Uluslararası Fen Araştırmalarında Yenilikçi Yaklaşımlar Dergisi
International Journal of Innovative Approaches in Science Research 2018, Vol. 2 (3), 103-111
https://doi.org/10.29329/ijiasr.2018.152.3

Original article

Volatile Constituents of Different Apricot Varieties in Cool Subtropical Climate Conditions

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Abstract

Apricot fruits with rich aromatic profiles are appreciated by consumers for their flavor, sweetness and juiciness; these characteristics are strongly related to the variety and ripening stage at harvest. Volatiles directly affect the sensorial quality and consumer acceptance of fresh fruits. The type and concentration of volatile compounds show great variability in apricots in cool subtropical conditions of Turkey. Aroma is a complex trait, determined by genetics and variety characteristics, followed by climatological conditions, ripening stage and cultural influences; it is further affected by harvest, post-harvest treatments, storage and processing conditions factors. In this study, aroma potentials of apricot varieties were evaluated. Twelve apricot varieties including 'Canino', 'Ethembey', 'Fracosso', 'Harcot', 'Macar', 'Monobella', 'Nebeb', 'Rakowsky', 'Roxana', 'Sakit-2', 'Soganci' and 'Tokaloglu' were investigated for their volatile compositions by using diethyl ether solvent for liquid-liquid extractions. The identification of volatile constituents was performed by Gas Chromatography / Mass Spectrometer (GC/MS) instrument. The major volatile constituents of the varieties were acetaldehyde, hexanal, benzaldehyde, ethanol, 1-hexanol, (Z)-3-hexenol, (E)-2-hexen-1-ol, linalool, ethyl acetate, hexyl acetate, (Z)-3-hexenyl acetate, (E)-2-hexenyl acetate, 6-methyl-5-hepten-2-one, (E)-β-ionone and γ-decalactone, limonene. The concentrations of the volatiles were significantly changed among the varieties. A total of 95 volatile compounds; C6 compounds, aldehydes, acetates, alcohols, esters, ketones, lactones, terpenoids and acids were found in the twelve cultivars. There were 52 compounds identified in 'Canino', 53 in 'Ethembey', 51 in 'Fracosso', 59 in 'Harcot', 56 in 'Macar', 63 in 'Monobella', 63 in 'Nebeb', 62 in 'Rakowsky', 64 in 'Roxana', 60 in 'Sakıt-2', 68 in 'Soganci' and 69 in 'Tokaloglu'.

Keywords: *Prunus armeniaca,* apricot, aromatic compounds, flavor.

Received: 01 August 2018 * **Accepted**: 15 October 2018 * **DOI**: https://doi.org/10.29329/ijiasr.2018.152.3

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INTRODUCTION

Over the last 20 years, world apricot production has increased 85%, mainly due to large plantings made in Asia (Turkey, Iran, Pakistan, Uzbekistan) and Africa (Algeria, Morocco, Egypt). According to the FAO Statistical Database, in 2016, 730.000 tons of apricot were produced in Turkey contributing to 18.81% of the total apricot production in the world. The uses of apricot are multiple and diverse: fresh fruit, processed fruit for drying, canning, jam, juice, sauce, puree for baby food, wine, liquor, and vinegar (Ercisli, 2009).

Although apricots are grown throughout Turkey, about half of the crop is produced in the Central Eastern Anatolia Region. Most important apricot producing centers in Turkey are Malatya, Elazig, Kahramanmaras, Aras valley (Igdir-Kagizman), Antalya, Isparta, Kayseri, Icel (Mut), Kars, Hatay, Afyon, Sivas, Adana and Konya provinces. However the first 4 provinces produce 89% of Turkey's total apricot production with about 74% of the trees. The best quality apricots come from Malatya with its unique taste and aroma, because of its unique ecological and soil endowments. This region has also supplies 65-70% of the world dried apricot production (Ercisli, 2009). Mediterranean and Aegean regions are the following apricot growing regions after Central Eastern Anatolia region. Çanakkale where is located in the Northwestern of Turkey has also great amount of apricot production especially for fresh consumption.

The Northwestern of Turkey has typical cool subtropical ecological conditions for apricot growing. High quality apricots which grown in the region have good market value especially in mid season varieties during June to September. As a popular fruit crop, there is no information on volatile constituents of apricots in cool subtropical ecological conditions. According to Gokbulut and Karabulut (2011), total concentration of aroma compounds are in the range of 514-6232 µg/kg in major Turkish apricot varieties grown in Malatya.

There has been growing dissatisfaction among consumers about the flavor of fruits. First-time purchases are often based on appearance and firmness. Repeat buys, however, are determined by internal quality traits such as mouth-feel and flavor. Apricot is one of the best crops for consumer satisfaction due to huge variability in aromatic condition.

Apricot fruits with rich aromatic profiles are appreciated by consumers for their flavor, sweetness and juiciness; these characteristics are strongly related to the variety and ripening stage at harvest.

The concentrations of aromatic compounds in all fruit crops including apricot are generally low (µg/kg). Aroma is a complex trait, determined by genetics and variety characteristics, followed by climatological conditions, ripening stage and cultural influences; it is further affected by harvest, post-harvest treatments, storage and processing conditions factors. (Baldwin, 2002; Şeker et al., 2011).

The major aroma compounds of apricot cultivars reported are aldehydes, alcohols, acetates, esters, terpenes and acids (Deflippi et al., 2009). Among those compounds ethyl acetate, hexyl acetate, limonene, 6-methyl-5-hepten-2-one, menthone, E-hexen-2-al, linalool, β-ionone and γ-decalactone were existed all major Turkish apricot cultivars (Gokbulut and Karabulut, 2011).

In this experiment aroma potentials of various commercial apricot varieties were evaluated in cool subtropical climate conditions of Turkey.

MATERIALS and METHODS

A total of 12 apricot cultivars ('Canino', 'Ethembey', 'Fracosso', 'Harcot', 'Macar', 'Monobella', 'Nebeb', 'Rakowsky', 'Roxana', 'Sakit-2', 'Sogancı' and 'Tokaloglu') were harvested from the orchards of Experimental Research Orchards at Çanakkale Onsekiz Mart University during the growing season in 2011 in Çanakkale – Turkey. All the varieties have commercial value at the region and harvesting time is between June to August.

Uniformly mature fruits free from visual symptoms of any diseases or blemishes were used for the experiment. The fruits were harvested when the green color of the fruit skin has almost disappeared. At the same time, the ground color of apricots turned yellow or orange according to variety characteristics. Fresh, tree-ripened apricots were sampled and stored at -18 ºC until analysis.

Fruits were cut in half, and the stones were removed and discarded. The skin and pulp were blended for 30 s. The volatile constituents were isolated using diethyl ether solvent for liquid-liquid extractions. 4-nonanol (48 μg) was used as an internal standard.

Twenty fruits for each cultivar were analyzed and the analyses were replicated three times. The detailed analysis procedure was reported by Şeker et al. (2012).

The identification and quantification of volatile components in the samples were performed on a Shimadzu QP2010 Plus GC-MS using the method described by Wang et al. (2009) with a slight modification. Separations were done with a DB-WAX column (60m × 0.2mm, i.d., and 0.25 μm, film thickness; J & W, USA), which was preconditioned at 250°C for a period of 2 hours. Helium was used as the carrier gas (3 ml/min). The analysis was conducted following the program at 40°C for 2 min, 40-150°C (3°C/min), then 150-220°C (10°C/min), and 250°C (5 min). The temperature of the injector was 250°C. The interface between GC and MS was at 250°C. Electron impact ionization was at 70 eV, EI mode, and the filament current was 0.25 mA. The ion-source temperature was 200°C. The scan range was 35-425 aMU.

The individual volatile compounds (identified peaks) were tentatively quantified based on their peak areas relative to that of the internal standard.

RESULTS and DISCUSSION

For 'Fracosso' and 'Tokaloglu', we determined 51 and 69 peaks respectively. Therefore, the number of the volatile compounds identified in our study was higher (Gokbulut and Karabulut, 2011).

A total of 95 volatile compounds; C_6 compounds, aldehydes, acetates, alcohols, esters, ketones, lactones, terpenoids and acids were found in the remaining twelve cultivars. There were 52 compounds identified in 'Canino', 53 in 'Ethembey', 51 in 'Fracosso', 59 in 'Harcot', 56 in 'Macar', 63 in 'Monobella', 63 in 'Nebeb', 62 in 'Rakowsky', 64 in 'Roxana', 60 in 'Sakıt-2', 68 in 'Soganci' and 69 in 'Tokaloglu'.

As can be seen from the Table 1, the highest concentration of total volatile compound was found in 'Tokaloglu', 'Soganci' and 'Roxana' (2776.9, 2281.3 and 1883.3 µg/kg FW, respectively). Those concentrations are lower than the findings conducted by Gokbulut and Karabulut (2011).

Five or six C_6 compounds were found in surveyed apricot cultivars. Among volatiles, C_6 compounds were found to be prominent aroma compounds of apricots changing from 666.4 in 'Ethembey' to 1962.4 µg/kg in 'Soganci' (Table 2.). Hexanal, 2-hexenal, (E)-2-hexenal found abundantly in all cultivars, and 2-hexenal were the major C_6 compounds.

In our experiment twenty aldehydes were determined. The highest concentration of aldehydes was found in 'Tokaloglu' (347.3 µg/kg FW) followed by 'Soganci'. Benzaldehyde and acetaldehyde were the most abundant aldehydes in all cultivars followed by (E, E)-2,4-hexadienal and (E, E)-2,4-heptadienal. Benzaldehyde has been reported as the main compound of volatiles in unripe Japanese apricots (Miyazawa et al., 2009). Gokbulut and Karabulut (2011) were reported that apricot cultivars contain benzaldehyde in the range of 2.1 to 305.4 µg/kg. In our study, benzaldehyde concentrations varied between 0.0 (Fracosso) to 289.0 µg/kg. Aldehydes are formed from linoleic and linolenic acids via the lipoxygenase pathway and are important to the flavor of vegetables. They also play a less significant but important role in fruit flavors (Baldwin, 2002).

Seven acetates in total were detected during this chromatographic experiment. Concentrations of the acetates were in the range of 70.0 to 901.4 µg/kg for 'Canino' and 'Roxana' cultivars, respectively. Those findings were comparable with the total acetates content reported by Gokbulut and Karabulut (2011). Hexyl acetate, (E)-2-hexenyl acetate, (Z)-3-hexenyl acetate were the most abundant acetates in all surveyed cultivars. Acetates has been described as fruity and floral characteristics of fresh apricot fruits in several reports (Guillot et al., 2006; Solis-Solis et al., 2007 and Gokbulut and Karabulut, 2011).

The values for alcohols, the cultivars ranged between 80.7 – 853.0 µg/kg. Total fourteen alcohol compounds were detected in our research and high variability had been noticed. 'Soganci' cultivar had the highest alcohol content whereas 'Canino' had the lowest value. Ethanol, 1-hexanol, (Z)-3-hexenol and (E)-2-hexen-1-ol were the main alcoholic compounds.

Total 21 esters were detected during the analyses. The values for total ester quantification, the varieties ranged between 11.6 – 124.4 µg/kg. Those findings were lower than the total acetates content reported by Gokbulut and Karabulut (2011). (E)-2-hexenyl butyrate was detected in all surveyed varieties in the range of 2.2 to 66.3 µg/kg FW in 'Canino' and 'Tokaloglu' varieties respectively.

Regarding the contents of ketones, a wide variability has been evident, too. In this current study ten ketones were detected. 'Tokaloglu' was the variety with high ketone quantity (335.2 µg/kg) whereas 'Canino' was the lowest (58.2 µg/kg). Among the ketones quantified 6-methyl-5-hepten-2-one was the greatest proportion of total ketones.

In this study, eight lactones were found. The γ-decalactone was the primarily among the lactones. The γ-decalactone content of the surveyed apricot varieties was the highest in 'Tokaloglu', ranging from 44.1 to 171.1 µg/kg; it was very low in 'Canino' where it reached a value of 44.1 µg/kg. In the previous studies, a large number of lactones have been identified. γ -decalactone and γ –octalactone may be responsible for the fruity, peach and coconut characteristics ((Takeoka et al., 1990; Guichard et al., 1990)

The total terpenes content is concerned, the varieties ranged between 0.0 – 153.0 µg/kg. 'Tokaloglu' variety had the highest value whereas 'Macar' had the lowest. (E)-β-ocymene was found in the range of 0.0 – 66.5 µg/kg as the most abundant terpen. Linalool was one of the primarily terpen compounds in all varieties except 'Fracosso', 'Macar' and 'Roxana'. Linalool may be responsible for the floral characteristics of apricot varieties as pointed out by Gomez et al. (1993).

Two acids, 2-propeonic and acetic acids, were detected in apricots in the range of 0.0 – 5.1 µg/kg in total. Gokbulut and Karabulut (2011) detected acidic volatile content in the range of 0.0 – 8.6 µg/kg in their apricot varieties.

CONCLUSION

In conclusion, aromatic compounds of twelve apricot varieties composed of mainly C_6 compounds, aldehydes, acetates, alcohols, ketones, esters, lactones, terpenes and acids. Great variability has been observed and the concentrations of volatiles lower than the apricots grown in the temperate zone of Turkey. However, 'Tokaloglu' was found to be highest concentrations of the volatiles. This variety should be having importance for consumer satisfaction.

Compared with peaches and nectarines, the apricots yielded lower volatile compound quantities at the same geographical conditions. (Seker et al., 2011).

Volatiles in apricots are complex, both in terms of chemical and sensory measurements and in terms of interfacing the two approaches. Flavor is also an important aspect of apricot quality for consumers and also for industry. Flavor quality of apricot fruits is at maximum at harvest and can only be maintained, at best, during storage, shipping and marketing.

ACKNOWLEDGEMENTS

Financial support for this research was provided by TUBITAK (Project number: TOVAG-110 O 109). I wish to thank Dr. Ebru KAFKAS for supporting this experiment.

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TABLES

Table 1. Some important chromatographic informations in apricot varieties

	CAN	ETH	FRA	HAR	MAC	MON	NEB	RAK	ROX	SAK	SOG	TOK
The number of the peak	**52**	**53**	**51**	**59**	**56**	**63**	**63**	**62**	**64**	**60**	**68**	**69**
Total identified volatile compound (µg/kg FW)	**343.6**	**667.5**	**853.5**	**1154.5**	**746.5**	**1029.6**	**940.0**	**978.7**	**1883.3**	**1582.1**	**2281.3**	**2776.9**

Table 2. Composition and quantification of the volatile compounds in apricot varieties

		CAN	ETH	FRA	HAR	MAC	MON	NEB	RAK	ROX	SAK	SOG	TOK
C_6 Com.	Hexane	4.3	3.8	2.8	6.5	4.2	3.8	6.0	7.4	6.5	7.4	8.1	8.8
	Hexanal	146.2	257.4	127.4	298.7	275.8	163.4	218.5	324.2	514.7	674.4	810.5	684.4
	2-hexenal	423.4	367.7	196.5	118.4	187.2	635.4	457.7	501.1	813.2	499.5	811.7	624.7
	(Z)-3-hexen-1-ol	-	-	2.4	1.6	-	1.8	2.7	4.1	3.1	-	2.7	2.6
	(E)-2-hexenal	27.6	7.8	119.1	46.4	178.2	361.7	118.9	76.1	45.1	103.8	145.2	125.4
	(E)-2-hexen-1-ol	144.1	29.7	541.6	208.1	315.7	324.5	300.1	189.1	465.6	329.1	184.2	286.4
	Total	**745.6**	**666.4**	**989.8**	**679.7**	**961.1**	**1490.6**	**1103.9**	**1102.0**	**1848.2**	**1614.2**	**1962.4**	**1732.3**
Aldehydes	Acetaldeyde	8.7	40.1	21.4	17.9	24.7	31.6	28	19.4	18.6	31.3	29.6	26.1
	(E)-2-heptenal	1.4	-	-	1.2	1.1	1.9	1.7	-	-	1.1	1.4	5.1
	Nonanal	-	-	3.1	-	-	4.2	3.0	2.1	-	-	-	-
	(E, E)-2,4-hexadienal	6.6	16.6	11.4	3.4	2.2	2.8	1.7	4.4	1.1	1.5	1.6	-
	(E, E)-2,4-heptadienal	3.1	11.3	4.3	-	-	-	-	3.8	11.1	7.2	4.2	5.4
	2,4-heptadienal	4.5	9.6	3.7	-	-	-	-	-	-	3.7	3.2	2
	Benzaldehyde	15.4	74.3	-	3.4	18.3	26.1	170.8	21.4	115.4	33.1	174.0	289.0
	b-Cyclocitral	-	-	-	3.1	2.6	-	1.7	-	7.4	-	-	-
	Benzeneacetaldehy de	-	-	3.1	2.3	-	7.7	-	-	11.5	-	12.0	9.1
	Phenylacetaldehyde	-	-	-	-	1.7	1.4	1.6	1.4	1.5	-	-	1.2
	Pentanal	1.6	-	-	1.4	1.7	1.4	1.7	1.4	1.7	1.4	1.4	1.1
	(E)-2-pentenal	-	-	-	-	1.6	1.7	-	1.6	1.0	1.1	1.0	1.2
	Heptanal	1.1	1.6	1.4	1.4	1.2	1.4	1.6	-	-	-	-	-
	(E,E)-2,4-hexadienal	-	-	-	-	1.6	-	-	1.1	1.5	-	-	1.2
	Octanal	1.4	-	-	-	1.1	1.2	1.4	1.0	1.0	-	-	1.0
	Benzeneacetaldehy de	1.1	-	-	-	1.7	1.7	1.6	1.0	1.5	1.5	1.5	-
	Nonanal	-	-	-	-	-	-	1.7	-	1.8	1.1	1.8	1.2
	(E)-2-nonenal	-	1.1	1.1	-	1.1	1.1	-	-	-	1.7	1.7	1.2
	Decanal	-	1.1	1.4	-	1.3	1.4	-	1.0	1.5	1.5	-	1.4
	Dodecanal	-	1.1	1.7	-	1.7	1.5	-	1.4	1.1	1.0	1.0	1.1
	Total	**44.9**	**156.8**	**52.6**	**34.1**	**63.6**	**87.1**	**216.5**	**61.0**	**177.7**	**87.2**	**234.4**	**347.3**
Acetates	Methyl acetate	3.7	3.8	2.8	2.0	5.4	3.7	2.4	3.4	3.8	7.0	6.8	8.6
	Ethyl acetate	6.2	31.7	28.9	34.6	61.6	54.8	28.2	30.6	41.7	17.4	31.7	28.7
	Butyl acetate	-	-	-	11.6	-	2.7	-	-	51.4	35.7	40.6	28.0
	Isoamyl acetate	1.2	1.4	1.4	1.8	-	-	1.8	-	-	-	-	-
	Hexyl acetate	31.4	28.7	41.8	40.6	35.0	131.7	103.7	27.7	613.7	176.1	288.0	501.0
	(E)-2-hexenyl acetate	10.3	27.8	124.7	31.2	27.3	131.4	56.6	41.2	87.6	49.0	65.2	103.6
	(Z)-3-hexenyl acetate	17.2	41.2	61.0	103.2	29.2	38.6	31.6	71.4	103.2	164.2	171.1	195.9
	Total	**70.0**	**134.6**	**260.6**	**225.0**	**158.5**	**362.9**	**224.3**	**174.3**	**901.4**	**449.4**	**603.4**	**865.8**

		CAN	ETH	FRA	HAR	MAC	MON	NEB	RAK	ROX	SAK	SOG	TOK
Alcohols	Ethanol	24.2	86.5	35.7	71.4	18.4	29.5	33.8	42.8	65.8	101.4	146.2	118.1
	2-butanol	-	-	-	1.6	-	-	1.0	1.8	1.7	2.7	1.7	-
	1-butanol	-	-	-	-	-	-	1.0	-	1.7	1.6	3.4	1.2
	1-hexanol	18.6	36.4	225.4	391.2	132.6	206.0	38.6	297.6	277.2	189	228.1	317.2
	(Z)-3-hexenol	12.7	13.5	13.6	22.7	17.6	25.5	24.7	13.7	22.8	-	-	-
	(E)-2-hexen-1-ol	19.6	41.1	74.0	80.6	69.0	74.1	36.2	149.0	28.3	201.6	467.0	311.7
	(Z)-2-hexen-1-ol	-	-	-	-	1.8	2.8	4.4	6.8	-	-	-	7.4
	1-penten-3-ol	-	-	-	1.1	-	-	-	-	-	-	-	1.7
	2-propanol	1.6	1.0	1.0	1.7	-	-	1.1	-	1.6	1.7	1.0	-
	2-nonanol	0.6	-	-	1.2	1.2	1.2	1.5	-	1.7	1.4	1.7	1.2
	1-pentanol	1.7	-	-	1.0	1.8	-	1.2	1.6	-	-	1.2	1.2
	1-octanol	-	-	-	-	-	1.1	-	1.4	-	-	1.2	-
	Nonanol	1.7	-	-	1.7	-	1.2	1.2	1.6	-	-	1.5	1.1
	Isoamyl alcohol	-	-	-	1.5	-	1.5	-	-	1.1	1.3	-	1.0
	Total	**80.7**	**178.5**	**349.7**	**575.7**	**242.4**	**342.9**	**144.7**	**516.3**	**401.9**	**500.7**	**853.0**	**761.8**
Esters	Methyl butyrate	1.1	1.3	1.0	1.4	1.5	1.2	1.4	1.6	1.8	1.2	1.5	1.2
	Methyl hexanoate	-	1.1	-	-	-	-	-	-	1.4	3.1	2.6	3.6
	Butyl butylate	10.2	1.2	2.4	1.5	1.5	3.3	3.5	3.6	15.1	4.8	7.0	4.6
	Ethyl caproate	-	-	-	-	-	-	2.3	2.5	2.5	2.0	2.6	2.0
	Ethyl benzoate	-	-	-	-	1.8	-	1.8	1.2	-	-	1.1	-
	Ethyl octanoate	-	-	-	11.5	13.8	-	1.8	10.1	9.5	11.6	11.0	22.2
	Ethyl nonanoate	-	-	-	-	1.8	1.3	-	-	1.1	1.0	1.3	-
	Ethyl hexadecanoate	-	1.0	-	1.4	-	-	1.1	1.6	-	-	-	-
	Hexyl isobutyrate	-	-	-	1.0	-	1.8	1.8	1.3	1.4	-	1.8	7.6
	Butyl hexanoate	-	-	-	1.4	-	-	1.5	1.4	1.7	-	-	-
	Hexyl butanoate	-	1.1	1.4	-	-	1.4	1.2	-	-	-	-	-
	(Z)-3-hexenyl butyrate	1.2	1.0	1.0	3.0	2.4	11.1	18.1	14.2	12.0	11.2	-	10.2
	(E)-2-hexenyl butyrate	2.2	2.3	2.3	6.2	12.2	18.2	21.4	24.3	61.2	14.7	19.9	66.3
	Hexyl hexanoate	-	-	-	1.5	1.5	1.8	2.4	-	3.4	-	-	2.2
	Methyl benzoate	-	-	-	1.2	-	-	-	-	-	-	-	-
	Diethyl succinate	-	-	-	-	-	-	-	1.0	-	-	1.8	-
	Methyl 4-decenoate	-	1.1	1.1	1.8	1.1	1.4	-	1.5	1.6	-	-	-
	2-Phenlethyl acetate	-	1.8	1.3	1.0	1.5	1.8	1.0	-	-	1.4	1.3	-
	Dibutyl pentanedioate	1.1	1.0	1.1	1.1	1.0	-	-	1.6	-	1.7	1.8	1.6
	Isopropyl palmitate	-	-	-	-	-	1.4	1.0	-	-	1.5	1.5	1.3
	Ethyl dodecanoate	1.3	1.3	-	-	-	1.0	1.0	-	-	1.3	1.3	1.6
	Total	**17.1**	**14.2**	**11.6**	**34.0**	**40.1**	**45.7**	**61.3**	**65.9**	**112.7**	**55.5**	**56.5**	**124.4**
Ketones	2-propanone	2.0	9.1	11.9	30.1	5.9	8.3	21.9	11.7	81.3	8.3	103.4	51.9
	2-butanone, 3-methyl	-	-	-	-	2.3	3.6	6.3	1.6	-	-	-	2.2
	6-Met.-5-hepten-2-one	20.1	3.0	70.1	17.6	4.0	8.1	78.3	71.0	30.6	28.1	16.1	121.0
	Dihydro-β-ionone	16.1	38	6.0	72.0	7.7	11.8	-	-	40.0	61.7	18.4	72.0
	Nerylacetone	-	-	-	-	4.5	7.3	11.0	-	-	103.2	71.6	68.6
	(E)-β-Ionone	15.9	14.1	14.0	12.6	64.9	34.1	41.6	-	18.1	71.3	61.3	18.1
	1-Penten-3-one	-	-	1.3	1.3	1.1	1.0	-	-	-	-	-	-
	1-Octen-3-one	-	-	-	-	-	-	1.0	-	1.0	-	1.0	-
	2-Methyl-3-octanone	2	1.1	4	2.6	-	-	-	1.1	1.9	2.0	1.9	1.4
	2-Acetylpyrrole	2.1	1.9	2.3	3.3	-	-	2.1	-	1.7	-	-	-
	Total	**58.2**	**67.2**	**109.6**	**139.5**	**90.4**	**74.2**	**162.2**	**85.4**	**174.6**	**274.6**	**273.7**	**335.2**

		CAN	ETH	FRA	HAR	MAC	MON	NEB	RAK	ROX	SAK	SOG	TOK
Lactones	γ-hexalactone	1.9	-	-	-	-	-	-	-	-	-	-	-
	γ -heptalactone	-	1.1	-	1.6	-	1.7	-	1.6	-	-	-	-
	δ-octalactone	1.1	1.3	1.7	1.7	-	-	-	1.1	-	-	-	-
	γ -octalactone	-	-	-	-	-	-	-	1.7	1.1	-	-	-
	γ -nonalactone	1.3	3.3	2.6	2.6	4.1	3.9	3.6	2.3	1.6	3.1	2.6	3.7
	γ -decalactone	44.1	51.7	48.7	113	141.3	103.5	114.6	38.5	103.0	161.0	104.1	171.1
	δ -decalactone	2.3	4.0	3.6	7.9	1.7	1.6	-	-	-	3.7	4.7	7.6
	7-decen-5-olide	-	-	1.9	-	1.9	-	-	-	-	1.5	11.6	1.9
	Total	**50.7**	**61.4**	**58.5**	**126.8**	**149.0**	**110.7**	**118.2**	**45.2**	**105.7**	**169.3**	**123.0**	**184.3**
Terpenes	β-myrcene	2.3	1.7	1.1	-	-	-	-	1.3	1.0	1.3	2.0	3.1
	α-phellandrene	1.9	1.3	-	-	-	-	-	-	-	-	1.5	1.1
	Limonene	-	-	-	-	-	-	-	-	3.3	4.4	11.1	7.0
	Linolool	11.1	7.6	-	8.1	-	2.1	1.1	3.7	-	33.1	55.1	66.0
	β-phellandrene	-	-	-	-	-	-	8.1	7.6	1.5	-	-	7.1
	(E)-β-ocymene	3.9	41.9	7.7	11.3	-	-	1.3	14.1	-	-	61.3	66.5
	Allo-ocymene	1.7	-	1.0	-	-	1.3		1.4	1.0	1.1	1.5	2.2
	Total	**20.9**	**52.5**	**9.8**	**19.4**	**0.0**	**3.4**	**12.8**	**28.1**	**6.8**	**39.9**	**132.5**	**153.0**
Acids	2-propenoic acid	1.1	1.3	-	-	1.4	1.7	-	1.1	1.3	3.4	3.7	2.7
	Acetic acid	-	1.0	1.1	-	1.1	1.0	-	1.4	1.2	2.1	1.1	2.4
	Total	**1.1**	**2.3**	**1.1**	**0.0**	**2.5**	**2.7**	**0.0**	**2.5**	**2.5**	**5.5**	**4.8**	**5,1**
TOTAL VOLATILES		**343,6**	**667.5**	**853.5**	**1154.5**	**746.5**	**1029.6**	**940.0**	**978.7**	**1883.3**	**1582.1**	**2281.3**	**2776.9**

CAN: 'Canino', ETH: 'Ethembey', FRA: 'Fracosso', HAR: 'Harcot', MAC: 'Macar', MON: 'Monobella', NEB: 'Nebeb', RAK: 'Rakowsky', ROX: 'Roxana', SAK: 'Sakıt-2', SOG: 'Soğancı', TOK: 'Tokaloğlu'

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