Uluslararası Fen Araştırmalarında Yenilikçi Yaklaşımlar Dergisi
International Journal of Innovative Approaches in Science Research 2024, Vol. 8 (4), 175-182
https://doi.org/10.29329/ijiasr.2024.1102.5

Original article

Determination of Volatile Aroma Compounds in the *Catherina* Peach Variety

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Abstract

Peach (*Prunus persica* L. Batsch), belonging to the *Rosaceae* family and classified under the *Prunoidea* subfamily of the *Rosales* order, is divided into three cultural forms: fuzzy (*Prunus persica* vulgaris Mill), non-fuzzy (Nectarines) (*Prunus persica* var. nectarina Maxim), and tomato peach (*Prunus persica* var. platycarpa). Peaches are primarily consumed as fresh fruit but are also used for industrial purposes. This study utilized the Catherina variety from a specific orchard in the Kumkale region of Çanakkale's. The collected samples were analyzed in the laboratory to examine their chemical properties. A total of 33 components were identified through the analyses. According to the results, the total values of the aroma groups were as follows: aldehydes (443.65 µg/kg), lactones (35.48 µg/kg), alcohols (10.80 µg/kg), esters (29.41 µg/kg), and terpenes (19.28 µg/kg). This study determined the volatile aroma compound values of the Catherina peach variety.

Keywords: Peach, Aroma, Quality, Volatile.

Received: 17 August 2024 * **Accepted:** 23 October 2024 * **DOI:** https://doi.org/10.29329/ijiasr.2024.1102.5

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INTRODUCTION

Peach production is carried out in temperate climate regions of both hemispheres of the world, located between the latitudes of 25° and 45° north and south of the equator (Demirören, 1992). Peach production is steadily increasing worldwide, and many new varieties are being developed. The main reasons for this include its high adaptability to various ecologies, wide harvest range, long shelf life, and broad consumer preference.

There are intra-species differences in peaches. These differences include tree and fruit size, chilling requirements, flower size and color, ripening time, growth form, fruit acidity, fruit size, fruit shape, flesh color, and the ease with which the pit separates from the flesh (Layne and Bassi, 2008). Due to its high adaptability, peaches are widely grown in Turkey, especially in the Aegean, Marmara, Mediterranean, and Central Black Sea regions (Ercan and Özkarakaş, 2003).

Peach (*Prunus persica* L. Batsch), belonging to the Rosaceae family and the *Prunoidea* subfamily of the *Rosales* order, has been cultivated since around 2000 BC, with its origin believed to be East Asia and China, from where it spread to Europe via Anatolia (Deveci, 1967).

Some peach varieties are excellent sources of antioxidants, including anthocyanins, carotenoids, and phenolic compounds. Peaches are globally recognized for these functional properties. The concentrations of phenolic compounds, ascorbic acid, and β-carotene are higher in the fruit skin than in the flesh, regardless of variety (Cevallos-Casals et al., 2006).

Peaches are primarily consumed fresh but are also popular as fruit juice concentrate, canned, dried, and in jams. For varieties used for canning, it is important that the fruit flesh is yellow, large, and uniform, with a peel that is easily removed (Özçağıran et al., 2003).

More than 100 volatile aroma compounds (alcohols, lactones, esters, terpenes, and ketones) have been identified in peaches. Due to the flavonoids present in aldehydes, they play a key role in preventing diabetes, cancer, inflammation, and cardiovascular diseases (Fusi et al., 2020). The concentrations of sugars and acids vary among peach varieties, though their compositions are similar. Peach varieties generally have high nutritional value, low acidity, high sugar content, and strong aroma and flavor (Aubert et al., 2003).

There are numerous volatile aroma components in peaches, depending on the methods used. The synthesis of aroma compounds is reported to vary according to factors such as cultivation, variety, rootstock characteristics, and climatic conditions (Şeker et al., 2013). These aroma components, even in very small amounts, play a significant role in quality parameters (Şeker et al., 2011). Among the volatile groups in peaches, the most commonly identified are aldehydes, esters, and terpenes (Şeker et al., 2013).

C_6 compounds create intense grassy odors derived from chlorophyll in immature fruits. Therefore, as the fruit ripens, the concentration of C_6 compounds decreases. The desired volatile aroma groups in peaches include lactones, esters, and the terpene compound linalool. Linalool contributes to a floral aroma and is widely used in the perfume industry (Gür et al., 2017).

Cover crops are control methods applied between rows of cultivated plants in the production of commercial crops, using fast-growing, annual or perennial plants that cover the soil surface.

Cover crops are grown without commercial purposes and are not harvested. This method has many benefits for the production system, including providing ground cover, suppressing invasive weeds through allelopathy, hosting beneficial insect populations, and increasing soil organic matter (Şeker et al., 2024).

The use of cover crops, a method increasingly adopted in developed countries, has gained attention as an alternative to soil tillage for weed control in fruit production in Turkey, aiming to protect the environment and maintain biodiversity. It is essential to promote such applications in our country for both current and future agricultural sustainability (Kitiş, 2010). Chemical control is typically the first option for managing pests. However, this method raises environmental and human health concerns.

Recent developments in ecology and agriculture have highlighted the importance of weed management and soil fertility, leading to a renewed interest in cover crops as a topic that needs further investigation.

Peach cultivation is still primarily practiced through conventional methods. In the areas where peaches are grown, soil tillage or herbicide use is continued for weed control.

This study aimed to determine the chemical properties of Catherina peach variety fruits and examine the effects of cover crops on the volatile aroma compounds in peaches.

MATERIAL

Catherina Peach Variety

In this study, the Catherina peach variety was used as material in a special operation established in the Kumkale region of Çanakkale on an area of 6.200 decares. The Catherina variety was developed in 1970 and is originally from New Jersey, USA. It is a mid-late variety, and depending on the local climate conditions, harvesting is typically done in the last week of July. This self-fertile variety has yellow skin and flesh. Its main uses are in the pastry industry, compote, and canning. However, it can also be consumed fresh. The average fruit weight ranges between 200-250 g.

Cover Crops

The species used as perennial cover crops in the experiment include: 15% red clover (*Trifolium pratense* L.), 15% Sainfoin (*Onobrychis sativa*), 10% Alfalfa (*Medicago sativa*), 10% White clover (*Trifolium repens* L.), and 5% Prennial (English) rye-grass (*Lolium perenne*). The species used as annual cover crops include: 15% Canola (Brassica napus L.), 10% Phacelia (*Phacelia tanacetifolia*), 10% Hungarian vetch (*Vicia pannonica* Crantz.), and 10% Field peas (*Pisum arvense* L.). A total of 9 different species were mixed together for the experiment.

METHOD

Catherina peach trees were planted at a spacing of 2.5 m x 5 m, and the palmette pruning method was applied. Between the rows of fruit trees, no planting was done, and the area was left for natural weed-infested (N.W. I.) growth. Additionally, cover crops (C.C.) were planted using a mixture of 9 different species in three replications. The seeds of the cover crops were sown using the broadcast method.

Aromatic Component Analysis

Aromatic components were extracted using the liquid-liquid extraction method. The fruit pulp, which was processed using a blender, was used to obtain fruit juice. 50 g samples were transferred into Falcon tubes and stored at -40°C. These samples were then transferred to 150 ml Erlenmeyer flasks, with 100 ml of diethyl ether added. The flasks were tightly sealed with aluminum foil and placed in a water bath for 10 minutes to evaporate the ether. The samples were shaken for 10 minutes at 200 rpm in a shaker and placed back in the water bath. Up to 15 ml of the upper phase of the remaining solution was extracted and transferred into clean Falcon tubes, which were then centrifuged. After centrifugation at 500 rpm for 5 minutes, the samples were transferred into vials and prepared for reading in a GC-MS device.

Figure 1. Catherina peach variety (Original photograph F. F. Cankı, 2023)

Figure 2. A: Cover crop row spacing view B: Row spacing view of a natural weed-infested plot (Original photograph F. F. Cankı, 2023)

FINDINGS and DISCUSSION

The number of aroma compounds detected in the Catherina variety is presented in Table 1. A total of 6 aroma compound groups were identified. The detected compounds include 8 aldehydes, 6 lactones, 7 esters, 3 alcohols, 6 terpenes, and 3 other compounds, totaling 33 compounds.

It is known that the flesh color of peaches is related to the aroma compounds, and hexanal, (E)-2-hexenal, decyl lactones, and linalool have been reported to be more abundant in white-fleshed varieties. It has been explained that the aroma values in fruits are formed by C_6 compounds, terpenes, esters, aldehydes, ketones, alcohols, and lactones (Gür et al., 2017).

According to the analysis data, the aldehyde group compounds detected in the cover crop application are as follows: hexenal (213.59 µg/kg), 2-hexenal (180.02 µg/kg), benzaldehyde (31.59 µg/kg), (E)-2-pentenal (15.56 µg/kg), β-sikrositral (1.92 µg/kg), decanal (0.44 µg/kg), dodecanal (0.33 µg/kg), and (E)-2-nonenal (0.20 µg/kg), with a total aldehyde value of 443.65 µg/kg.

The lactone group compounds detected in the cover crop application are as follows: δ-decalactone (19.45 µg/kg), γ-decalactone (9.34 µg/kg), δ-octalactone (3.95 µg/kg), γ-hexalactone (1.86 µg/kg), γ-heptalactone (0.55 µg/kg), and γ-nonalactone (0.33 µg/kg), with a total lactone value of 35.48 µg/kg.

In the cover crop application, 3 alcohol group aroma compounds were detected: (Z)-3-hexen-1-ol (8.16 µg/kg), hexanol (1.63 µg/kg), and (E)-2-hexen-1-ol (1.01 µg/kg), with a total alcohol value of 10.80 µg/kg. From the ester group, the following compounds were found: ethyl acetate (10.04 µg/kg), hexyl acetate (8.82 µg/kg), (Z)-3-hexyl acetate (3.58 µg/kg), (E)-2-hexyl acetate (3.37 µg/kg), ethyl hexanoate (2.02 µg/kg), ethyl octanoate (0.97 µg/kg), and ethyl nonanoate (0.61 µg/kg), with a total ester value of 29.41 µg/kg.

In the analysis, 6 terpene group compounds were detected: linalool (9.16 µg/kg), D-limonene (6.5 µg/kg), osimen (1.87 µg/kg), δ-cadinene (0.82 µg/kg), thymol (0.54 µg/kg), and eucalyptol (0.39 µg/kg). Among other compounds, hexene was found at 53.33 µg/kg.

Gür et al. (2017) examined the volatile aroma compounds of Cardinal, Armking, and White nectarine genotypes. In the Cardinal variety, 59 compounds were identified, in Armking 56, and in the White nectarine variety, 71 compounds were detected. Important C_6 compounds, such as hexanal and (E)-2-hexenal, were detected at 311.0 µg/kg and 245.7 µg/kg, respectively, in the Cardinal variety. In the terpene group, the linalool compound was found at 71.7 µg/kg in Cardinal and 85.4 µg/kg in Armking.

Şeker et al. (2013) studied the aroma components in some table peach varieties and identified 57 compounds in Cresthaven, 63 in Glohaven, 49 in J.H. Hale, 59 in Redhaven, and 58 in Washington varieties. The volatile aroma values in the Catherina variety were found to be lower compared to the table peach varieties grown for consumption.

A significant portion of the aroma in peaches and nectarines is composed of C_6 compounds. As the fruit ripens, the concentration of C_6 compounds decreases. In peaches, fruity and floral aromas are mainly attributed to ester groups. When esters are present in high amounts, peaches have a distinct taste and aroma. γ-decalactone and δ-decalactone are the main aromatic compounds desired at high levels in peaches (Şeker et al., 2013).

As a result of the obtained data, the aroma compounds in the cover crop combination were found to be higher than those in the control group in 31 compounds. The two most important groups in peaches, lactones and esters, were found to be higher in total values in the cover crop application compared to the control group. Among other compounds, 4-acetyl toluene and tridecane were found to be higher in the control peaches compared to those treated with cover crops.

Conclusion

As a result of the study, it was determined that the Catherina peach variety contains a total of 33 volatile aroma compounds. The obtained data showed that the aroma compounds in the cover crop application were higher than those in the control group in 31 compounds. The two most important groups in peaches, lactones and esters, were found to be higher in total values in the cover crop-treated peaches compared to the natural weed-infested plot. In the other compounds group, 4-acetyl toluene and tridecane were found to be higher in the control peaches compared to those treated with cover crops. The average values of aroma compounds in the cover crop application group were higher than those in the control group. With the increasing temperature values and changing climate, the importance of developing new cultivation criteria in fruit growing is increasing. In addition to the effects of cover crops

on fruit yield and quality, further studies should focus on topics such as soil temperature, irrigation regimes, salinity, shoot length, leaf chlorophyll measurement, macro and micronutrient values.

Note: This study was prepared as part of the first author's master's thesis.

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Table 1. Volatile Aroma Compounds in Catherina Peach Variety (μg/kg fruit)

COMPOUNDS	**C.C.**	**N. W. I.**	**COMPOUNDS**	**C.C.**	**N. W. I.**
Hexenal	213.59	177.45	***δ-Decalactone***	19.45	15.38
(E)-2-Hexenal	180.02	143.76	***γ-Decalactone***	9.34	7.28
Benzaldehyde	31.59	26.65	***δ-Octalactone***	3.95	3.25
(E)-2-Pentenal	15.56	13.05	***γ-Hexalactone***	1.86	0.65
β-Sikrositral	1.92	0.00	***γ-Heptalactone***	0.55	0.00
Decanal	0.44	0.00	***γ-Nonalactone***	0.33	0.00
Dodecanal	0.33	0.00	**TOTAL LACTONE**	35.48	26.56
(E)-2-Nonenal	0.20	0.00	***Ethyl acetate***	10.04	8.06
TOTAL ALDEHYDE	443.65	360.91	***Hexyl acetate***	8.82	7.16
Linalool	9.16	6.14	***(Z)-3-Hexyl acetate***	3.58	2.95
D-Limonene	6.5	4.43	***(E)-2-Hexyl acetate***	3.37	2.85
Osimene	1.87	0.36	***Ethyl hexanoate***	2.02	0.51
δ-Cadinene	0.82	0.00	***Ethyl octanoate***	0.97	0.00
Thymol	0.54	0.00	***Ethyl nonanoate***	0.61	0.00
Eucalyptol	0.39	0.00	**TOTAL ESTER**	29.41	21.53
TOTAL TERPENE	19.28	10.93	***Hexene***	53.33	45.42
(Z)-3-Hexen-1-ol	8.16	6.46	***4-Acetyl toluene***	0.00	0.11
Hexanol	1.63	0.42	***Tridecane***	0.00	0.28
(E)-2-Hexen-1-ol	1.01	0.00	**TOTAL OTHERS**	53.33	45.81
TOTAL ALCOHOL	10.80	6.88	**TOTAL AMOUNT**	591.95	472.62