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CHANGES IN POMOLOGICAL AND ANTIOXIDANT PROPERTIES OF NECTARINE FRUITS (CV. FANTASIA) SAMPLED FROM DIFFERENT CANOPY POSITIONS

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ABSTRACT

The present study was conducted in Battalgazi county of Malatya Province, Turkey in order to determine the effects of fruit canopy position within the tree on pomological traits and antioxidant properties of nectarine cv. Fantasia. For this purpose, the trees were divided into four directions of north, east, west and south ant then each direction divided again into two parts as bottom and top. Fruits at commercially maturity stage were sampled from eight canopy positions and coded as top-west (TW), top-south (TS), top-north (TN), top-east (TE), bottom-north (BN), bottom-east (BE), bottom-west (BW) and bottom-south (BS). Results indicated significant differences in all evaluated parameters except titrable acidity (TA). Fresh weight (FW), flesh firmness (FF) and total soluble solids (TSS) varied between 189.1 g – 215.3 g, 4.5 kg/cm^2 – 5.9 kg/cm^2 and 12.3% - 14.2%, respectively. Color values of *L,* a and bvaried between 31.4 – 35.9 16.3 – 18.4 and 22.5 – 25.5. Total phenolic content (TPC) and antioxidant activity (AA) varied between 448.6 mg GAE/100 g FW – 525.4 mg GAE/100 g FW and 189.0 mmol TE/100 g FW – 441.7 mmol TE/100 g FW, respectively. According to overall evaluations, FW, TSS, *L*, a, b, TPC and AA values were higher while FF, pH and TA lower in concentration in the fruits located on the top of the canopy.

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INTRODUCTION

The nectarine (*Prunus persica* var. nucipersica) that is known for before common era and can be grown through the relative warmer temperate zones of both hemispheres, is included in Rosaceae family. In terms of leaf characteristics and tree shape, it cannot be distinguished by peaches, but nectarine fruits look more like plums than peaches because of the smooth skin. Both kernels and stones of two fruits are alike in appearance (Lal *et al*., 2007). Annually, about 2000 lakh tons of peaches and nectarines are produced on an area of 15 thousand hectares in the world. Almost half of the production is obtained from China, while Italy, USA and Spain follow China respectively. However, Italy and Spain stand out in terms of export.Today, as in many fields, in countries where agriculture is carried out with modern methods and suitable varieties, significant incomes are obtained from peach and nectarine production. For example, according to 2016 data, Spain exports 529,577 tons of peaches and nectarines annually, generating approximately $ 590 million. Italy, on the other hand, generates approximately 390 million dollars annually with 357,146 tons of exports (FAO, 2019). Nectarines are table fruits consumed fresh and the fruits are highly valued for its taste and attractive color. The fruits are a rich source of sugars, vitamins and minerals and malic acid. Nutritive value and fruit quality attributes of nectarines play a key role in consumer preference. Factors such as nitrogen fertilization (Daane *et al*., 1995), temperature (Bible and Singha, 1993) light exposure (Marini, 1985), water stress (Basiouny and Buchanan, 1977), and crop load (Dann and Jerie, 1988) influence nectarine and peach fruit quality. Similarly, canopy position also affects nectarine fruit quality. Nectarines in the top of the tree tend to be dark colored, have higher TSS and pH, lower acid concentrations and less firm than the fruits set in the bottom of the tree. Although the light intensity and the canopy position are considered to be directly related to each other, the effect of canopy position may be somewhat independent of light intensity. Because, in a study it was reported that fruit quality characteristics are affected more by proximity to the roots than to light intensity. Fruit set far from the roots, have higher TSS and dry weight and matures earlier. (Dann and Jerie, 1988). The objective of this study was to investigate the variations in quality traits of nectarine fruits by the reason of fruit setting position on the tree.

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For this aim,nectarines sampled from different canopy positions and their total phenolic compounds contents, antioxidant capacity and some pomological traits were determined.

MATERIALS AND METHODS

As the plant material, nine years old nectarine trees (cv. Fantasia) were used. The trees were grown in research orchards of Malatya Turgut Ozal University where is located in Battalgazi district of Malatya Province, Turkey. Fruit samples were collected at harvest maturity level from different parts of each tree in order to represent different canopy positions. The trees were divided into four directions of north, east, west and south. Later on, each direction divided again into two parts as bottom and top. Fruits at commercially maturity stage were picked from eight different positions and coded as top-north (TN), top-east (TE), top-west (TW), top-south (TS), bottom-north (BN), bottom-east (BE), bottom-west (BW) and bottom-south (BS). Five trees at the age of six grafted on apricot seedling were used for the experiment. Twenty fruits from each different position were sampled from the same tree and these fruits constituted one replicate. Sampled fruits were heighted just after the harvest by a precision scale. The flesh firmness was detected on both sides of each fruit with hand penetrometer and was reported as kg/m^2. For soluble solids, fruits were pressed with fruit press and reported as Brix with a hand refractometer. The pH values of nectarine juices were determined with a pH meter. Color values on the surface of nectarine fruits were measured with a hand spectrophotometer. The measurements were displayed in *L**, a*, and b* values. Finally, 10 ml of the sample was taken and made up to 50 ml with distilled water in order to determine the titrable acidity. This solution was titrated with 0.1 M sodium hydroxide (NaOH) to pH 8.1 using magnetic stirrer and electronic pH meter. Then titrable acidy was calculated according to amount of spent NaOH. The total phenolic content value of nectarine fruits was detected by Folin–Ciocalteu method according to Kraujalyte *et al*., (2013). 100 mL of extract, 400 mL of distilled water, 1mL of sodium carbonate at 7% consistency and 1 mL of 0.2 N Folin–Ciocalteu solution blend were preserved in a room without light for 120 minutes at 25°C and the absorbance values were determined at 725 nm using a spectrophotometer. The TPC contents of samples were calculated according to measuring the absorbance of gallic acid at the same wavelength and the results stated as mg of GAE (gallic acid equivalents) per 100 g of dry matter. The antioxidant activity of the nectarines was determined according to Brand-William *et al*., (2005). 100 mL of fruit extract and 1.9 ml of DPPH solution (1000 ppm) were homogenized ant the solution was kept at room temperature for 60 minutes. Thereafter, absorbance values were determined at 520 nm. The results were stated according to a calibration curve as mmol trolox per 100 g of dry matter. The obtained datafrom all experiments were interpreted according to Duncan's multiple range test ($P \leq 0.05$).

RESULTS AND DISCUSSION

Comparison of pomological traits (fresh weight, flesh firmness, total soluble solids, pH, titrable acidity and color

Table 1. Pomological traits of the nectarine samples picked from different canopy positions

Canopy Position	FW (g)	FF (kg/cm^2)	TSS (%)	pH	TA (%)
TN	198.4 cd	4.3 c	12.3 c	3.3 cde	0.7
TE	205.2 bc	4.4 bc	13.3 b	3.4 cd	0.7
TW	211.3 abc	4.5 b	13.4 b	3.4 cd	0.7
TS	215.3 ab	4.7 b	14.2 a	3.2 de	0.7
BN	189.1 d	5.9 a	12.1 bc	3.7 bc	0.8
BE	196.2 cd	5.3 ab	12.3 c	3.6 b	0.8
BW	201.2 bcd	5.3 ab	13.3 b	3.7 ab	0.8
BS	210.0 abc	4.5 b	12.5 bc	3.8 ab	0.8

FW: Fruit Weight, FF: Flesh Firmness, TSS: Total Soluble Solids, TA: Titratable Acidity Differences between values signed with different letters are significant at $P \leq 0.05$

Table 2. Color values of nectarine fruits sampled from different positions within the canopy

Canopy Position	*L**	a*	b*
TN	35.9 a	18.6 a	25.7 a
TE	34.4 ab	17.8 b	24.7 b
TW	33.5 b	17.4 b	24.0 bc
TS	35.5 a	18.4 ab	25.5 a
BN	31.4 c	16.3 c	22.5 c
BE	32.2 bc	16.7 bc	23.1 c
BW	34.7 ab	18.0 ab	24.9 b
BS	32.5 bc	16.8 bc	23.3 c

Differences between values signed with different letters are significant at $P \leq 0.05$

Table 3. Total phenolic content and antioxidant activity of nectarine fruits sampled from different canopy positions

Canopy Position	TPC(mg GAE/100 g FW)	AA(mmol TE/100 g FW)
TN	494.4 ± 5.9 bc	257.5 ± 4.9 d
TE	525.4 ± 4.4 a	342.7 ± 5.8 c
TW	515.6 ± 6.1 ab	441.7 ± 5.1 a
TS	502.3 ± 8.5 b	365.4 ± 5.2 b
BN	502.9 ± 4.5 b	265.5 ± 3.3 cd
BE	475.9 ± 4.5 c	248.5 ± 4.4 e
BW	448.6 ± 5.2 d	211.5 ± 2.5 f
BS	497.4 ± 3.4 abc	189.0 ± 5.5 g

TPC: Total Phenolics Content, AA: Antioxidant Activity; Differences between values signed with different letters are significant at $P \leq 0.05$

values) was performed for nectarines sampled from different directions and positions within the canopy and results are given in Table 1 and Table 2. In general, the mean values of the pomological traits were significantly affected by canopy positions. In terms of FW and TSS, the highest values were obtained from top-south position (215.3 g and 14.2^{o}) while the highest firmness value (5.9 kg/cm^{2}) was obtained from the fruits located at the bottom-north position. Similarly, fruits set at the bottom of the tree have higher pH and TA values. The highest pH value (3.8) and TA value (0.8) were obtained from the fruits located on bottom-south position. On the contrary, the highest L (35.9), a (18.6) and b (25.7) values were obtained from top-north position while the lowest ones were obtained from bottom-north position with the values of 31.4, 16.3 and 22.5 respectively. When the pomological traits data analyzed, it can be concluded that fruits set at top of the tree are weightier and have more TSS content than the fruits set at bottom of the tree. Dann and Jerie (1998) concluded that fruits set top of the tree, have higher TSS and dry weight and matures earlier because of the light intensity. In accordance with a previous report Lewallen and Marini (2003), nectarine fruits that set at the bottom of the tree have higher pH and TA values then fruit from the lower canopy. Although there is not enough data on this subject, it is thought that this affect is also caused by light intensity. Similarly, when the L values are examined, it can be concluded that the fruits formed at the bottom of the tree are darker in color. In several previous reports (Addoms *et al*., 1930, Seymour *et al*., 1993, Erez and Flore, 1986) it was indicated that as nectarines ripen, the color of the flesh and skin changes from green to purple because chlorophyll concentrations decline and anthocyanin increase. Concordantly, since bottom of the tree receive less sunlight than the top, the disintegration of chlorophyll here is faster.

Antioxidant properties (total phenolic content and antioxidant activity) of nectarine fruits sampled from the different positions of the tree showed significant variations (Table 3).TPC of nectarine fruits sampled from upper positions, but not from the north were higher than the fruits set at the bottom position. In furtherance with these findings, Drogoudiand and Pantelidis (2011) indicated that TPC of apples and Karabulut *et al*. (2017) apricots were higher in fruits set from upper positions since they were exposed to more sunlight than lower canopy locations.Correlatively, antioxidant activities of nectarines sampled from upper positions were found higher than those sampled from bottom. Since the antioxidant activity of the fruits strongly correlated with sugars, vitamins phenolic compunds and organic acids Garcia-Viguera *et al*., (1994), Karabulut *et al*. (2017), the revealed knowledge is expected.

Conclusion

As a result of this study, various impacts of canopy position were observed on the pomological traits and antioxidant properties of nectarine fruits. In general, the fruits set on the upper part of the tree were found to be better in terms of all pomological traits and antioxidant properties. The most important reason for this effect is thought to be early ripening of the fruits set on the top of the tree due to exposing more sunlight. Therefore, the practice of harvesting all nectarine fruits on a tree at once might not be appropriate and the harvest should be separated in order to reduce the variations in quality.

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