol with a range of 0.4 to 34.3% had the highest rates in the Azarbaijan West and the lowest in Isfahan 3, Methyl Tetra Decanoate with a range of 0.4 to 19.2 percent, the highest in Charmahal and the lowest in Semnan 1, hexadecanol with the range of 0.6 to 14.3 percent, the highest rate was in Kerman 1 and the lowest rate was in Azarbaijan West; n-nonadicane with the range of 5 to 51.7 percent had the highest rates in Tehran 1 and the lowest rates were in the West Azarbaijan, n-enicozane with the range of 0.7 to 13.2% was highest in Kermanshah 4 and the lowest in Hamadan 1, n-henicosane with the range of 0.7 to 31.3% was highest in Zanjan 1 and the lowest in Isfahan 9 and n-tericosane with a range of 3.2 to 9.9% was highest in Balochistan 1 and the lowest in Kermanshah 1.

Also, in the third year (2017), following Table 5, chemical compounds of citronellol, geraniol, n-tetradecanol, methyl tetradecanoate, n-hexadecanol, n-nonadicane, n-eicosane, n-henicosane, n-tericosane in the essence of *Rosa damascena* of different regions of the country had the highest rate. Because of the combination of citronellol, geraniol, Tetradecanol, Methyl tetradecanoate, n-hexadecanol, n-nonadicanol, n-eicosane, n-henicosane, n-penacosane, and n-triocosane, they are considered as the main and important components of the essence in *Rosa damascena* (4, 5, 14, 15, 24).

Therefore, it can be seen, there are a lot of changes in the accessions and their traits related to them (essential weight and chemical composition of the essence), which was due to the same climatic variation in different regions of the country. Iranian flower samples have a good quality in comparison to some of the other countries of the region. Also, the range of diversity in different traits of *Rosa damascena* in different geographical regions and even the accessions within a region and the importance of the effect of environmental genetic factors and the contribution of each in the quality and quantity of essence were studied (2, 17, 32, 33, 37). Considering the importance of essence as the most important product in the trade of *Rosa damascena*, selection of genotypes in order to produce high yielding cultivars, especially in terms of quantity and quality of essence, has a particular priority in genetic modification of *Rosa damascena*. Therefore, the direct and indirect effects of different plant traits on the formation of flowers and essence as useful functions are essential measures that should be considered in research programs aimed at improving the yield of flowers and essence (15, 24, 37). Meanwhile, more and more studies are needed in these cases.

References

1. Smulders M, Arens P, Koning-Boucoiran C, Gitonga V, Krens F, Atanassov A, Atanassov I, Rusanov K, Bendahmane M, Dubois A. Rosa. *Wild Crop Relatives: Genomic and Breeding Resources*: Springer; 2011: 243-275.

2. Loghmani-Khouzani H. Essential oil composition of Rosa damascena Mill cultivated in central Iran. Scientia Iranica. 2007; 14(4).

3. Chevallier A. Encyclopedia of medicinal plants. Dorling kindersley pty limited, St Leonards; 1996.

4. Tabaei-Aghdaei SR, Babaei A, Khosh-Khui M, Jaimand K, Rezaee MB, Assareh MH, Naghavi MR. Morphological and oil content variations amongst Damask rose (Rosa damascena Mill.) landraces from different regions of Iran. Sci Hortic. 2007; 113(1): 44-48.

5. Tabaei-Aghdaei S, Sahebi M, Jafari A, Rezaei M. Evaluation of flower yield and morphological characteristics of 11 Rosa damascena Mill. genotypes using multivariate analyses. J Herbs Med Herbs Res. 2005; 1: 122-111.

6. Curir P, Damiano C, Cosmi T. In vitro propagation of some rose cultivars. Paper presented at: I International Symposium of the Research and Cultivation of Roses 189, 1985.

7. Tucker A, Maciarello M. Nomenclature and chemistry of the Kazanlik Damask rose and some potential alternatives from the horticultural trade of North America and Europe. Dev Food Sci. 2013; 18: 99-114.

8. Mebakerlin M, Chakravorty S. Value Addition in Flowers. *Value Addition of Horticultural Crops: Recent Trends and Future Directions*: Springer; 2015: 83-99.

9. Martínez M-C, Santiago J-L, Boso S, Gago P, Álvarez-Acero I, De Vega M-E, Martínez-Bartolomé M, Álvarez-Nogal R, Molíst P,

Caser M. Narcea—an unknown, ancient cultivated rose variety from northern Spain. Hort Res. 2020; 7(1): 1-12.
10.Lawless J. The Encyclopedia of essential oils: the complete guide to the use of aromatic oils in aromatherapy, herbalism, health, and well being: Conari Press; 2013.
11.Taylor B. Fruit and Juice Processing. Vol 2: John Wiley & Sons, Ltd. ; 2016.
12.Raaman N. Phytochemical Techniques: New India Publishing; 2006.
13.Younis A, Khan MA, Khan AA, Riaz A, Pervez MA. Effect of different extraction methods on yield and quality of essential oil from four Rosa species. Flori Ornam Biotech. 2007; 1(1): 73-76.
14.Chughtai A, Navaee M, Alijanvand MH, Yaghoubinia F. Comparing the Effect of Aromatherapy With Essential Oils of Rosa damascena and Lavender Alone and in Combination on Severity of Pain in the First Phase of Labor in Primiparous Women. Crescent J Med Biol Sci. 2018; 5(4): 312-319.
15.Babu KG, Singh B, Joshi VP, Singh V. Essential oil composition of Damask rose (Rosa damascena Mill.) distilled under different pressures and temperatures. Flavour Fragrance J. 2002; 17(2): 136-140.
16.Alamgir A. Secondary Metabolites: Secondary Metabolic Products Consisting of C and H; C, H, and O; N, S, and P Elements; and O/N Heterocycles. *Therapeutic Use of Medicinal Plants and their Extracts: Volume 2*: Springer; 2018: 165-309.
17.Jan Ahmadi S, Mortazaeinezhad F, Zeinali H, Askari-Khorasgani O, Pessarakli M. Evaluation of Various Rosa Damascena Mill. Genotypes Grown under Rainfed Semi-arid Condition. Commun Soil Sci Plan. 2019; 50(20): 2534-2543.
18.Honarvar M, Khosh-Khui M, Javidnia K. Effect of Some Factors on Quantity and Composition of Flower Essential Oil in Damask Rose. Paper presented at: V International Symposium on Rose Research and Cultivation 870, 2009.
19.Honarvar M, Khosh-Khui M, Javidnia K. Factors affecting essential oil quantity and quality of Damask rose in two regions of southern Iran. Acta Hort. 2010; (870): 241-248.
20.Younis A, Riaz A, Khan MA, Khan AA. Effect of time of growing season and time of day for flower harvest on flower yield and essential oil quality and quantity of four Rosa cultivars. Flori Ornam Biotech. 2009; 3: 98-103.
21.Baser K. Turkish rose oil. Perfumer Flavorist. 1992; 17: 45-45.
22.Rout G, Samantaray S, Mottley J, Das P. Biotechnology of the rose: a review of recent progress. Sci Hortic. 1999; 81(3): 201-228.
23.Tabai Oghdai S. Evaluation of flower yield and morphological traits in a number of Rosa damascene Mill genotypes. Journal Herbs Med Herbs Res. 2005; 1: 111-122.
24.Tabai Oghdai S, Rezaii M, Jaynmand K. Comparison of experimental and industrial samples of Rosa damascena essential oil in terms of quantity and quality of major compounds from Kashan region. Journal Herbs Flowers. 2003; 19(1): 63-72.
25.Sefidkon F, Abbasi K, Khaniki GB. Influence of drying and extraction methods on yield and chemical composition of the essential oil of Satureja hortensis. Food Chem. 2006; 99(1): 19-23.
26.Jaimand K, Rezaee M. Chemical constituents of essential oils from Mentha longifolia (L.) Hudson var. asiatica (Boriss.) Rech. f. from Iran. J Essent Oil Res. 2002; 14(2): 107-108.
27.Zebarjadi A, Rostami Ahmadvandi H, Kahrizi D, Cheghamirza K. Assessment of Genetic Diversity by Application of Inter Simple Sequence Repeat (ISSR) Primers on Iranian Harmal (Peganum harmala L.) Germplasm as an Important Medicinal Plant. J Appl Biotech Rep. 2016; 3(3): 441-445.
28.Rostami-Ahmadvandi H, Kahrizi D, Cheghamirza K, Nosratti I, Zargooshi J. Molecular and agro-morphological genetic diversity assessment of Chickpea mutants induced via ethyl methane sulfonate. Cell Mol Biol. 2016; 62(11): 8-12.
29.Rostami-Ahmadvandi H, Cheghamirza K, Kahrizi D, Bahraminejad S. Comparison of morpho-agronomic traits versus RAPD and ISSR markers in order to evaluate genetic diversity among Cuminum cyminum L. accessions. Aust J Crop Sci. 2013; 7(3): 361.
30.Kahrizi D, Azizi K, Haghi Y. Relationships among yield and yield components and essence in cumin (Cuminum cyminum L.) under different climate conditions. Biharean Biol. 2011; 5(1): 63-68.
31.Pal PK. Evaluation, genetic diversity, recent development of distillation method, challenges and opportunities of Rosa damascena: a review. Journal of Essential Oil Bearing Plants. 2013; 16(1): 1-10.
32.Rasouli O, Ahmadi N, Monfared SR, Sefidkon F. Physiological, phytochemicals and molecular analysis of color and scent of different landraces of Rosa damascena during flower development stages. Sci Hortic. 2018; 231: 144-150.
33.Rusanov K, Kovacheva N, Atanassov A, Atanassov I. Rosa damascena Mill., the oil-bearing Damask rose: genetic resources, diversity and perspectives for molecular breeding. Floriculture Ornamental Biotech. 2009; 3: 14-20.
34.Raziei Z, Kahrizi D, Rostami-Ahmadvandi H. Effects of climate on fatty acid profile in Camelina sativa. Cell Mol Biol. 2018; 64(5): 91-96.
35.Chen Y, Nelson RL. Genetic variation and relationships among cultivated, wild, and semiwild soybean. Crop Sci. 2004; 44(1): 316-325.
36.Pal PK. Evaluation, genetic diversity, recent development of distillation method, challenges and opportunities of Rosa damascena: a review. J Essential Oil Bearing Plants. 2013; 16(1): 1-10.
37.Nayebi N, Khalili N, Kamalinejad M, Emtiazy M. A systematic review of the efficacy and safety of Rosa damascena Mill. with an overview on its phytopharmacological properties. Complement Ther Med. 2017; 34: 129-140.
38.Clarke S. Chapter 7 - Composition of essential oils and other materials. In: Clarke S, ed. *Essential Chemistry for Aromatherapy (Second Edition)*. Edinburgh: Churchill Livingstone; 2008: 123-229.
39.Evans WC, Evans D. Chapter 22 - Volatile oils and resins. In: Evans WC, Evans D, eds. *Trease and Evans' Pharmacognosy (Sixteenth Edition)*: W.B. Saunders; 2009: 263-303.
40.Tariq S, Wani S, Rasool W, Shafi K, Bhat MA, Prabhakar A, Shalla AH, Rather MA. A comprehensive review of the antibacterial, antifungal and antiviral potential of essential oils and their chemical constituents against drug-resistant microbial pathogens. Microb Pathol. 2019/09/01/ 2019; 134: 103580.