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Original article

# Aroma and Some Quality Characteristics of Sweet Black Colored Oskar $F_1$ (Capsicum Annuum L. Cv. Oskar $F_1$) Pepper Variety

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**Abstract**

The number of new varieties has increased in the world day by day. These new varieties has developed for some properties such as more yield, superior nutritional properties and higher possibility of marketing in domestic and foreign trade. The evaluation of the performance of these varieties in different ecological conditions is an important study subject. Oskar $F_1$ is a black coloured pepper also called purple colored. Oskar $F_1$ is a registered hybrid sweet pointed pepper variety and is subject to export. Oskar F1 pepper variety is stands out in terms of marketing with its black color in addition to having high ascorbic acid amount (222.33 mg / 100g) and hexanal was found as major aroma component which creates a sensory perception as a freshly cut grass.

**Keywords:** Black pepper, sweet pointed pepper, aroma, ascorbic acid.

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## INTRODUCTION

Many developments have been made in the development of new varieties and hybrid (F1) seed production by evaluating populations that are genetic sources in Turkey. Oskar F1 is a hybrid pepper variety that stands out especially for its black color and high amount of vitamin C. However, it should be known that hybrid seeds are different from genetically modified seeds.

Hybrid seed (or plant) is obtained by pollinating two or more unrelated self-bred plants. Hybridization of two different varieties results in a seed which has one or more advantageous properties. Hybrid seeds are obtained by natural hybridization of varieties. They are not genetically modified seeds (Anonymous, 2019a).

Hybrid plants should not be mixed with genetically modified organisms. Genetically modified organisms are genetically modified by using molecular genetic techniques such as gene cloning and protein engineering (Anonymous, 2019b).

The seed obtained by cross-pollination of two different varieties of the same species will form a flower or fruit containing the desired color, size, shape, disease resistance, early harvest, high yield and homogeneity characteristics in hybrid pant production. Genetically modified organisms or transgenic plants are obtained by genetic engineering by transferring genes from one organism to another (Tuquero, 2017).

Marketing of a variety depends on the yield and quality characteristics of that variety. The black color of the Oskar F1 variety makes this variety interesting and attractive for marketing. In a study (Sürmeli et al. 2007), it was aimed to resolve 'Yalova Çorbacı 12' pepper's marketing problem which arised from it's light colour and 'Sürmeli Biberi' variety was developed and entered into registered varieties which has preferred dark green colour, high yield and pointed type.

An important reason for hybrid seeds to be preferred is their high productivity. Some farmers prefer hybrid seeds especially for higher yield. Ergun and Aktaş (2018), studied grafting applications in Efil F1 pepper variety and determined that fruit length was 19.12 ± 0.19 cm, fruit width was 23.475 ± 0.33 mm, fruit weight was 32.98 ± 0.7 g, total yield was 0.66 ± 0.09 kg / plant to ungrafted plants. Ayas (2019), studied irrigation applications in the greenhouse and determined the yield amount of Demre F1 green pepper as 26.2 tons / ha and 27.8 tons / ha in 2009 and 2010 respectively in the plants which were water restriction not applied. In another study (Arancon et al., 2005), different fertilization applications were made in bell pepper (Capsicum annuum L. cv. King Arthur) and the highest yield was found between 16-18 tons / ha with 10 ton / ha animal fertilization, the lowest yield was found between 10-12 tons / ha with inorganic fertilization in the first year of study and the highest yield was found between 7-8 tons / ha with 10 ton / ha animal fertilization, the lowest yield was found between 5-6 tons / ha with inorganic fertilization in the second year of study.

Another quality parameter in pepper which has a high amount of vitamin C, is the vitamin C content, which is known to be necessary for the prevention of scorbut disease which occurs due to vitamin C deficiency.

Peppers are rich in vitamin C also known as ascorbic acid. Vitamin C is known to be necessary for the prevention of scorbut disease.

In a study (Iqbal et al., 2004), it was mentioned that vitamin C is necessary for the development and protection of connective tissues, bone formation, healing of wounds, healthy gums. In addition, it has been reported that it's involved in the activation of vitamin B and folic acid, transformation of bile acids to cholesterol, tryptophan into serotonin, protection against free radicals, cure of many diseases. Furthermore, Vitamin C has been reported to protect the immune system, reduce many allergic reactions, and prevent infections.

Topuz and Ozdemir (2007), determined ascorbic acid content of pepper varieties as 64.9 mg/100g in 1245 F1, 63.1 mg/100g in 730 F1, 57.5 mg/100g in Serademre 8, 25.6 mg/100g in Generation 295 F1, 15.2 mg / 100g in Amazon F1. Simonne ve ark. (1997), determined ascorbic acid content of pepper varieties (Caspsicum annuum L. cv. Dove, Iwory, Blue Jay, Lilac, Valencia, Oriole, Black Bird, Chocolate Beauty, Cardinal, King Arthur, Var 862 R, Red Bell G, Red Bell C, Klondike bell, Canary, Orobelle, Golden Bell) as between 62±7.91 and 162±4.0 in mature not ripe stage and between 62±2.6 and 124±4.1 in full colour stage.

Buczkowska et al., (2016), found that marketable yield was 3.8 kg/m2, total yield was 4.99 kg/m2, total fruit number was 49.6, marketable fruit number was 32.1, vitamin C content was 202.1 mg/100g, soluble solids content was 4.14% in red sweet pepper (Capsicum annuum L. cv. Caryca F1) in control treatment of their study.

In a study (Bernardo ve ark., 2008), two spanish pepper variety (Capsicum annuum L. 'Fresno de la Vega', 'Benavente-Los Valles') examined in different maturity stages (mature green, version stage, mature red) and solible solids contents were determined as 6.93, 6.73, pH values were determined as 4.98, 4.79, titratable acidity values were determined as 1.30, 1.05 respectively in the 'Fresno de la Vega' and 'Benavente-Los Valles' pepper cultivars in mature red stage.

High levels of Major essential oils in two kinds of peppers (Capsicum annuum L. cv. Twingo, Capsicum annuum L. cv. No.1) were found as Benzaldehyde (%20.9), 2-Methoxy-3-isobutyl-pyrazine (%20.4), Z-B-Ocimene (%13), Dimethylbenzene (%8.5), Heptane-2-one (%8.0) in Twingo variety and as 2-Methoxy-3-isobutyl-pyrazine (%12.7), Linalool (%8.3), Z-β-Ocimene (%6.2), Nona-trans,cis-2,6-dienal (%6.2), Hexanal (%5.6) in No.1 variety (El-Ghorab ve ark., 2013).

## MATERIALS and METHODS

This research was carried out at the experimental fields of Çanakkale Onsekiz Mart University's Faculty of Agriculture in Turkey in 2019.

Fertilization of the experimental field was applied based on soil analysis results which was determined by Ç.O.M.Ü. ÇOBİLTUM – Science and Technology Application and Research Center. Seeds of Oskar F1 pepper variety (Capsicum annuum L. Oskar F1) were used in study.


**Figure 1.** Photo from Oskar F1 pepper variety (Capsicum annuum L. Oskar F1)

Oskar F1 pepper variety is a hybrid pepper variety which is produced by breeding project applied in green pointed pepper (Anonim, 2014).

In the experiment, seeds were sown in viols using a mixture of 2/3 peat and 1/3 perlite to a depth of 1 cm.

Seedlings planted with a distance of 0.33 meters within the row and 1 meter between rows. Experiment was set up based on completely randomised design with 3 replications consist of 30 plants in each replication. Analysis and measurements were made from 12 plants selected from each replication. 3 marketable fruits were chose for each plant for some parameters which explained below.

When the seedlings had 3-4 true leaves, they were planted in the field on 23/5/2019 and harvesting continued until 1/10/2019.

Analysis and measurements:

Total Yield (g / plant): It was determined by collecting the weight of all fruits using 0.01 g precision scales.

Marketable Yield (g / plant): It was determined by calculate the amount of yield obtained from fruits that has proper color, size characteristics and were not contaminated with diseases and pests.

Fruit Weight (g): Fruit weights were determined by using 0.01 g precision scales and average weights were calculated.

Fruit Length (mm): Fruit length was determined by measuring the length of marketable 30 fruits from fruit stem hole to fruit tip with using 0.01 mm precision caliper in each replication.

Fruit Diameter (mm): Fruit diameter was determined by measuring the diameter of marketable 36 fruits below the stem hole with using 0.01 mm precision caliper in each replication.

Fruit Pulp Thickness (mm): Fruit pulp thickness was determined by measuring the fruit pulps of marketable 36 fruits with using 0.01 mm precision caliper in each replication.

Fruit Color (L, Hue, Chroma): It was determined by measuring the fruit color of marketable 36 fruits with using Minolta CR 400 colorimeter.

Soluble Solids Content (%): It was determined by measuring soluble solids content of fruit juices with using digital hand refractometer (Pal-1, Atago, Tokyo, Japan) in marketable 36 fruits.

pH Value and Titratable Total Acidity (g / 100g): It was determined according to the titration method by using 0.1 N NaOH in fruit juice. Amount of NaOH that was spent when pH value was 8.1 was determined by using Orlab digital burette and WTW digital desktop pH meter. The amount of titratable acidity (g / 100g) was calculated in terms of citric acid by formula (Anonymous, 1968).

Total Phenolics (mg GAE/100g): 5 g fruit juice was supplemented with 5 ml methanol and centrifuged at 4000 rpm for 10 minutes. The samples were then supplemented with 2.,5 ml 10% Folin-Ciocalteu and 2 ml 1 M Na2CO3 and kept in water bath at 45°C for 15 minutes. Samples were taken to Shimadzu UV-VIS spectrophotometer (UV-Vis Spectrophotometer, Shimadzu Corporation, Tokyo-Japan) and read at 765 nm absorbance value against 10% Folin-Ciocalteu. Results were expressed in total gallic acid equivalent (GAE) mg/100 g (Zheng and Wang, 2001).

Ascorbic Acid Content (Vitamin C) (mg / 100g): It was determined by method of Pearson and Churchill (1970) with using Shimadzu UV-VIS -1800 spectrophotometer. 175 ml of 0.4% Oxalic Acid was supplemented to 25 g fruit pulp and samples were filtered from Whatmann No:2 filter paper for ten minutes. L1 value was determined by reading of Oxalic acid / 2.6 Diclorophenol indophenol: 1/10 solution in response to Oxalic acid / Pure water: 1/10 solution at 520 transmittance value. L2 value was determined by reading of filtered sample / 2.6 Diclorophenol indophenol: 1/10: solution in response to Oxalic acid / Pure water: 1/10 solution at 520 transmittance value. In this way, ascorbic acid content was calculated by using the formulation.

Extraction of Aroma Profiles: Aroma analyzes were carried out using Shimadzu QP2010 Plus Gas Chromatography-Mass Spectrometer system located in Çanakkale Onsekiz Mart University, Faculty of Agriculture, Department of Horticulture.

The methods reported by Vichi et al. (2007), Sabatini and Marsilio (2008), Reboredo-Rodriguez et al. (2013), Ekinci et al.vd. (2016) and Bozok et al.vd. (2018) were modified and used for the identification of flavor components in pepper samples. The step of preparing samples for the analysis were as follows: 50g sample of pepper purees obtained with homogenizer were treated with 100 ml diethyl ether solvent in erlenmayer and the solvent was concentrated to 1 ml by centrifuge and concentrator. The operating conditions of the GC / MS device were described below.

Carrier Gas: Helium

Column: DB-WAX® polyethylene glycol (PEG) (30m x 0.,25 mm x 0.,25 µm)

Injection block temperature 280°C

Linear flow: 41cm/sn

Pressure: 70.,3 kPa

Injection mode: Split (1:50)

Oven temperature program: It was 1 minute at 40°C at the beginning, then 2 minutes at 200 °C with a speed of 4 ° C / min and 10 minutes at 250 °C with a speed of 10 °C/min. Time of total analysis was 58 minutes.

Detector: Mass spectrometer (MS)

Library: Nist and Wiley

Ion temperature: 250 ° C

Interfacial temperature: 230 ° C

Solvent Cut Time: 4 dk

Scanned mass range and scanning speed: 40-350 amu (m/z) ve 666 amu/sn

Ionization energy: 70 eV

## RESULTS and DISCUSSION

The marketable yield amount of Oskar F1 pepper cultivar was 858.8 g / plant in Çanakkale region. In a study (Ergun and Aktaş, 2018), the yield of Efil F1 (Capsicum annuum L. cv. Efil F1) was 0.66 kg / plant in open field conditions, in another study (Ayas et al., 2019) the yield of Demre F1 green pepper variety (Capsicum annuum L. cv. Demre F1) was 26.2 tons / ha in the first year and 27.8 tons / ha in the second year of the study in the greenhouse conditions.

In Oskar F1 pepper cultivar, a certain amount of red fruit were obtained in comparison to the number of marketable fruits. These fruits were edible, but not included in the marketable yield because they were not show characteristics of variety.

Ascorbic acid content of Oskar F1 variety was determined as 222.33 mg / 100g. Ascorbic acid contents were determined in examined varieties (Capsicum annuum L. cv. 730 F1, 1245 F1, Amazon F1, Serademre 8, Kusak 295 F1) by Topuz ve Ozdemir, (2007) between 64.,9-15,2 mg/100g., In another study (Buczkowska ve ark., 2016) ascorbic acid content was determined in Caryca F1 (Capsicum annuum L. cv. Caryca F1) variety as 202.,1 mg/100g., In study concerning red conic pepper genotipes (Balkaya ve Karaağaç, 2009) ascorbic acid contents were determined between 53.,0-155.,0 mg/100g. Ascorbic acid content of full ripe "Zarco HS" pepper variety was found as 188 mg / 100g (Antoniali et al., 2007). Ascorbic acid contents of 29 pepper cultivars grown in Turkey were found between 522 to 1631 mg / kg (Frary et al., 2008).

Soluble solids of Oskar F1 variety was determined as 7.2%. The soluble solids content is used to estimate the amount of sugar which is the most abundant water-soluble substance in fruit and vegetable juices (Kleinhenz & Bumgarner, 2012). Soluble solids contents of 'Fresno de la Vega' and 'Benavente-Los Valles' pepper cultivars were determined as 6.93 and 6.73 respectively (Bernardo et al., 2008). Balkaya and Karaağaç (2009) were determined the amount of water-soluble dry matter in the range of 5.2-8.0% in their study conducted on the red conical pepper (*Capsicum annuum* var. Conoides Mill.) genotypes.

Phenolics content was determined as 60.41 mg/100g in Oskar F1 pepper variety. Sim and Sil (2008) were determined phenolics content as 47.52 mg/g GAE in red pepper. Phenolics content of 29 pepper varieties which were grown in Turkey, were determined between 607-2724 mg/kg (Frary et al., 2008). Kolton et al. (2011) determined the amount of phenolics content in sweet pepper (*Capsicum annuum* L. cv. Spartacus) as 35.77 in the green maturity and 56.44 mg / 100g in the red maturity.

4-methoxy-phenol (3.69 ppm.), ethyl hexadecanoate (3.64 ppm.), hexanal (1.22 ppm.) and isopulegol (1.01 Ppm.) were the highest amount of aroma substances in green pepper (*Capsicum annuum* L.) in study performed by Jang et al. (2008). In a study (El-Ghorab et al. 2013), benzaldehyde was determined as 20.9% in the Twingo pepper variety (*Capsicum annuum* L. cv. Twingo) and hexanal was determined as 5.6% in the No.1 pepper variety. In the Oskar F1 pepper variety, the hexanal (31.89%) was found as the major compound, while the benzaldehyde was determined as 6.22%.

**Table 1.** Fruit Characteristics of Oskar $F_1$ Pepper Variety (*Capsicum annuum* L. cv. Oskar F1)

| Marketable Yield (g/plant) | Total Yield (g/plant) | Weight of Fruit (g) | Fruit Flesh Thickness (mm) | Fruit Width (mm) | Fruit Length (mm) |
|---|---|---|---|---|---|
| 858.8 | 1049.98 | 16.26 | 1.95 | 21.23 | 133.45 |

**Table 2.** Colour Characterisitcs of Oskar $F_1$ Pepper Variety (*Capsicum annuum* L. cv. Oskar $F_1$)

| Color a (Red-Green) Value | Color b (Yellow-Blue) Value |
|---|---|
| 1.72 | 1.92 |
| Color L (Lightness) Value | Color Hue (Angle of Color) Value |
| 15.24 | 48.18 |
| Color Chroma (Intensity of Color) Value | |
| 2.58 | |

**Table 3.** Some Chemical Properties of Oskar $F_1$ Pepper Variety (*Capsicum annuum* L. cv. Oskar $F_1$)

| pH | Titratable Acidity (g/100g) | Soluble Solids (%) | Total Phenolics (mg GAE/100g) | Ascorbic Acid Content (mg/100g) |
|---|---|---|---|---|
| 6.95 | 0.08 | 7.2 | 60.41 | 222.33 |

**Table 4.** Aroma components detected in Oskar $F_1$ Pepper Variety (*Capsicum annuum* L. cv. Oskar F1)

| **Compound** | **Rate (%)** |
|---|---|
| Hekzanal | 31.89 |
| E-2-tetradesenal | 11.43 |
| Benzaldehit | 6.22 |
| 3-Fenil butanal | 5.69 |
| **Total Aldehyde (%)** | **55.23** |
| Hekzanol | 14.31 |
| Z-3-Hekzenol | 2.96 |
| **Total Alcohol (%)** | **17.27** |
| Metil salisilat | 6.43 |
| Hekzil 2 metil bütirat | 4.99 |
| **Total Ester (%)** | **11.42** |
| γ-Muurolen | 9.41 |
| Z-Linalool oksit | 1.31 |
| **Total Terpen (%)** | **10.72** |
| İzobutil metoksi pirazin | 3.69 |
| Hekzanoik asit (Kaproik asit) | 1.67 |
| **Total Other Compounds (%)** | **5.36** |

## CONCLUSION

It is known that yield may differ according to the ecological conditions. When compared with yield content of studies in other pepper varieties (Ergun and Aktaş, 2018; Ayas et al., 2019), it was determined that the marketable yield (858.8 g / plant) of Oskar F1 pepper variety which grown in ecological conditions of Çanakkale was not at a low value as a hybrid green pepper variety. When yield content evaluated in studies (Ergun and Aktaş, 2018; Ayas et al., 2019) in other pepper varieties, it can be expressed that the marketable yield (858.8 g / plant) of Oskar F1 pepper variety which grown in

ecological conditions of Çanakkale should not entitled as a low value. Oskar F1 was similar to other pointed pepper varieties in terms of morphological features.

In Oskar F1 pepper variety, hue color value (48.18) was found between orange color and yellow color but close to orange color. It was thought that low chroma value (2.58) caused the variety to perceived as black color. Black color creates a different and unusual perception compared to other pepper varieties and facilitates the marketing of the variety. L value (15.24), which is not too low, gives a bright appearance.

Examined studies in some other pepper varieties concerning soluble solids content (Bernardo et al., 2008; Balkaya and Karaağaç, 2009) express that Oskar F1 pepper has high level of soluble solids (7.,2%). Soluble solids indicates the ratio of the amount of sugar, which is an important quality criterion.

It was determined that ascorbic acid (222.33 mg / 100g) content of Oskar F1 pepper was at a high level with evaluation of studies in other pepper varieties In study also other studies examined about ascorbic acid content (Topuz ve Ozdemir, 2007; Buczkowska ve ark., 2016; Balkaya ve Karaağaç, 2009; Antoniali et al., 2007; Frary et al., 2008). It was determined that ascorbic acid content of Oskar F1 pepper was at a high level. Quality of Oskar F1 pepper variety affects positively by it's high amount of ascorbic acid content (222.33 mg / 100g), ascorbic acid (Vitamin C) is an essential component in the prevention of scurvy disease which emerge especially in its deficiency.

It was determined that Oskar F1 has enough content of phenolics (60.41 mg GAE/100g) for a pepper variety.

When compared with phenolic compounds content of studies in other pepper varieties, it was determined that phenolic compounds content (60,41 mg GAE/100g) of Oskar F1 pepper variety was at an enough content for a pepper variety, Phenolic compounds related to taste properties such as bitterness, acridness, and sourness.

In Oskar F1 pepper variety, a total of 12 flavor components were determined. from 4 component groups and each 2 of them were found from alcohol, ester, terpene and other component groups, and 4 from aldehyde groups. 4 components were determined from aldehyde groups and each 2 of them were found from alcohol, ester, terpene and other component groups.

It was determined that the aldehyde components were composed major content (55.23%) in the flavor profile of Oskar F1. It is determined that the aldehyde components are the main content (55.23%) of the flavor profile of Oskar F1. Among the aldehydes, Hekzanal (31.89%), E-2-tetradecenal (11.43%), Benzaldehyde (6.22%) and 3-phenyl butanal (5.69%) components were determined. It was reported that hexanal component creates a newly cut grass, fresh leaf-like sensory perception and E-2-Tetradecenal component creates citrus and peppery smell and green waxy taste perception (Ziino et al, 2009; Anonymous, 1982; Anonymous, 1985; Anonymous, 2009Anonymous, 2020).

In Oskar F1 pepper fruits, a total of 2 alcohol components were determined with a rate of 17.27%. Hexanol (14.31%) which creates a fruity, banana like, soft sensory perception, was identified as the major alcohol component. Z-3-hekzenol which creates freshly cut green grass was found as a rate of %2.96 (Aparicio ve Luna, 2002; Angerosa ve ark., 2004).

2 ester components were found with a rate of 11.42% in the total flavor components. Methyl salicylate (6.43%) and Hexyl 2-methyl butyrate (4.99%) components have been reported to provide sensory perception such as sweet-teaberry and green-apple respectively (Anonymous, 1995; Anonymous, 1999Anonymous, 2020).

2 flavor components belonging to the terpenes group were identified and it was determined that they had a share of 10.72% among the general volatile components. It is seen that γ-Muurolen (9.41%) component, which has a smell of herb, wood and spice causes green, herb and woody sensory perception within the terpen group, has major importance (Li et al., 2016)(Ziino et al., 2009). The Z-Linalool oxide (1.31%) component, which provides sweet caramel and fresh floral sensory perception, was found in a lower rate.

The isobutyl methoxy pyrazine (3.69%) specified in the other components group causes the sensory perception of green pepper. However, the hexanoic acid (1.67%) component, a 6-carbon saturated acid, is also known as caproic acid and generally causes sour, oily, cheesy and sweat-like sensory perception. The sum of both components constitutes 5.36% of the overall flavor profile.

As a result, 6 carbon compounds constitute a large part of the flavor profile of Oskar F1 pepper variety. Hexanal (31.89%), hexanol (14.31%) and Z-3-hexenol (2.96%) components were identified from these components, also known as C6 components, produced by lipoxygenase and forming the desired aroma components in fruits and vegetables. The detected C6 components constitute 49.16% of the total flavor components. In addition, it can be said that besides the C6 components, aldehydes and especially E-2-tetradecenal and benzaldehyde are also in significant amounts.

To summarize, black colour of Oskar F1 increases its chance of marketing in domestic and foreign trade. Oskar F1 is a pointed pepper variety and it has an adequate yield (858.8 g/plant) and phenolic content (60.41 mg GAE/100g). Oskar F1 has high level of ascorbic acid (222.33 mg/100g) and soluble solids (%7.2). In study, hexanal (%31.89), hexanol (%14.31) and E-2-Tetradecenal (%11.43) components constituded more than half of the Oskar F1's aroma composition.

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