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The Main Compounds in Essential Oil Composition of Damask Rose Genotypes under Mulched Rainfed Condition

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ABSTRACT

To evaluate the variation in the essential oil quality of 12 damask rose genotypes under mulched rainfed condition, this experiment was conducted in 2010, at Homand Research Station of Upland Farming, Absard-Damavand, Iran. The experiment was conducted in the form of a randomized complete block design with three replications. The 12 genotypes of damask rose were indigenous to Ardebil, Ilam, Tehran, Chaharmahal-o-Bakhtiari, Fars, Kerman, Kermanshah, Arak, Hormozgan and Esfehan provinces, Iran. Citronellol, geraniol, n-nonadecane and phenylethyl alcohol, which are the main compounds in the essential oil of damask rose, were evaluated in this experiment. Results indicated the significant variation of the four compounds percentage and yield between the 12 genotypes. Mean comparison showed that citronellol and n-nonadecane yield were the highest in Ilam genotype, geraniol yield was the highest in Fars genotype and phenylethyl alcohol yield was the highest in Arak genotype.

Keywords: citronellol, geraniol, n-nonadecane, phenylethyl alcohol, *Rosa damascene.*

INTRODUCTION

Damask rose (*Rosa damascena* Mill), belonging to Rosaceae family, has various genotypes in Iran with high variations in morphology, phenology and flower yield and quality [11]. Because environmental conditions, mainly drought, are the most important limiting factor to plants yield, finding drought resistant accessions is an important objective of plant breeding programs. Drought resistance of a plant can be defined as the ability of that plant to produce higher yield compared with other plants, under similar drought conditions. Different indices are evaluated in drought stress studies such as stress tolerance index [5], stress susceptibility index [10], tolerance index and mean productivity index [2] and geometric mean productivity [5].

For selection of genotypes under stressed and non stressed conditions, Kristin et al. [3] suggested that the genotypes must be selected that have the same situation under irrigated and non irrigated conditions. On the other hands, the effect of drought stress must be studied on essential oil composition in order to select the genotypes with higher quality of essential oil.

Citronellol, geraniol, n-nonadecane and phenylethyl alcohol are the most important compounds in the essential oil of damask rose. Citronellol is a flavoring compound which is under attention of industrial companies because it may be used to produce other aromatic compounds [7, 8, 12]. Geraniol is also a compound which is emitted from the flowers of many plants including roses [1, 4]. Geraniol is a colorless liquid, smelling like roses [9]. Sadraei et al. [6] tested the effect of damask rose essential oil on rat ileum contraction and found the inhibitory effect of the essential oil. They contributed the inhibitory effect mostly to geraniol and citronellol, the two main compounds in the essential oil of damask rose.

Regarding the mentioned issues, this experiment was conducted to evaluate the variation of the main compounds in the essential oil of 12 damask rose genotypes.

MATERIALS AND METHODS

This experiment was conducted in 2010, at Homand Research Station of Upland Farming, Absard-Damavand, Iran (35° 40' N, 52° 5' E, 1960 m above the sea level, 65 km East of Tehran). Homand Research Station is a plain area with 4% grade, brown alluvial soil and pH of 7.7. The soil type at the upper soil layer was loam, and at the lower soil layers contained calcareous layers. The area is classified as cold climates. Absolute minimum temperature is -24^{o}C, occurring in December, absolute maximum temperature is +37^{o}C, occurring in July, and mean annual temperature is +10.5°C. Mean annual evaporation is about 1226 mm, mean daily sunshine hour is 8 h and underground water stands 110-150 m below the soil surface.

The experiment was conducted in the form of a randomized complete block design with three replications. The 12 genotypes were indigenous to Ardebil, Ilam, Tehran, Chaharmahal-o-Bakhtiari, Fars, Kerman, Kermanshah, Arak, Hormozgan and Esfehan provinces, Iran.

In June 2007, planting was conducted in 60 cm deep × 50 cm wide hollows, filled with sand, field soil, manure and 100 g ammonium phosphate. To produce the essential oils, receptacles were detached from petals each day, and essential oils were extracted by hydrodistillation method using a Clevenger. GC and GC-MS were used to detect the main compounds in essential oil:

GC analysis. GC analysis was conducted using Shimadzu GC-9A gas chromatograph equipped with DB-5 column (60 m × 0.25 mm × 0.25 µm). The temperature was kept 50°C for the first 5 min and was programmed to increase up to 250°C at the rate of 4°C/min. Injector and detector temperature was 260°C, the carrier gas was helium with linear velocity of 32 cm/s.

GC-MS analysis. GC-MS analysis was conducted on a Varian 3400 GC-MS system equipped with a DB-5 column (60 m × 0.25 mm × 0.25 µm). The temperature programming was similar to GC. Carrier gas was helium with linear velocity of 31.5 cm/s; scan time, 1 s; ionization energy, 70 V; and mass range, 40-340 amu.

Finally, data were tested for their normality, courtosis and skewness, and then were analyzed by MSTAT-C. Means were compared according to the Duncan's multiple range test.

RESULTS

Analysis of variance indicated the significant effect of block on yield and percentage of n-nonadecane and phenylethyl alcohol. Genotype had also a significant effect on yield and percentage of all four evaluated compounds (Table 1).

Table 1. Analysis of variance of the effect of treatments on the measured traits

SOV	df	Mean Squares (MS)							
		Citronellol		Geraniol		n-nonadecane		Phenylethyl alcohol	
		Percentage	Yield	Percentage	Yield	Percentage	Yield	Percentage	Yield
Block	2	ns	ns	ns	ns	**	*	**	**
Genotypes	11	**	**	**	**	**	**	**	**
Error	22	1.41	4.65	0.57	0.98	1.31	14.07	0.0001	0.0005
CV (%)	-	5.63	7.51	15.87	14.22	4.07	9.84	3.08	6.10

*ns, nonsignificant; *, significant at P≤0.05; **, significant at P≤0.01.*

Mean comparison indicated that the highest citronellol percentage and yield were achieved in Arak (32.9% and 65.19 g/ha, respectively) (Table 2). Citronellol yield was the highest in Ilam genotype (66.72 g/ha). The lowest percentage and yield of citronellol were achieved in Kerman genotype (2.26% and 1.57 g/ha, respectively). Geraniol percentage and yield were the highest in Fars genotype (22.86% and 36.88 g/ha, respectively) and the lowest in Kerman genotype (0.53% and 0.37 g/ha, respectively). N-nonadecane percentage was the highest in Tehran genotype (42%) and the yield was the highest in Ilam genotype (112.35 g/ha). The lowest percentage and yield of n-nonadecane were achieved in Ardebil genotype (25.13% and 10.43 g/ha, respectively). Phenylethyl alcohol percentage and yield were the highest in Ardebil (0.8% and 1.04 g/ha, respectively) and the lowest in Kerman genotype (0.26% and 0.18 g/ha, respectively).

Table 2. Variation of the four compounds percentage and yield in different genotypes

Treatments	Citronellol		Geraniol		N-nonadecane		Phenylethyl alcohol	
	Percentage (%)	Yield (g/ha)	Percentage (%)	Yield (g/ha)	Percentage (%)	Yield (g/ha)	Percentage (%)	Yield (g/ha)
Esfehan 8	24.5d	23.58c	1.23de	1.18fgh	31.06d	29.89e	0.37f	0.36cd
Esfehan 6	26.23d	19.33d	-	-	31.76d	23.42e	0.4e	0.29e
Esfehan 3	25.93d	23.15c	5.63c	5.04d	29.0e	25.9e	0.43d	0.38c
Hormozgan	30.63b	42.64b	5.6c	7.8c	-	-	0.5c	0.69b
Arak	32.9a	65.19a	0.82de	1.63fgh	31.3d	62.02b	0.53b	1.04a
Kermanshah	19.9e	25.54c	0.52de	0.67gh	35.13b	45.15d	0.29g	0.37cd
Kerman	2.26h	1.57g	0.53de	0.37gh	34.06bc	23.64e	0.26h	0.18f
Fars	5.33g	8.6f	22.86a	36.88a	14.23b	23.0e	-	-
Chaharmahal-o-Bakhtiari	26.53cd	43.82b	1.7d	2.83ef	31.3d	51.93c	0.4e	0.66b
Tehran	10.83f	12.8e	1.8d	2.13fg	42.0a	49.76cd	0.29g	0.34cd
Ilam	19.36e	66.72a	6.06c	20.9b	32.6cd	111.35a	-	-
Ardebil	28.4c	11.77ef	10.7b	4.44de	25.13f	10.43f	0.8a	0.33de

Means in a column followed by the same letter are not significantly different at P≤0.01.

Determining the correlation of the traits indicated that citronellol percentage had significantly positive correlation with phenylethyl alcohol percentage (r=0.67**), citronellol yield (r=0.58**) and phenylethyl alcohol (r=0.68**), and had significantly negative correlation with geraniol yield (r=-0.38*). Geraniol percentage had significantly negative correlation with n-nonadecane percentage (r=-0.53**) and phenylethyl alcohol yield (r=-0.43**), and had significantly positive correlation with geraniol yield (r=0.88**). N-nonadecane percentage had significantly negative correlation with geraniol yield (r=-0.43**) and had significantly positive correlation with n-nonadecane yield (r=0.52**). Phenylethyl alcohol percentage had significantly negative correlation with geraniol yield (r=-0.63**) and n-nonadecane yield (r=-0.49**), and had significantly positive correlation with phenylethyl alcohol yield (r=0.61**). A significantly positive correlation was observed between citronellol yield with n-nonadecane yield (r=0.65**) and phenylethyl alcohol yield (r=0.48**). Finally, geraniol yield had significantly negative correlation with phenylethyl alcohol yield (r=0.65**) (Table 3).

Table 3. The correlation of the measured traits

	Citronellol	Geraniol	n-nonadecane	Phenylethyl alcohol	Citronellol yield	Geraniol yield	n-nonadecane yield	Phenylethyl alcohol yield
Citronellol	1							
Geraniol	-0.29ns	1						
n-nonadecane	-0.20ns	-0.53**	1					
Phenylethyl alcohol	0.67**	-0.26ns	-0.1ns	1				
Citronellol yield	0.58**	-0.22ns	-0.06ns	-0.03ns	1			
Geraniol yield	-0.38*	0.88**	-0.43**	-0.63**	0.04ns	1		
n-nonadecane yield	-0.03ns	-0.19ns	0.52**	-0.49**	0.65**	0.17ns	1	
Phenylethyl alcohol yield	0.68**	-0.43**	-0.1ns	0.61**	0.48**	-0.51**	-0.09ns	1

*ns, nonsignificant; *, significant at P≤0.05; **, significant at P≤0.01.*

DISCUSSION

Nowadays, producing medicinal plants with a certain aim for consumption is very important. So, selection of the suitable genotypes that fit the objective of production is of a high importance. This is mainly because, high essential oil content does not always meet the needs of the market and sometimes an especial compound in the essential oil composition is under attention.

Analysis of variance (Table1) showed the significant variation in the percentage and yield of the four compounds of the 12 evaluated genotypes. This variation indicates that different genotypes can be selected for different purposes. For example, if the aim is to produce higher citronellol, Arak or Ilam genotypes must be selected, according to the results of mean comparison (Table 2). On the other hand, if the aim is to produce an essential oil with higher geraniol content, Fars and Tehran genotypes can be cultivated. N-nonadecane was the highest in Ilam and Tehran genotype but phenylethyl alcohol was the highest in Arak and Ardebil genotypes.

Evaluating the correlation of the measured traits indicated that there are significantly positive and negative correlations between the four compounds percentage and yield. This can also affect the selection of genotypes.

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