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Gas Chromatography Analysis of the Absolute Rose Oil from *Rosa damascena* Landraces and Scented Rose Species from Pakistan

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ABSTRACT

For perfume industry, *Rosa damascena* Mill. is the most important species used in the production of rose attar, which is made by distilling volatile oils from the petals of flowers. Eight landraces of Damask rose and four related rose species were collected from Punjab province and their oil constituents were determined by using GAS chromatograph. The major components identified were citronellol (8.32-2.31%), farnesol (6.62%-0.78%), geraniol (5.43-0.42%), eugenol (3.72%-0.42%), citral mixture of cis and trans (5.12-0.23%), 2- phenethyleacetate (2.53-0.22%), linalool (1.35-0.23%), nerol (1.33-0.81%), citronellyle acetate (2.53-0.12%), phenethyl alcohol (5.43-0.52%), benzyle alcohol (3.12-0.31%) and benzaldehyde (3.12-0.32%). The variation in oil constituents in rose oil from different essential oil *Rosa* species was due to the morphological variations and genetics.

Key Words: *Rosa damascena*; Solvent extraction; Oil content; Rose oil; GC analysis

INTRODUCTION

Rose is the most popular ornamental plant that has been cultivated systematically (Wylie, 1995). Genus *Rosa* consists of 200 species and about 18,000 cultivars (Gudin, 2000). Roses are mainly used for showy purposes (both flowers & hips) and oil extraction (petals) but they are also used for straight utilization or creation of a variety of food stuff like tea, jam and confectionary. They are a rich source of Vitamin C and used in the making of medicinal stuff. The earliest reference about the extraction of oils dates back to ninth century when production was established in Iran (Van de Pol, 2003). Rose oil is extremely unstable essence extracted from rose petals having strong aromatic compounds. The Rose species mainly used for oil production are *R. damascena* Mill. *R. gallica* L., *R. moschata* Herrm., *R. centifolia* L., and *R. bourboniana* (Tucker & Maciarello, 1988; Kaul *et al*., 2009). Rose oil is the most exclusive essential oil in the world due to having low content and unique scent. About 3000 kg of rose petals can produce only one kg of rose oil (Baser, 1992; Baydar & Baydar, 2005). The price of the rose oil has been rising during the last years getting 5000 Eur/kg in 2007 (Rusanov *et al.*, 2009). It is true that there is neither any alternate of rose oil present in nature nor it has been prepared synthetically (Baydar & Baydar, 2005). Other than rose oil, a number of significant raw stuff for the perfume and cosmetics industry is attained, which includes rose concrete, rose absolute and rose water (Nilgum *et al.*, 2004). The oil content and constituents of the rose oil differ among species used for the production of rose oil. Chemical constituents are determined the by gas chromatography (Brown, 1990). These compounds consist of different chemicals which are found naturally in the plants. The major compounds, for example, are alcohol, hydrocarbons, phenols, aldehydes, esters and ketones (Bruneton, 1995; Seigler, 1998). Naves and Mazuyer (1939) had mentioned the chemical composition of various rose oil constituents. Panda (2004) characterized various volatile compounds in rose oil like alcohol, citronellol, nerol, gerinol, linalool, eugenol, aldehydes, ether and stearpten.

In Pakistan, the rose oil is being produced from *R. damascena*, *R. centifolia*, *R. bourboniana* and Gruss an Teplitz. The main rose cultivation regions are found in Punjab; Kallar Kahar, Chakwal, Choha Syedan Shah, Pattoki, Islamabad, Chota Shahiwal (Sargodha) and Faisalabad. Some other *Rosa* species are also being cultivated for the purpose of oil production in Sindh Province. The aim of this study was to determine the rose absolute oil composition from *R. damascena* landraces and related essential oil roses cultivated in Pakistan.

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MATERIALS AND METHODS

Recovery of rose absolute oil: The petals were detached from the flowers of *R. damascena* landraces and related *Rosa* species collected from various production areas of Punjab Pakistan (Table I). The rose oil was extracted with the help of Soxlet's Apparatus at *Rosa* project area, Institute of Horticultural Sciences, University of Agriculture, Faisalabad Pakistan. N-hexane (95%) was used as a solvent using 500 g of petals for each landrace. Rotary evaporator was used to remove the remaining hexane from the extract. To get absolute oil from concrete oil, alcohol was added in it, filtered and a wax free rose oil was obtained. To remove alcohol, again rotary evaporator was used. Finally absolute rose oil was obtained by removing slight amount of alcohol, by bubbling nitrogen gas through the oil.

GC analysis: Oil constituents of rose oil were determined using 12 different standards of rose oil by using gas chromatograph (GC). The Shimadzu 17-A GC, equipped with capillary column (0.25 µm×30 m) (DB-Wax) and flame ionization detector (FID) was used. Analysis was done by keeping injector temperature (250°C) and column oven initial temperature at 90°C for 2 min. to 180°C @ 2°C/min. and final temperature was 240°C @ 3°C/min. Detector temperature was 260°C. Sample injection volume was 1 µL and helium was used as carrier gas @ 30 mL/min. flow rate. Qualitative analysis was done by comparing with standards. For qualitative analysis, peak area was calculated by using software CSW-32. To conduct this experiment, rose extract from each *R. damascena* landraces/related *Rosa* species was injected three times using completely randomized design.

Statistical analysis: The data were analyzed statistically to find the significance of the results of oil constituents of *R. damascena* landraces and related species and means were compared by DMR test at $p<0.05$ % (Steel *et al.,* 1996). Pearson's correlation among the chemical components was also analyzed according to Pearson's coefficient. Principle component analysis and cluster analysis were done by using Statistica 7, Stat soft. Inc. 1984-2007.

RESULTS

The analysis of variance and the means and standard deviations for rose absolute oil constituents are presented in Table II and III. The major components identified were citronellol, farnesol, geraniol, eugenol, citral mixture of cis and trans, 2- phenethyleacetate, linalool, nerol, citrynellylacetate, phenethylalcohol, benzylealcohol and benzaldehyde. Cironellol, which is main constituent for the fragrance in *R. damascena* showed highest value in a Damask rose landrace from Kallar Kahar (8.32%) followed by landrace from Islamabad (6.13%), Choha Syedan Shah (3.51%), Pattoki-1 (3.41%), Chota Sahiwal (3.51) and Chakwal (1.43). However the oil extracted from *R. centifolia*, *R. bourboniana* and Gruss an Teplitz showed

Table I: Essential oil roses from different regions of Pakistan

Code	Collection site	Name of species	Province/Country
G1	Faisalabad	*R. damascena*	Punjab/Pakistan
G2	Pattoki-1	*R. damascena*	Punjab/Pakistan
G3	Pattoki-2	*R. damascena*	Punjab/Pakistan
G4	Islamabad	*R. damascena*	Capital Territory
G5	KallarKahar	*R. damascena*	Punjab/Pakistan
G6	ChohanSyedan Shah	*R. damascena*	Punjab/Pakistan
G7	Chakwal	*R. damascena*	Punjab/Pakistan
G8	ChotaSahiwal (Sargodha)	*R. damascena*	Punjab/Pakistan
G9	Faisalabad	*R.centifolia*	Punjab/Pakistan
G10	Faisalabad	Gruss an teplitz	Punjab/Pakistan
G11	Faisalabad	*R. Bourboniana*	Punjab/Pakistan
G12	Tando jam	*R.Indica*	Sindh/Pakistan

7.13, 3.55 and 2.31% of citronellol, respectively. Citronellol was not detected in essential oil of *R. Indica*.

The highest percentage of component Linalool was observed in the Gruss an Teplitz (1.35%) and lowest in *R. damascena* landraces from Kallar Kahar (0.23%), which was not identified in essential oil from *R. damascena* landrace from Pattoki-2, *R. centifolia* and *R. Indica*. Rose oil of Damask rose landraces from Faisalabad and Chota Sahiwal (Sargodha) showed non- significant value for linalool with the values of 1.22 and 1.23%, while the landraces from Islamabad and Choha Syedan Shah showed the values for this chemical 0.53 and 0.54%, respectively, which are also non-significant statistically.

Nerol showed the highest value in the Gruss an Teplitz (1.33%) and lowest in *R. damascena* landraces from Pattoki-2 (0.21%). The second highest amount was found in the oil of Damask rose landraces from Chota Sahiwal (1.23%) followed by landraces from Chakwal (0.92%), Faisalabad (0.81%) and Choha Syedan Shah (0.53%). Nerol could not be identified in essential oils extracted from *R. damascena* landrace from Pattoki-1, *R. centifolia* and *R. Indica*. Eugenol presented highest value (3.72%) in Damask rose landrace from Islamabad followed by rose oil from Gruss an Teplitz (1.82%), *R. bourboniana* (1.12%), *R. centifolia* (0.92%) and Damask rose landrace from Pattoki-2 (0.87%) and Chota sahiwal (0.82%). *R. damascena* landraces from Kallar Kahar showed the lowest value (0.42%) for eugenol.

Graniol was present in *R. damascena* landrace from Chakwal with highest percentage (5.43%) while Choha Syedan Shah presented lowest amount (0.42%) for this component. It showed least values for Damask rose landraces from Pattoki-1 (0.63%) and Chota Sahiwal (0.87%), while 5.12, 4.02 and 3.73% in Pattoki-2, Kallar Kahar and Islamabad, respectively. The rose oil extracted from *R. centifolia*, Gruss an Tepliz and *R. bourboniana* showed the values for graniolas 1.02%, 1.43% and 1.22%. *R. indica* did not show any evidence for the presence of graniol in its oil.

Farsenol showed highest value (6.62%) in rose oil extracted from *R. damascena* landrace from Kallar Kahar, while landrace from Faisalabad showed lowest results in

Table II: Analysis of variance (mean squares) for oil composition

Source of variation	Df	Mean squares											
		Citronellol	Linalool	Nerol	Eugenol	Graniol	Farnesol	2-phenethyle acetate	Citral mix of cis and trans	Citronelly-le alcohol	Phenethyl alcohol	Benzyle alcohol	Benzalde-hyde
Genotypes	11	17.9058**	0.74112**	0.66330**	2.74135**	10.8524**	13.1767**	7.00206**	6.63529**	2.29977**	9.4115**	3.18926**	3.17657**
Error	24	0.0004	0.00007	0.00015	0.00011	0.0001	0.0001	0.00012	0.00009	0.00009	0.0001	0.00012	0.00013

Table III: Comparison of means

Genoty-pes	Citronellol	Linalool	Nerol	Eugenol	Graniol	Farnesol	2-phenethyle acetate	Citral mix of cis and trans	Citronellyle alcohol	Phenethyl alcohol	Benzyle alcohol	Benzal-dehyde
G-1	2.11±	1.22±	0.81±	0.53±	2.32±	0.78±	3.52±	0.53±	0.52±	0.52±	0.93±	0.93±
	0.009 I	0.006 B	0.006 D	0.009 I	0.006 E	0.009 H	0.006 B	0.006 H	0.006 G	0.007 I	0.006 G	0.009 G
G-2	3.41±	0.42±	0.00±	0.63±	0.63±	0.00±	0.62±	0.67±	2.22±	0.68±	2.92±	2.92±
	0.006 F	0.009 F	0.000 I	0.006 H	0.006 J	0.000 I	0.009 H	0.003 F	0.003 B	0.006 H	0.006 B	0.009 B
G-3	2.29±	0.00±	0.21±	0.87±	5.12±	0.00±	5.13±	5.12±	2.53±	0.87±	3.12±	3.12±
	0.015 H	0.000 H	0.006 H	0.006 E	0.006 B	0.000 I	0.006 A	0.006 A	0.006 A	0.003 F	0.003 A	0.006 A
G-4	6.13±	0.53±	0.32±	3.72±	3.73±	1.83±	1.53±	3.02±	1.32±	3.73±	1.52±	1.52±
	0.033 C	0.006 D	0.009 G	0.006 A	0.012 D	0.006 E	0.003 E	0.009 B	0.006 D	0.003 C	0.010 E	0.007 E
G-5	8.32±	0.23±	0.23±	0.42±	4.02±	6.62±	2.02±	0.63±	0.72±	4.01±	0.43±	0.42±
	0.009 A	0.006 G	0.009 H	0.003 J	0.009 C	0.006 A	0.006 D	0.006 G	0.003 F	0.003 B	0.009 I	0.006 I
G-6	3.51±	0.54±	0.53±	0.72±	0.42±	4.62±	0.62±	0.23±	0.53±	1.82±	0.33±	0.32±
	0.006 E	0.003 D	0.006 E	0.009 G	0.006 K	0.003 B	0.003 H	0.009 I	0.006 G	0.003 D	0.003 J	0.006 J
G-7	1.43±	0.92±	0.92±	0.62±	5.43±	2.38±	2.62±	0.63±	2.12±	5.43±	2.62±	2.58±
	0.009 J	0.009 C	0.009 C	0.006 H	0.009 A	0.006 D	0.007 C	0.006 G	0.006 C	0.006 A	0.009 C	0.006 C
G-8	2.52±	1.23±	1.23±	0.82±	0.87±	0.81±	0.93±	0.82±	0.12±	0.93±	0.43±	0.43±
	0.003 G	0.006 B	0.009 B	0.003 F	0.006 I	0.003 G	0.003 F	0.006 C	0.003 J	0.006 E	0.006 I	0.006 I
G-9	7.13±	0.00±	0.00±	0.92±	1.02±	2.92±	3.52±	0.76±	0.22±	0.87±	1.43±	1.42±
	0.006 B	0.000 H	0.000 I	0.006 D	0.006 H	0.006 C	0.009 B	0.003 D	0.009 I	0.003 F	0.003 F	0.006 F
G-10	2.31±	1.35±	1.33±	1.82±	1.43±	0.00±	0.67±	0.00±	0.00±	0.00±	0.73±	0.72±
	0.003 H	0.003 A	0.012 A	0.006 B	0.006 F	0.000 I	0.003 G	0.000 J	0.000 K	0.000 J	0.003 H	0.006 H
G-11	3.55±	0.44±	0.43±	1.12±	1.22±	1.02±	2.62±	0.72±	0.82±	0.73±	1.63±	1.63±
	0.007 D	0.006 E	0.003 F	0.009 C	0.006 G	0.006 F	0.009 C	0.003 E	0.006 E	0.009 G	0.009 D	0.007 D
G-12	0.00±	0.00±	0.00±	0.00±	0.00±	0.00±	0.12±	0.00±	0.42±	0.00±	0.31±	0.32±
	0.000 K	0.000 H	0.000 I	0.000 K	0.000 L	0.000 I	0.007 I	0.000 J	0.006 H	0.000 J	0.003 J	0.007 J

Means sharing similar letter in a column are statistically non-significant (P>0.05)

Table IV: Correlation between oil constituents of *Rosa damascena* landraces and related *Rosa* species

Components	Citronellol	Linalool	Nerol	Eugenol	Graniol	Farnesol	2-Phenethyl acetate	Citral mix of cis and trans	Citronell-yle acetate	Phenethyl alcohol	Benzyle alcohol
Linalool	-0.324										
Nerol	-0.353	0.929**									
Eugenol	0.328	0.173	0.135								
Graniol	0.159	-0.025	0.068	0.215							
Farnesol	0.699*	-0.215	-0.157	-0.090	0.211						
2-phenethyl acetate	0.160	-0.231	-0.150	-0.052	0.608*	-0.004					
Citral mix of cis and trans	0.098	-0.347	-0.252	0.387	0.606*	-0.195	0.615*				
Citronellyle acetate	-0.122	-0.298	-0.330	0.030	0.613*	-0.175	0.382	0.618			
Phenethyl alcohol	0.362	0.005	0.038	0.225	0.706*	0.611*	0.088	0.115	0.370		
Benzyle alcohol	-0.101	-0.230	-0.266	0.083	0.499	-0.353	0.513	0.573*	0.902**	0.172	
Benzaldehyde	-0.100	-0.235	-0.271	0.085	0.495	-0.357	0.512	0.578*	0.902**	0.165	0.999**

* = Significant (P<0.05); ** = Highly significant (P<0.01)

chemical composition with the value of 0.78%. The landraces from Pattoki-1 and Pattoki-2 did not show the presence of this chemical in their oil. In other related essential oil of *Rosa* species, *R. centifolia* showed highest value (2.92%) followed by *R. bourboniana* (1.02%), while Gruss an Teplitz and *R. indica* showed no farnesol in their oil.

Damask landrace from Pattiki-2 represented chemical composition with the value (5.13%) for the component of 2-phenthyl acetate followed by landrace from Faisalabad, *R. centifolia*, Chakwal, *R. bourboniana*, Kallar Kahar and Islamabad with the values of 3.52, 3.52, 2.62, 2.02 and 1.53%, respectively. The value for the component of 2-phenthyl acetate was observed in *R. Indica* (0.12%). Similarly, Damask landrace from Pattiki-2 represented chemical composition with the value (5.12%) for the component of Citral mix of cis and trans followed by (3.02%), the value for landrace from Islamabad. Rest of all Damask rose landraces showed the values below 1.00%. *R. damascena* landrace from Chota Sahiwal showed the value for Citral mix of cis and trans as 0.82% followed by *R. centifolia, R. bourboniana*, Damask rose landraces from

Pattoki-1, Kallar Kahar, Chakwal, Faisalabad and Choha Syedan Shah with the values of 0.76, 0.72, 0.67, 0.63, 0.63, 0.53 and 0.23%, respectively. Gruss an Teplitz and *R. indica* did not show citral mix of cis and trans in their oil.

Citronellyle acetate got the highest percentage 2.53 and 2.22% value for the *R. damascena* landrace from Pattoki-2 and Pattoki-1 while Chota Sahiwal presented the lowest value (0.12%) for this component. Phenethyl alcohol was highest (5.43%) in the oil extracted from the Damask rose landrace from Chakwal. This value was followed by 4.01, 3.73 and 1.82%, which are related to the Damask rose landraces from Kallar Kahar, Islamabad and Choha Syedan Shah respectively. Rest of all Damask rose landraces and related essential oil of *Rosa* species showed the least values for this constituent. These small values are related to Chota Sahiwal (0.93%), Pattoki-2 (0.87%), Pattoki-1 (0.68%) and Faisalabad (0.52%). Among other related essential oil *Rosa* species, *R. centifolia* and *R. bourboniana* showed the values for phenethyle alcohol as 0.87 and 0.73%, while Gruss an Teplitz and *R. Indica* did not show this chemical in their oil. Damsk rose landrace from Pattoki-2 and *R. centifolia* from Faisalabad showed the same value for this constituent (0.87%).

Damask rose landraces from Pattoki-2 and Pattoki-1 showed the highest value for benzyle alcohol as 3.12 and 2.92%, respectively followed by Damask rose landrace from Chakwal, Islamabad, Faisalabad, Chota Sahiwal and Kallar Kahar with the values of 2.62, 1.52%, 0.93, 0.43 and 0.43% respectively. However, in other related essential oil *Rosa* species *R. bourboniana, R. centifolia* and Gruss an Teplitz showed the values of 1.63, 1.43 and 0.73%, respectively. *R. damascena* landrace from Choha Syedan Shah and *R. Indica* showed the least value for this chemical having the value of 0.33 and 0.31%, respectively.

The last component identified was benzaldehyde, the values of which were similar to benzyle alcohol with minor differences. Benzaldehyde was highest in the oil extracted from Damask rose landrace from Pattoki-2 and Pattoki-1 with the value of 3.12 and 2.92%, respectively. These values were followed by Damask rose landrace from Chakwal, Islamabad, Faisalabad, Chota Sahiwal and Kallar Kahar with the values of 2.58, 1.52, 0.93, 0.43% and 0.42 respectively, whilst *R. bourboniana, R. centifolia* and Gruss an Teplitz showed the values of 1.63, 1.42 and 0.72%, respectively. *R. damascena* landrace from Choha Syedan Shah and *R. Indica* showed the least and value (0.32%) for this chemical.

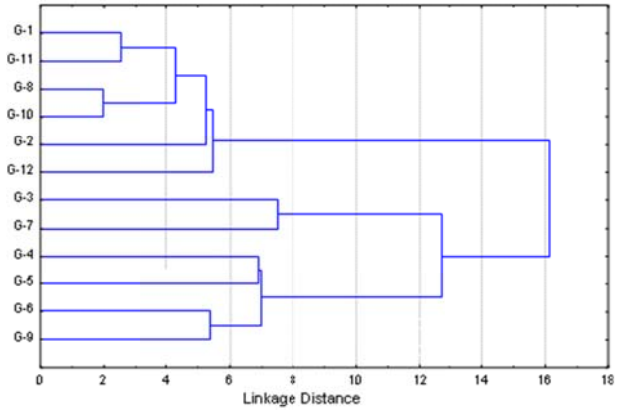
The citronellol showed a negative association with some other chemical component sincluding linalool (-0.3242), neraol (r = -0.3529), citronellyle acetate (r = -0.1219), benzyle alcohol (r = -0.1005) and benzaldehyde (r = -0.0997). Farnesol showed a strong and positive correlation with citronellol with the value of r = 0.6993. While all other components showed a positive association with cironellol. Eugenol, graniol, 2-phenethyl acetate, citral mixture of cis and trans and phenethyle alcohol showed the positive values of association which are r = 0.3277, r = 0.1595, r = 0.1599, r = 0.0982 and r = 0.3618 respectively (Table IV).

In contrast to citronellol, linalool showed a positive correlation with only three components out of total twelve components. Linalool showed a highly significant positive value of correlation with nerol (r = 0.9293), while a weak but positive correlation with eugenol (r = 0.1726) and phenethyle alcohol (r = 0.0048). Linalool showed a negative correlation with graniol, farnesol, 2-Phenethyl acetate, citral mixture of cis and trans benzaldehyde and benzyle alcohol with the values of r = -0.0249, r = -0.2149, r = -0.2308, r = -0.3473, r = -0.2976, r = -0.2303 and r = -0.2347, respectively (Table IV). Nerol also behaved almost similar to linalool but with some variations. It showed negative correlation with all chemical components except for eugenol, graniol and phenethyle alcohol with the values of r = 0.1345, r = 0.0683 and r = 0.0375, respectively. It showed a negative correlation with farnesol (r = -0.1569), 2-phenethyl acetate (r = -0.1498), citral mixture of cis and trans (r = -0.2515), Citronellyle acetate (r = -0.3297), benzaldehyde(r = -0.2713) and benzyle alcohol (r = -0.2657). Eugenol showed a weak but positive association with all the other components of rose oil except with farnesol (r = -0.0903) and 2-Phenethyl acetate (r = -0.0515). It showed a positive correlation with Graniol (r = 0.2146), Citral mixture of cis and trans (r = 0.3873), Citronellyle acetate (r = 0.0303), Phenethyl alcohol (r = 0.2251), Benzaldehyde (r = 0.0849) and Benzyle alcohol (r = 0.0830). Graniol showed a strong and positive association with almost all of components. It showed a significant and positive correlation values with 2-phenethyl acetate (r = 0.6077), citral mixture of cis and trans (r = 0.6064), Citronellyle acetate (r = 0.6125), phenethyle alcohol (r = 0.7060), while a positive correlation with farnesol (r = 0.2105), benzyle alcohol (r = 0.4989) and Benzaldehyde (r = 0.4946). It was observed from data that Farnesol have shown a negative correlation with 2-phenethyl acetate (r = -0.0.0035), citral mixture of cis and trans (r = -0.1946), Citronellyle acetate (r = -0.1748), benzylealcohol (r = -0.3531) and benzaldehyde (r = -0.3574), while a positive and strong correlation with phenethyle alcohol (r = 0.6106).

The 2-phenethyl alcohol showed a positive association with citral mixture of cis and trans, Citronellyle acetate, phenethyle alcohol, benzyle alcohol and benzaldehyde with the values of r = 0.6154, r = 0.3822, r = 0.086, r = 0.5127 and r = 0.5122 respectively. While citral mixture of cis and trans showed a positive and stong correlation with citronellyle acetate (r = 0.6178), benzyle alcohol (r = 0.5734) and benzaldehyde (r = 0.5783). It also showed a positive association with phenethyle alcohol with the value of r = 0.1148. citronellyle acetate had a positive correlation with phenethyle alcohol (r = 0.3704), while a strong and positive with benzyle alcohol and benzaldehyde with a highly significant values of r = 0.9018 and r = 0.9024 respectively. Phenethyl alcohol showed a positive

Fig. 1: Map of Pakistan showing the production areas of *R. damascena* and related essential oil *Rosa* species in PUNJAB and SINDH Province

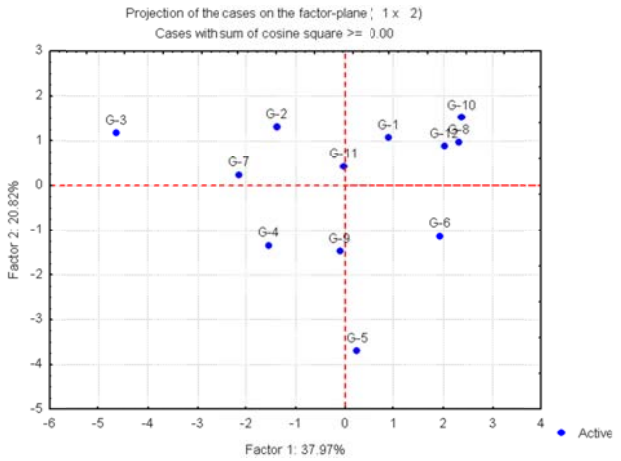
Fig. 2: Dendrogram showing the grouping of *R. damascena* landraces and related essential oil *Rosa* species on the basis of percentage composition of rose oil constituents



correlation with benzyle alcohol (r = 0.1718) and benzaldehyde (r = 0.1646), while benzylealcohol showed a very strong and positive correlation with benzaldehyde with a highly significant value of r= 0.9999 (Table IV).

Phylogenetic tree was created by Statistica, using 12 genotypes including eight landraces of Damask roses and four related essential oil *Rosa* species. Cluster analysis performed on the whole of data set (Fig. 2) showed 3 main clusters at linkage distance of 8. Cluster I comprised G-1 (*R. damascena* from Faisalabad) and G-11 (*R. bourboniana*), G-8 (Chota Sahiwal), G-10 (Gruss an Teplitz), G-2 (*R. damascena* from Faisalabad) and G-12 (*R. indica*). Cluster II included two landraces (Pattoki-2 & Chakwal) and the Cluster III included four landraces, which are G-4 (Islamabad), G-5 (Kallar Kahar), G-6 (Choha Syedan Shah) and *R. centifolia*. Dendrogram revealed further six subgroups at linkage distance of 6.

Fig. 3: Plot of principal component based on means of *R. damascena* landraces and related essential oil *Rosa* species for oil constituents



The plot for component analysis showed grouping of all landraces based on oil composition of from different landraces of *R. damascena* and related essential oil *Rosa* species and presented in the Fig. 3. The first two components of the PCA analysis explained 37.97 and 20.82% of the total variation. The plot divided the *R. damascena* landraces and related *Rosa* species into different groups confirmed the previous results of cluster analysis.

DISCUSSION

Twelve main components were identified from *R. damascena* landraces and related scented species using GC. The major components were citronellol, farnesol, geraniol, eugenol, citral mixture of cis and trans, 2- phenethyle acetate, linalool, nerol, citronellyle acetate, phenethyle alcohol, benzyle alcohol and benzaldehyde. Citronellol is an important constituent of rose oil (Chen *et al.*, 1985; Li *et al.*, 1988; Baser, 1992; Sood *et al.*, 1994). In the present study, cironellol showed values in a *R. damascena* landrace from 8.32 to 1.43%. In the previous studies, citronellol was identified as 12.09 and 3.72% in *R. centifolia* and *R. damascena* respectively (Khan & Rehman, 2005). In contrast to these results, 20% (Rose & Jeanne, 1999), 25.2% (Chowdhury *et al.*, 2009), 31.27% (Bahaffi, 2005), 40% (Sood *et al.*, 1992) and 52% of citronellol (Wang, 2000) was reported. Almasirad *et al.* (2007) compared the historical, Turkish and Bulgarian rose oil and got the percentage of citronellol as 25.1, 30.9 and 33.4%, respectively. The variation in chemical composition of different species was due to their genetic makeup. Different extraction methods also matter in the variation of chemical composition of essential oils.

The highest percentage of component 'linalool' was observed in the Gruss an Teplitz (1.35%) and lowest in *R. damascena* landraces from Kallar Kahar (0.23%), which was greater than 0.01% found in rose oil from different

varieties of *R. damascena* (Antonelli *et al*., 1997). These values for linalool from the present study (1.35-0.23%) are comparable with Mumtaz *et al.* (2007) and Khan and Rehman (2005), where they stated the value of linalool as 0.222% and 1.68% for *R. centifolia*, respectively. Whereas higher values for linalool 2.8, 10.98% were observed in rose oil from *R. damascena* (Babu *et al*., 2002; Chowdhury *et al.*, 2009) and 12.68% from *R. abyssinica* (Eckart, 1991; Al-Rehaily *et al*., 2003). Highest of nerol in the Gruss an Teplitz (1.33%) and lowest one in *R. damascena* landraces from Pattoki-2 (0.21%) in this study were lesser than those reported in *R. damascena*; Kazanlik, Marie Louise and Pompon des Princes, respectively (Antonelli *et al*., 1997). A higher value (8.2%) for nerol has also been reported (Chowdhury *et al*., 2009).

Eugenol ranged from 3.72 to 0.42% in the oil of *R. damascena* landraces which are comparable with the values obtained from rose oil from *R. centifolia* and *R. damascena* (Babu *et al.*, 2002; Khan & Rehman, 2005; Almasirad *et al*., 2007; Chowdhury *et al*., 2009).

Graniol was present in *R. damascena* landrace from Chakwal with highest percentage (5.43%) while Choha Syedan Shah indicated the least value (0.42) for this component. A similar range of values was obtained for historical Turkish and for Bugharian (2.1%) rose oil (Almasirad *et al.*, 2007) and from *R. damascena* varieties (Antonelli *et al*., 1997). In the previous study, rose oil from *R. damascena* and *R. centifolia* showed the values as 2.98 and 1.53% respectively (Khan & Rehman, 2005). However, these data are contrary to a previous study indicating the high concentrations of geraniol for *R. centifolia* and *R. damascena* (Sood *et al*., 1992; Go'ra *et al.*, 1995; Babu *et al.*, 2002; Chowdhury *et al*., 2009). Farsenol showed the highest value (6.62%) in oil from landrace of Kallar Kahar (G-5), while Faisalabad (G-1) showed lowest value (0.78%). The present study has showed the range of Farsenol from 6.62 to 0.78% in oil of *R. damascena* landraces, which are in conformity with previous reports (Sood *et al*., 1992; Babu *et al*., 2002). *R. damascena* landrace from Pattiki-2 showed 5.13% 2-phenthyle acetate and 5.12% for citral mixture of cis and trans, which are not explained in the previous study. Citronellyle acetate got the highest percentage 2.53 and 2.22% value for the *R. damascena* landrace from Pattoki-2 and Pattoki-1which are almost similar to those reported by Khan and Rehman (2005), while Chota Sahiwal (G6) presented least value (0.12%) for this component. *R. damascena* landraces from Chakwal, Islamabad, *R. bourboniana*, Kallar Kahar (G5), Choha Syedan Shah, *R. Indica* and *R. centifolia* ranged within 2.12-0.22% for the citronellyle acetate, which also confirmed the earlier reports (Almasirad *et al.*, 2007). Phenethyle alcohol showed maximum percentage in the landrace from Chakwal 5.43% supporting the prior results (Babu *et al.*, 2002). The *R. damascena* landrace from Kallar kahar got the value of 4.01% for phenethyle alcohol, which also supports the previous data (Sood *et al.*, 1992). On the other hand this compound showed variation with very small value (1.8%) for its percentage composition (Almasirad *et al*., 2007) and very high value up to 70% (Antonelli *et al.*, 1997; Khan & Rehman, 2005). A study in Iran showed higher percentage of phenyl ethyl alcohol (28%) in the essential oil of rose collected from Tehran (Manfared *et al.*, 2002). Wang (2000) reported 15% phenyl alcohol. Both benzyle alcohol and benzaldehyde were less than 3.13%, which supports the earlier work (Surburg *et al.*, 1993). This compound could not be detected by Brunke *et al.* (1992) in the Lichtk Onigin Lucia cultivar.

CONCLUSION

In conclusion the variation in the chemical composition of the major constituents of essential oil may be due to the different genotypes and genotype-environmental interaction. However, some other components should be added in future, which would be a better marker for rose oil quality.

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