Доклади на Българската академия на науките
Comptes rendus de l'Académie bulgare des Sciences
Tome 75, No 10, 2022

CHEMISTRY
Phytochemistry

DETECTION OF VOLATILE COMPOUNDS OF HYACINTH FLOWERS (*Hyacinthus orientalis* L.) FROM TURKEY

Mozhgan Zarifikhosroshahi[#], Zeynep Ergun[*], Sevket Alp[**], Gulsah Yasa Ozturk[***]

Received on April 17, 2021
Presented by D. Ivanov, Corresponding Member of BAS, on June 21, 2022

Abstract

Hyacinth (*Hyacinthus orientalis* L.) is one of the most beloved ornamental plants with fragrant flowers. As one of the important bulbous plants, hyacinth is used as a cut flower, potted flower, and garden flower. Due to their unique aroma, hyacinth flowers are used in perfumery especially in France whose perfume industry is well-known in the world. In this study, Headspace Solid Phase Micro Extraction (HS-SPME) GC/MS (Gas Chromatography/Mass Spectrometry) technique was used for the analysis of volatile compounds of flower samples. A total of 28 volatile compounds were identified in the fresh flowers of hyacinths. Phenylethyl alcohol, benzyl acetate, a-pinene, and furfural were the major aromas accounting for hyacinth fragrance.

Key words: *Hyacinthus orientalis* L., HS-SPME/GC/MS, volatile compounds

Introduction. Hyacinth (*Hyacinthus orientalis* L.) is one of the favorite ornamental plants with its fragrant flowers with high consideration both in cosmetics and folk medicine. Hyacinth is a bulbous perennial plant and belongs to the Hyacinthaceae family, Asparagales order [1]. The wild form of the hyacinth is native to the Mediterranean coasts of western Iran, and also tropical parts of Africa [2]. Hyacinth is distributed in West Asia, Anatolia, the Northwest of Syria, and Lebanon [1]. In Turkey, two subspecies are found but only one subspecies

[#]Corresponding author.
DOI:10.7546/CRABS.2022.10.06

(*Hyacinthus orientalis* subsp. *Chionophilus* (Kopça)) is endemic in Turkey and distributed naturally in high parts of Southern and Central regions of Turkey even in altitudes up to 2000 m [1]. Most garden hyacinths are derived from the purple flowering hyacinth species. Hyacinth flowers bloom at the tip of a stem that emerges in the middle of a thin and smooth leaf bunch. The bulbs and bulb shells are bright, dark purple, or lighter in colour and are composed of fleshy scales arranged in single-centred circles separated by internodes [1]. Due to its attractive colourful flowers in pink, red, yellow and even dark blue, and powerful fragrance, the hyacinth hybrids are so popular [3]. The individual florets can also be used in corsage, wedding arrangements, and perfume industry as well. In Iran, hyacinth is used for the traditional "Norouz" ceremony in "Haftsin" [4]. In the past, absolute solvent extraction of hyacinth was used in perfumes in microscale quantities. However, the limited availability and high cost of this method lead to using more economical and more easily standardized perfume bases of the hyacinth [3]. In addition to beauty and fantastic smell, the bulbs of *H. orientalis* are a rich source of polyhydroxy alkaloids and glucomannan polysaccharide. Polyhydroxy alkaloids have strong enzyme inhibitory properties on bacterial and mammalian β-glucosidases. Glucomannan is also used in cosmetics and minerals [5].

The sensory properties of flowers differ from the natural model to a greater or lesser extent. On the other hand, the quantitative composition of flower aroma may be affected by many factors such as the geographical environment and/or the season of harvesting the flowers, cultivars, and different extraction methods [6,7]. Hence, this study aims to identify volatile compounds of hyacinth accounting for its unique scent from Turkey.

Material and method. Hyacinth flowers grown wildly in the Anatolia region of Turkey were used as the study material. Hyacinth flowers were collected in April after flowering. Collected *Hyacinthus orientalis* subsp. *Chionophilus* Wendelbo plant specimens are kept in the personal herbarium of Prof. Dr. Sevket Alp, Van Yuzuncu Yıl university. The fresh flowers were transferred to University of Cukurova, Faculty of Agriculture, Horticulture Laboratory, and volatile analysis was immediately carried out. Two grams of flowers were weighed and extracted with 5 mM calcium chloride on a magnetic stirrer at 40 °C for 20 min in the standard Headspace glass bottle (Supelco 75 × 23 mm). n-Octane was used as the external standard for quantitative analysis. Analyses were made with 3 replications. Absorption of volatiles was done by polydimethylsiloxane (PDMS) SPME needle (Supelco, Bellefonte, PA). Perkin Almer GC/MS (Clarus 600) with splitless mode equipped with HP-5 MS (30 m × 0.25 mm × 0.25 µm), fused-silica capillary column was used. The carrier gas was Helium (1 ml/min). The injection temperature was 250 °C. The oven temperature was set at 50 °C and increased at the rate of 4 °C/min and reached 200 °C. Compounds were determined by taking mass spectra and using NIST, Wiley, and Flavor libraries according to their retention time. The percentage area of detected compounds was compared to internal

standard area and quantity of compounds was calculated based on the rate of internal standard concentration to the obtained area.

Results and discussion. Gas chromatography is a basic analytical technique that is used for analyzing plant metabolites due to its efficiency, versatility, and sensitivity. Many types of plant compounds can be analyzed by GC both in the vapour phase and the ones that can be vapourized at a suitable temperature [8]. Solid Phase Micro Extraction (SPME) is also a fast and solventless technique for analyzing the volatiles between the headspace above the sample and a stationary phase coated on a fused-silica fibre [9,10]. In total 27 compounds were identified including three monoterpenes, three aromatic esters, two aliphatic esters, two aromatic and four aliphatic aldehydes, three aliphatic alcohols, four ketones, four acids, and two other compounds The main fragrances of the hyacinth flowers were phenyl ethyl alcohol (1004.59 µg/ml), benzyl acetate (202.83 µg/ml), a-pinene (62.66 µg/ml), (E)-p-Ocimene (30.17 µg/ml) and benzyl benzoate (28.9 µg/ml) (Table 1). Aromatic compounds were predominant compounds in hyacinth flowers

Table 1

Fragrance compounds of wild hyacinth flowers from Turkey

R.T	Compound	µg/ml	R.T	Compound	µg/ml
	Monoterpenes			**Aliphatic alcohols**	
3.26	(E)-p-ocimene	30.17 ± 0.58	7.74	1-penten-3-ol	5.39 ± 0.08
7.1	α-pinene	62.66 ± 1.86	13.35	2-ethyl-1-hexanol	5.3 ± 0.58
7.56	D-limonene	5.39 ± 0.53	14.87	5-octen-1-ol	3.01 ± 0.17
	Σ Monoterpenes	**98.22**		**Σ Aliphatic alcohols**	**13.7**
	Aromatic esters			**Ketones**	
15.38	Benzyl acetate	202.83 ± 9.67	8.91	3-octanone	1.53 ± 0.63
23.94	Benzyl tiglate	1.11 ± 0.03	9.82	2-pentanone	2.53 ± 0.36
17.49	Benzyl benzoate	28.9 ± 1.47	10.29	6-methyl-5-hepten-2-one	1.65 ± 0.39
	Σ Aromatic esters	**232.84**	12.97	1-phenyl-1,2-propanedione	1.38 ± 0.41
	Aliphatic ester			**Σ Ketones**	**7.09**
12.13	Octanol acetate	5.23 ± 0.33		**Acids**	
1.77	Methyl acetate	5.55 ± 0.61	7.53	pentanoic acid	24.18 ± 0.72
	Σ Aliphatic ester	**10.78**	12.003	acetic acid	8.07 ± 1.39
	Aliphatic aldehydes		16.54	hexanoic acid	1.97 ± 0.01
7.702	Heptanal	9.05 ± 0.71	22.53	benzoic acid	10.58 ± 0.73
8.39	2-hexenal	2.33 ± 0.2		**Σ Acids**	**44.8**
9.44	Octanal	2.3 ± 0.28		**Other compounds**	
12.18	furfural	13.27 ± 1.01	19.046	1,2,4-trimethoxybenzene	11.16 ± 1.59
	Σ Aliphatic aldehydes	**26.95**	34.060	Indole	19.98 ± 2.39
	Aromatic aldehydes			**Σ Other compounds**	**31.14**
12.95	Benzaldehyde	4.66 ± 0.01	19.046	1,2,4-trimethoxybenzene	11.16 ± 1.59
	Aromatic alcohol		34.060	Indole	19.98 ± 2.39
18.07	Phenylethyl alcohol	1004.59 ± 9.69		**Σ Other compounds**	**31.14**
	Σ Aromatic alcohol	**1004.59**			

including aromatic alcohols (1009.29 µg/ml) and aromatic esters (232.84 µg/ml), respectively, followed by monoterpenes (98.22 µg/ml), and acids (44.8 µg/ml). Phenylethyl alcohol as the main aroma of hyacinth is a member of the fragrance structural group aryl alkyl alcohols and is a primary alcohol. It is a colourless oily liquid with a mild and warm, rose-honey-like odour of moderate to poor tenacity [10,11]. Benzyl acetate the second major aroma of hyacinth is a member of the fragrance structural group aryl alkyl alcohol simple acid esters (Fig. 1) [12]. Phenylethyl alcohol and benzyl acetate are the fragrance ingredients used in many compounds such as decorative cosmetics, fine fragrances, shampoos, toilet soaps, and other toiletries as well as in non-cosmetic products such as household cleaners and detergents. They are also used in foods as an ingredient in beer, wine, olive oil, grapes, tea, apple juice, and coffee. Benzyl benzoate which is also found in a considerable amount in hyacinth aroma is used in the treatment of scabies and lice and has an important place in the medicine industry. It is also used as an insect repellent [13,14]. The results of the aroma compounds detected in this study are in agreement with several studies. Brunke et al. [3] reported benzyl acetate, α-farnesene, phenyl ethyl alcohol, and β-ocimene as the major scent compounds in narcissus flowers, respectively. Although the results were similar, α-farnesene was not detected in this study. Lamparsky [15] just investigated hyacinth flowers fragrance and reported that terpenoids were in low concentrations, i.e. cis- and trans-β-ocimene to the extent of about 0.005% and 0.02%, respectively. Hosokawa and Fukunaga [16] investigated the composition of essential oils from flowers regenerated in vitro and flowers grown in the field. Nine essential oils were detected by gas-liquid chromatography six and ten components from stage 3 and stage 4 flowers grown in the field, respectively. The author reported that in the regenerated flowers phenethyl alcohol was a major constituent (75%), whereas two compounds, phenethyl alcohol (stage 3, 55%; stage 4, 48%) and cinnamyl alcohol (stage 3, 23%; stage 4, 29%) were the major constituents in the case of flowers grown in the field. Although limited research studies are on the volatile profile of hyacinth, it has been used in the perfumery industry for decades. The genuine hyacinth absolute is scarce and sold at a high price and is used in top-class fragrances and perfumes [17–20]. Consequently, evaluating new cultivars that are grown wildly in nature with a high concentration of volatiles and improved extraction methods is an important step in advancing this sector.

Conclusions. Hyacinth is a kind of flower used in the cosmetic industry due to its strong odour. As far as we know, there are very limited studies on volatile compounds of wild hyacinth flowers. Different numbers of volatile compounds were detected in hyacinth flowers from Turkey. Phenylethyl alcohol, a-pinene, benzyl acetate, β-ocimene, and benzyl benzoate were the main aroma components for studied hyacinth flowers. Due to increasing demands for cosmetic products beside natural ones versus synthetic perfumes, investigating flower scents from naturally grown plants with improved extraction methods are of interest. However, agricul-

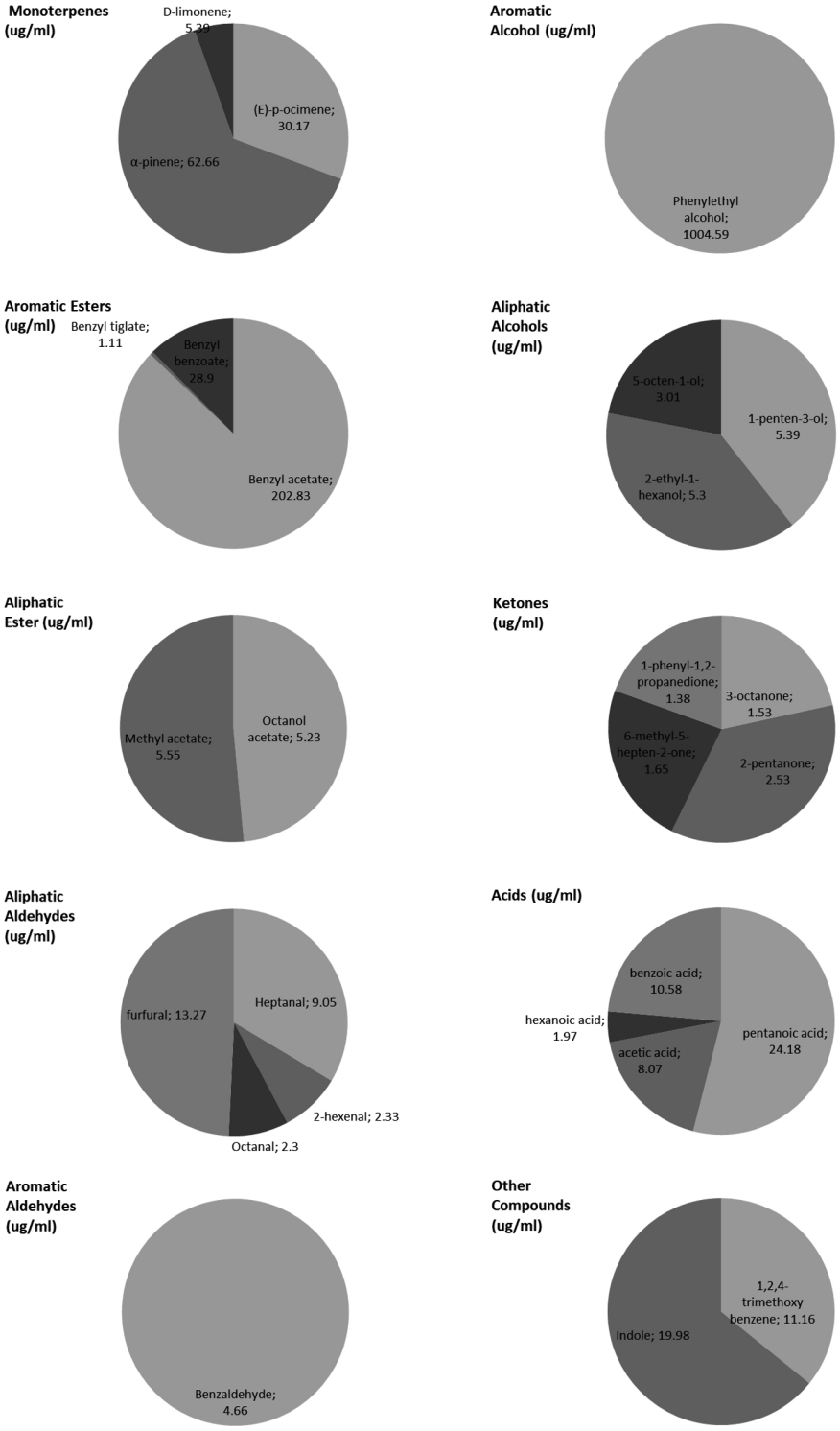

Fig. 1. Depiction of the fragrance compounds of wild hyacinth flowers from Turkey

tural industry needs plants that have various applications such as medicine and landscape. Therefore, this study may be a way for achieving these purposes in the future because it is unavoidable to transform our genetic resources into economic values and to ensure the sustainable use of these resources. This is the first study on *Hyacinthus orientalis* scent in Turkey.

REFERENCES

[1] Kaya E. (2014) Geophytes of Turkey, Yalova, Atatürk Horticultural Central Research Institute, **2**, 317 (in Turkish).

[2] Olgac Y., R. Kasim, M. U. Kasim (2019) Post-Harvest Quality in Tulip, Daffodil and Sumbul from Soganli Suspension Plants. In: Proc. Book (Natural and Applied Sci.), Int. Marmara Sci. Congr. (Autumn), 623–631 (in Turkish).

[3] Brunke E. J., F. J. Hammerschmidt, G. Schmaus (1994) Headspace analysis of hyacinth flowers, Flavour Fragr. J., **9**, 59–69.

[4] Mulholland D. A., S. L. Schwikkard, N. R. Crouch (2013) The chemistry and biological activity of the Hyacinthaceae, Nat. Prod. Rep., **30**, 1165–1210.

[5] Nazari F., H. Farahmand, M. Khosh-Khui, H. Salehi (2011) Effects of coir as a component of potting media on growth, flowering and physiological characteristics of hyacinth (*Hyacinthus orientalis* L. cv. Sonbol-e-Irani), Int. J. Agricult. Food Sci., **1**, 34–38.

[6] Edris A. E., R. Chizzola, C. Franz (2008) Isolation and characterization of the volatile aroma compounds from the concrete headspace and the absolute of *Jasminum sambac* (L.) Ait.(Oleaceae) flowers grown in Egypt, Eur. Food Res. Technol., **3**, 621–626.

[7] Zarifikhosroshahi M., Z. T. Murathan, E. Kafkas, V. Okatan (2020) Variation in volatile and fatty acid contents among *Viburnum opulus* L. fruits growing different locations, Sci. Hortic., **264**, 109160.

[8] Sgorbini B., C. Cagliero, C. Cordero, E. Liberto, P. Rubiolo et al. (2006) Encyclopedia of Analytical Chemistry: Applications, Theory and Instrumentation, 1–31.

[9] Bartak P., P. Bednar, L. Cap, L. Ondrakova, Z. Stransky (2003) A valuable tool for investigation of flower scent, J. Sep. Sci., **26**, 715–721.

[10] Roberts D. D., P. Pollien, C. Milo (2000) Solid-phase microextraction method development for headspace analysis of volatile flavor compounds, J. Agric. Food Chem., **48**, 2430–2437.

[11] Scognamiglio J., L. Jones, C. S. Letizia, A. M. Api (2012) Fragrance material review on phenylethyl alcohol, Food Chem. Toxicol., **50**, S224–S239.

[12] McGinty D., D. Vitale, C. S. Letizia, A. M. Api (2012) Fragrance material review on benzyl acetate, Food Chem. Toxicol., **50**, S363–S384.

[13] Bachewar N. P., V. R. Thawani, S. N. Mali, K. J. Gharpure, V. P. Shingade et al. (2009) Comparison of safety, efficacy, and cost effectiveness of benzyl benzoate, permethrin, and ivermectin in patients of scabies, Indian J. Pharmacol., **41**, 9.

[14] Sharma G., G. Dhankar, K. Thakur, K. Raza, O. P. Katare (2016) Benzyl benzoate-loaded microemulsion for topical applications: enhanced dermatokinetic profile and better delivery promises, AAPS PharmSciTech, **17**, 1221–1231.
[15] Lamparsky D. (1985) Headspace technique as a versatile complementary tool to increase knowledge about constituents of domestic or exotic flowers and fruits. In: Essential Oils and Aromatic Plants, Dordrecht, Springer, 79–92.
[16] Hosokawa K., Y. Fukunaga (1995) Production of essential oils by flowers of *Hyacinthus orientalis* L. regenerated *in vitro*, Plant Cell Rep., **14**, 575–579.
[17] Boeriu C. G. (2015) Plants4Cosmetics: perspectives for plant ingredients in cosmetics, Wageningen UR-Food & Biobased Research, No. 1603.
[18] Keles B., Y. Ertürk (2021) Advantages of microorganism containing biological fertilizers and evaluation of their use in ornamental plants, J. Agricult. For. Life Sci., **5**, 189–197.
[19] Kafkas E., M. Güney, S. Sadighazadi, H. Yildirim, S. Kefayati (2012) Volatile compounds of selected white and black myrtle (*Myrtus communis* L.) types from Mediterranean region of Turkey, J. Med. Plants Res., **6**(49), 5881–5885, DOI: 10.5897/JMPR12.262.
[20] Güney M., A. T. Oz, E. Kafkas (2015) Comparison of lipids, fatty acids and volatile compounds of various kumquat species using HS/GC/MS/FID techniques, J. Sci. Food Agricult., **95**, 1268–1273.

Department of Horticulture
Faculty of Agriculture
University of Cukurova
Adana, Turkey
e-mail: mn_zarifi@yahoo.com

**Department of Bioengineering*
Faculty of Engineering
Adana Alparslan Turkes Science and Technology University
Adana, Turkey
e-mail: zergun@atu.edu.tr

***Department of Landscape Architecture*
Faculty of Agriculture
University of Van Yuzuncu Yil
Van, Turkey
e-mail: alpsevket@yyu.edu.tr

****Adana City Hospital*
Adana, Turkey
e-mail: gulsahyasaozturk@gmail.com