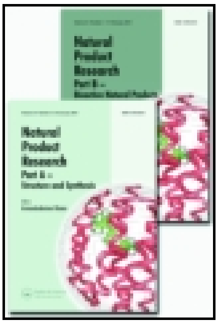

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Volatile compound in cut and un-cut flowers of tetraploid *Freesia hybrida*

Man Ao [a], Baofeng Liu [a b] & Li Wang [a]

[a] Institute of Genetics and Cytology, Northeast Normal University, Changchun, People's Republic of China

[b] National Analytical Research Center of Electrochemistry and Spectroscopy, Changchun Institute of Applied Chemistry Chinese Academy of Sciences, Changchun, People's Republic of China

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SHORT COMMUNICATION

Volatile compound in cut and un-cut flowers of tetraploid *Freesia hybrida*

Man Ao[a], Baofeng Liu[ab] and Li Wang[a]*

[a]*Institute of Genetics and Cytology, Northeast Normal University, Changchun, People's Republic of China;* [b]*National Analytical Research Center of Electrochemistry and Spectroscopy, Changchun Institute of Applied Chemistry Chinese Academy of Sciences, Changchun, People's Republic of China*

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The flower volatile compounds (FVCs) of two tetraploid *Freesia hybrida* (pink-yellow and yellow) cultivars and their cut flowers were analysed by headspace solid-phase microextraction combined with gas chromatography–mass spectrometry. Twelve FVCs were identified in the pink-yellow cultivar, with linalool as the major compound; 30 FVCs were identified in the yellow cultivar, with linalool and terpineol as the two major compounds. The FVCs (>1%) of the two cut flower cultivars were very similar to that of the un-cut flowers, and no significant difference was observed.

Keywords: Freesia; cut flower; flower volatile compounds; headspace solid-phase microextraction; gas chromatography–mass spectrometry

1. Introduction

Freesia was found around 1800 s by the German C.F. Ecklon and named after the botanist Friedrich (F.H.Th.) Freese (Wang, 2006). It belongs to the Iridaceae family and is one of the most popular and widely grown cut flowers in the world. *Freesia × hybrida* is a new brand of freesia. Its sales and yield in the international flower market has been dramatically increasing in recent years (Wang, 2006).

The most appreciated characteristic of freesia is its pleasant and strong fragrance, which makes it play an important role in the perfume and cosmetic industries. However, compared with the successful utilisation in industry, the study of freesia fragrance is limited (Fu et al., 2007; Kimihiro & Satoru, 1984; Wongchaochant, Inamoto, & Doi, 2005). Especially, as a symbol of the quality and economic value, whether the fragrance of freesia cut flowers changes or not is still unreported and such a research is expected.

In this article, yellow and pink-yellow tetraploid *Freesia × hybrida* cultivars were chosen as plant materials, of which the former cultivar emits a strong sweet scent while the latter a weak and fresh one. The FVCs of these two cultivars as well as their cut flowers were investigated by headspace solid-phase microextraction (HS-SPME) combined with gas chromatography–mass spectrometry (GC–MS) approach. It is expected that based on current study, a scientific assessment criterion for different freesia varieties and their cut flowers can be drawn.

*Corresponding author. Email: wangli@nenu.edu.cn

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2. Results and discussion

The FVCs of two freesia cultivars and their cut flowers were listed in Table 1 in terms of area percentage.

The fragrance profiles of these two freesia cultivars were apparently different. In the pink-yellow cultivar, 12 FVCs were identified. Linalool was the most major component and comprised the largest proportion of the total fragrance (96.36%). The contents of the

Table 1. FVCs in cut and un-cut flowers of tetraploid *F. hybrida*.

		Relative contents (%)[a]			
		Pink-yellow cultivar		Yellow cultivar	
Compounds	RI	Un-cut flower	Cut flower	Un-cut flower	Cut flower
Thujene	918	nd	nd	0.05	nd
Pinene*	928	nd	nd	2.08	2.50
Phellandrene*	973	nd	nd	1.99	2.34
Myrcene*	993	nd	nd	2.34	2.46
Eucalyptol*	1028	nd	nd	5.76	6.06
Limonene	1045	nd	nd	0.36	0.29
Terpinene	1053	nd	nd	0.29	0.24
cis-Linaloloxide	1075	nd	nd	tr	tr
Terpinolene	1081	nd	nd	0.21	tr
Linalool*	1088	96.36	96.87	68.04	66.87
Naphthalene	1162	0.29	0.28	tr	nd
L-4-Terpineneol	1166	nd	nd	0.16	0.16
Terpineol*	1179	nd	nd	11.87	12.70
Decanal	1192	0.19	0.16	tr	0.05
Eucarvone	1196	0.14	0.09	tr	tr
Cyclocitral	1202	nd	nd	tr	tr
cis-Geraniol	1219	0.26	0.20	0.05	0.06
2,6-Dimethyl-undecane	1227	0.33	0.30	tr	tr
trans-Geraniol	1246	nd	nd	0.05	0.05
2-Methyl-naphthalene	1277	0.58	0.46	nd	nd
2,6,10-Trimethyl-dodecane	1297	0.26	0.28	nd	nd
trans-Ionone	1362	nd	nd	tr	tr
4-(2,6,6-trimethyl-2-cyclohexen-1-ylidene)-2-butanone	1372	nd	nd	tr	tr
Diphenyl ether	1378	nd	nd	tr	tr
Longifolene	1411	nd	nd	tr	tr
Dihydro-ionone*	1426	nd	nd	3.25	3.08
Sesquiphellandrene	1444	nd	nd	0.05	tr
Farnesene	1456	0.57	0.56	nd	nd
Ionone*	1475	0.35	0.41	2.50	2.14
Gurjunene	1481	0.30	0.24	tr	tr
2,6,10-Trimethyl-pentadecane	1666	nd	nd	0.05	tr
2,6,10,14-Tetramethyl-pentadecane	1723	nd	nd	tr	tr
Hexadecanoic acid methyl ester	1928	nd	nd	tr	tr
Hexadecanoic acid ethyl ester	1998	0.18	0.14	nd	nd
Total compounds		12	12	30	28

Notes: tr, trace; percent $<0.05\%$; nd, not detected; and RI, retention indices.
[a]Average values (peak area relative to total peak area) of three replicate samples.
*These volatiles with the area percentage $>1\%$ were enrolled in the *t*-test for the comparison between the cut and un-cut flowers. Statistical results revealed that all the *p*-values were >0.05.

other 11 FVCs were at a low level, composing less than 4% of the total compounds. In the yellow cultivar, 30 FVCs were detected, with linalool and terpineol (represent 68.04% and 12.16%, respectively) as the two major FVCs. Besides, all the contents of pinene, phellandrene, myrcene, eucalyptol, dihydro-ionone and ionone in the yellow cultivar were higher than 1% but lower than 6%, and the rest of the compounds were in trace quantities. These results reveal that the different quantities and quality of FVCs induce the difference in fragrance of the two freesia cultivars.

Fu et al. (2007) also investigated the fragrance of the yellow cultivar using an aqua-space method, but their result is quite different from that of this study. The discrepancy can be ascribed to the application of different extraction methodologies. Generally, the HS-SPME method is more sensitive and solvent free, and thus it is suitable for volatiles extraction (Arthur & Pawliszyn, 1990; Ferreira, Perestrelo, & Camara, 2009; Movafeghi, Djozan, & Torbati, 2010). However, in order to obtain a more precise outcome and comprehensive understanding, to analyse and synthesise all these results is crucial.

Furthermore, 12 and 28 FVCs were identified in the pink-yellow and yellow cut flower cultivars, respectively. It is almost the same components as that of the un-cut flower except the missing of two trace-level compounds (thujene and naphthalene) in the yellow cut flower (Table 1). With all the constituents representing more than 1% of volatiles enrolled, we found that there was no significant difference in area percentage between the FVCs of the cut and un-cut flowers (*t*-test). A similar conclusion was also drawn by Helsper, Davies, Bouwmeester, Krol, and van Kampen (1998) who investigated the volatiles of *Rosa hybrida* L. cv. Honesty. Our finding confirms that the FVCs of the two cut flower cultivars of freesia will generally maintain stability in common storage condition for 4–6 days after harvest. This characteristic is highly desirable for the selling of cut flower as well as the other commercial purposes. However, in order to precisely understand the changes of fragrance, detection of more freesia cultivars at different picking and storage conditions is needed.

3. Experimental

3.1. *Plant materials*

We have worked on two *Freesia* × *hybrida* cultivars which are designated as tetraploid *F. hybrida* including pink-yellow and yellow cultivars. All the plant materials were obtained from our lab and the voucher specimens (NOs NENUWL001 and NENUWL002, respectively) were deposited in the Herbarium of Central Laboratory of General Biology, Northeast Normal University.

3.2. *Plant cultivation*

All plants were cultivated in a greenhouse in 20-cm-diameter pots containing humus and sand (3/1, v/v). Culture was maintained at 18–20°C with 10 : 14 h (light : dark) photoperiod at 85 $\mu mol\, m^{-2}\, s^{-1}$ photosynthetic photon flux density. Plants were watered when the top inch of soil dried out. Neither chemical treatment nor fertiliser was applied. Branches were cut off when the flower buds at the base of inflorescence had become fully pigmented. Then, they were immediately transferred into the vases filled with common tap water and cultivated on windowsill of our lab at about 20°C under natural light conditions. The analyses of FVCs of cut flowers were preformed after 4–6 days as soon as the most flowers fully opened.

3.3. *HS-SPME sampling*

Full opened flowers (about 2 g) were collected and placed in a 20 mL vial. The 100 µm PDMS fibre was exposed in the upper space of the sealed vial at 20°C for 35 min to adsorb the analytes. Thereafter, the fibre was withdrawn and directly introduced to the GC–MS injector for desorption and analysis. HS-SPME and subsequent analysis were replicated three times.

3.4. *GC–MS analyses*

System: Agilent 6890N gas chromatograph system coupled to an Agilent 5975 quadrupole inert mass selective detector; column: HP-5 MS $30\,m \times 0.25\,mm \times 0.25\,\mu m$ capillary column; Carrier gas: Helium ($1\,mLmin^{-1}$); injection: 250°C 2 min; column temperatures: 40°C for 3 min; 7°C min^{-1} to 100°C, 10°C min^{-1} to 250°C; 250°C for 10 min; mass range: m/z 20–500; electron energy: 70 eV; constituents were identified by NIST 2008 library and retention indices (RI).

4. Conclusions

To sum up, the FVCs of two tetraploid *F. hybrida* cultivars and their cut flowers were analysed. Twelve FVCs were identified in the pink-yellow cultivar and 30 FVCs were identified in the yellow cultivar. No significant difference in FVCs (>1%) was observed between the cut and un-cut flowers. Our findings confirm that with a good FVCs stability, long fragrance retention time and no requirement of special store room, the pink-yellow and yellow tetraploid *F. hybrida* cultivars are highly desirable for commercial purposes.

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