Yield and Some Pomological Characteristics of Organically Grown "Alyanak" and "Hasanbey" Apricots (*Prunus armeniaca* L.)*

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Abstract: This research was carried out to see the effects of organic farming and determine the yield and some pomological characteristics of apricots in Isparta, Turkey. Isparta province which is located in the west Mediterranean part of Turkey has also gained importance in terms of especially organic apricot production. Two apricot varieties (Hasanbey, Alyanak) were grown with organic farming practices in this study. These two varieties are table types apricot varieties commonly grown in Turkey's one of the world's major producers. In this research, pomological characteristics as fruit size (fruit height, fruit width, fruit weight, fruit length), fruit firmness, pH, total soluble solid (TSS) content, titrable acidity (TA) and yield values were determined. Total phenolic and antioxidant activity were also determined. Hasanbey cultivar had higher yield value (66.21 kg/tree) than Alyanak (45.71 kg/tree) cultivar. At the same time the total phenolic content of Hasanbey (307.12 mg GAE/100g) variety was determined higher than Alyanak (175.91 mg GAE/100g). Antioxidant activity of Alyanak and Hasanbey were determined as 32.86 mg/ml IC_{50} and 17.37 mg/ml IC_{50} respectively. In terms of observed characteristics, Hasanbey cultivar was found to be prominent in Isparta. It can also been recommended for other places similar to Isparta ecological conditions (highland climate).

Keywords: apricot; total phenolic; antioxidant activity; organic growing; Hasanbey; Alyanak

1. Introduction

The apricot has been cultivated since ancient times and its motherland extends from Turkestan to Western China (1). Apricot is geographically distributed in almost all parts of the world, but it is grown in Europe, Central Asia, America and Africa, mostly in countries near the Mediterranean (2, 3).

Turkey is ranked the first in the world in terms of production of apricots (2). Turkey's apricot production is 730000 tons in 2016 according to FAO statistics (2). This production amount constitutes 18.81% of world apricot production. The most important apricot producer province is Malatya, encounters approximately 50% portion of total apricot production in Turkey (4). Isparta province which is located in the west Mediterranean part of Turkey has also gained importance in terms of especially organic apricot production. In terms of organic apricot production, it ranks second after Malatya. Isparta's organic apricot production made to 1645.84 tons in 2014. The same year Turkey's total organic apricot production is 4102.34 tons. Turkey's total organic apricot production is 94798 tons in 2013, while in 2014 it is the 4102.34 tons (5). It is obvious there is a very high reduction in the production of organic apricots. The reason for this is that in addition to the crop damage caused by late spring frosts, many producers give up organic farming because organic apricot growing is more difficult than other species. Namely, in organic apricot cultivation, it is very difficult to combat especially fungal and bacterial diseases. Organic certified pesticides that can be used for this purpose are very limited. In addition, another problem faced by organic apricot producers is that, organic products, which are relatively low in quality compared to conventional products, are not bought by merchants. Even if purchased, the same price as the conventional product is

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paid despite it should be priced higher than conventional products. For these reasons, organic apricot producers in Turkey are quickly return to conventional production. However, the production of organic apricots was 2533 tons in Isparta in 2017.

Whether organic or conventional, apricot is an important food. Apricot is rich in sugar, vitamins, minerals, fibers and bioactive phytochemicals like phenolic, carotenoids and antioxidants. The positive effects of these phytochemicals on human health are known. Many studies in this area have reported that antioxidants protect lives from oxidative damage and chronic diseases (6, 7, 8). The possibility of cancer and other health problems caused by residues of chemical fertilizers and herbicides lead researches to improve production methods which can prevent these calamities (9).

Although, conventional apricots have been much investigated for their quality characteristics and contents of phytochemicals by many researchers in the world (6, 10, 11, 4, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22) however, studies on organic apricots are less in literature (14, 16, 23). Therefore, some pomological characteristics, total phenolic contents and antioxidant activities of organic apricots grown in the Isparta region (highland climatic conditions) where organic apricot cultivation is increasingly important are investigated in this study.

2. Materials and Methods

2.1.Experimental Site

This study was conducted in Isparta/Turkey (37°45′ N latitude, 30°33′ E longitude). Isparta is located in the west Mediterranean part of Turkey. There are highland climate conditions in Isparta region. It has a very favorable climate in terms of temperate fruit species. Apples and cherries are the most grown species in commercially, although apricot cultivation has gained importance in recent years.

2.2.Experimental Design and Plant Material

The experiment was carried out in 2015-2016 and the randomized plots design with three replications. Two apricot varieties (Hasanbey and Alyanak) grown with organic farming practices in the experiment were used as plant material. Both varieties examined in this study are grown for fresh consumption. The fruits of the Hasanbey variety are heart-shaped, large and delicious. It has good strength when transported to distances. Alyanak variety have large fruits and the color of pulp is white. Fruits are tabular shaped and allure is high. It is also a juicy and delicious variety. In this study, the growing methods were suitable the "Organic Farming Regulations" in force in Turkey and certified production was carried out.

2.3. Pomological characteristics, total phenolic, antioxidant activities and yield

The fruit characteristics of the apricots were determined and cluster samples were randomly selected in 30 units of fruits. The fruit weights (g) were determined using a 0.01g-sensitive weighing. Fruit width (mm), length (mm), and height (mm) were measured by a 0.01 mm sensitive digital compass. Fruit width was measured across the fruit cheek. Fruit length was measured as distance from the fruit stalk to the fruit apex and fruit height was measured as length from fruit suture to the fruit back. Fruit firmness (lb) was determined by using penetrometer (24).

Total soluble solids contents (TSS) were determined by a hand refractometer (%). pH measurements were performed using a Hanna HI 98103 pH meter at 20 °C. Titrable acidity

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(TA) was determined with potentiometrically using 0.1M NaOH to the end point of pH 8.1 and expressed as grams of malic acid per litre (25).

Total phenolic and antioxidant activity were determined by spectrophotometric assay. Total phenols were determined according to the Folin-Ciocalteu method (26), using the Folin–Ciocalteau reagent. Absorbance was measured on spectrophotometer at 765 nm. Results were expressed as mg of Gallic acid equivalents (GAE 100g-1 FW) of extract. Antioxidant activities were determined by DPPH assay (27). Absorbance was measured on spectrophotometer at 517 nm. The percentages of DPPH radical-scavenging activity were expressed as mg/ml IC_{50}.

Yield is determined by weighing the fruits harvested from each tree and expressed in kg/tree.

2.4. Statistical analyzes

The study analyzed by Randomized Factorial design. Difference between means determined by using "Tukey" multiple comparison tests. All analyses were performed using Minitab 18 program (28).

3. Results and Discussions

3.1. Pomological properties

Some pomological characteristics of the apricot varieties investigated in the study are presented in Table 1, 2, 3 and 4. The differences between the cultivars, years and interaction (cultivars x years) for fruit weight were statistically significant (P≤0.01). But for other traits, differences between the only cultivars are statistically significant (P≤0.01). Differences in the years and interaction (cultivars x years) were insignificant. Hasanbey variety had heavier fruits. While fruit weights were determined as 66.21 g in Hasanbey variety, fruit weight in Alyanak variety was determined as 45.71 g. In both varieties, fruit weight was higher in 2016 than in 2015 (for Hasanbey variety; 69.83 g and 62.60 g, for Alyanak variety; 45.84 g and 45.58 g, respectively). In terms of fruit weight, it is observed that when taking into consideration of the years averages were 54.09 g in 2015 and 57.84 g in 2016, (Table 1).

Table 1. Fruit weight of apricots

Cultivars	Fruit Weight (g)					
	Years					
	2015		2016			
	Mean	SE	Mean	SE	Mean	SE
Hasanbey	62.60 b	1.22	69.83 a	1.22	66.21 A	0.86
Alyanak	45.58 d		45.84 c		45.71 B	
Mean	54.09 B	0.86	57.84 A	0.86		

Mean differences among interaction terms (cultivars x years) are shown in small superscripts (P≤0,01)

Mean differences in years and cultivars are shown in capital superscripts (P≤0,01)

When literature is examined in terms of fruit weight it was reported as 52.35-69.67 g in integrated farming and 38.64-82.83 g in organic farming in an apricot cultivation compared to integrated system and organic farming (14). In another research, organic fertilizer application and standard "N, P, K" application were compared and it was found that organic fertilizer application has the highest fruit weight (72.3-102.1 g) in all varieties. It was also reported that

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it varied between 70.43-100.9 g in "N, P, K" treatment. (23). In a study conducted with conventional cultivation and 11 apricot varieties, the fruit weight varied between 21.16-38.24 g. In the same study, it was reported that the heaviest fruits were obtained from Hasanbey variety (4). Another study in which Hasanbey variety was used as a control variety showed that the fruit weight ranged from 28.5 to 71.1 g and the fruit weight for Hasanbey variety was 47.2 g (29). The findings in our study are consistent with the values reported in the literature for organic agriculture in terms of fruit weight. Our data are higher than known for conventional agriculture in literature. It is understood from the yield values that fruit weight has a positive effect on yield (Table 6).

In this research, fruit height values were determined as 49.38 mm, 42.75 mm in Hasanbey and Alyanak varieties, respectively (Table 2). In terms of fruit width, Hasanbey variety had higher values than Alyanak variety. Hasanbey variety had a fruit width of 45.39 mm and Alyanak variety had a width of 38.97 mm (Table 2). Fruit length was determined as 53.95 mm in Hasanbey variety. The Alyanak variety (46.06 mm) was also behind Hasanbey variety (Table 2). Hasanbey variety had harder fruits. Fruit firmness was determined as 9.89 lb in Hasanbey variety and 8.35 lb in Alyanak variety (Table 2). The differences between the varieties in terms of these properties are statistically significant (P≤0.01). The differences in the years and interactions (cultivars x years) are not statistically significant. High variability was reported among regarding apricot fruit size and fruit firmness in literature (14, 30, 31, 24, 10, 32, 33). The findings in our study are consistent with the values reported in the literature. Although we grow organic, any decrease in fruit size did not occur. In particular, Hasanbey variety had higher values than traditional apricot fruit sizes reported by many other researchers. This is due to the genetic characteristics of the cultivar and we think it the positive effects of the highland climate.

Table 2. Some pomological properties of apricots

Cultivars	Fruit Height (mm)		Fruit Width (mm)		Fruit Length (mm)		Fruit Firmness (lb)	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Hasanbey	49.38a	0.71	45.39a	0.62	53.95a	0.58	9.89 a	0.19
Alyanak	42.75b		38.97b		46.06b		8.35 b	

Mean differences between cultivars are shown in small superscripts (P≤0,01)

The pH of the Hasanbey variety was determined as 4.86. The fruits of the Alyanak variety were more acidic (3.79) (Table 3). Total soluble solid contents (TSS) of Hasanbey and Alyanak varieties were determined as 16.38 and 11.44, respectively (Table 4). For both features, the differences between cultivars are statistically significant (P≤0.01). But the differences in years and cultivars x years interactions were not statistically significant.

Table 3. Total soluble solid and pH of apricots

Cultivars	pH		TSS (%)	
	Mean	SE	Mean	SE
Hasanbey	4.86 a	0.88	16.38 a	0.36
Alyanak	3.79 b		11.44 b	

Mean differences between cultivars are shown in small superscripts (P≤0,01)

Titratable acidity of apricot cultivars are presented in Table 4. The differences between the varieties for titratable acidity were statistically significant (P≤0.01). At the same time, differences between years were statistically significant for titrable acidity. But interaction

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between cultivars x years were not significant. In terms of titratable acidity (TA), Alyanak variety (0.85) had a higher degree than Hasanbey variety (0.22). Titrable acidity was observed as 0.52 in 2015 and 0.55 in 2016, taking into consideration of the years averages (Table 4). The data we obtained in pH, TA and TSS in our study are matching to the values reported by many researchers in previous studies for both organic cultivation and conventional apricots (3, 4, 29, 34, 23, 24).

Table 3. Titrable acidity of apricots

Cultivars	Titratable Acidity (g/L)					
	Years					
	2015		2016			
	Mean	SE	Mean	SE	Mean	SE
Hasanbey	0.20	0.01	0.24	0.01	0.22 a	0.01
Alyanak	0.83		0.87		0.85 b	
Main	0.52 A	0.01	0.55 B	0.01		

Mean differences between cultivars are shown in small superscripts (P≤0,01)

Mean differences between years are shown in capital superscripts (P≤0,05)

3.2. Total phenolic and antioxidant activity

Total phenolic contents and antioxidant activities of the Hasanbey and Alyanak apricot cultivars grown in organically are presented in Table 5. As shown in Table 5, the total phenolic content of Hasanbey variety (307.12 mg GAE / 100g) was found to be higher than that of Alyanak (175.91 mg GAE / 100g). In terms of antioxidant activity, the Alyanak variety (32.86 mg/ml IC_{50}) had a higher value. For both traits, the differences between cultivars were statistically significant (P≤0.01). But the differences between years and cultivars x years interactions were not statistically significant. The total phenolic and antioxidant activity values we obtained were generally in accordance with the literature, but our findings were higher than the values reported by some researchers (24), and lower than some of them (14, 35, 36, 37). Considering that phytochemical properties such as total phenolic and antioxidant activity can change even during the day, it is thought that these effects can occur due to such as climate effects, genetic characteristics and harvesting time.

Table 5. Total phenolic and antioxidant activities of apricot varieties

Cultivars	Total Phenolic (mg GAE/100g)		Antioxidant Activity (mg/ml IC_{50})	
	Mean	SE	Mean	SE
Hasanbey	307.12 a	4.74	17.37 b	1.02
Alyanak	175.91 b		32.86 a	

Mean differences between cultivars are shown in small superscripts (P≤0,01)

3.3. Yields (kg/tree)

The yields of the apricots produced in the highland climate conditions are shown in Table 6. Hasanbey variety yielded about 69.84 kg per tree while Alyanak variety yielded 61.80 kg. The differences in years and interactions (cultivar x years) were not statistically significant, but the differences between the varieties were significant (P≤0.01). The yield values obtained in our study were higher than those reported in the literature (3, 23, 31, 38). This suggests that

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in the highland climate, there is no reduction in the yield of apricots with organic farming and even positive effects.

Table 6. Yields of apricot varieties

Cultivars	Yield (kg/tree)	
	Mean	SE
Hasanbey	69.84 a	1.49
Alyanak	61.80 b	

Mean differences between cultivars are shown in small superscripts (P≤0,01)

4. Conclusions

In our study conducted in the highland climate conditions in order to determine some pomological and phytochemical properties of organically grown Hasanbey and Alyanak apricot varieties, it is considered that the highland climate has a positive effect on especially the pomological characteristics and yield values. For this reason, it is more appropriate to evaluate the organic apricot cultivation in highland climate zone. However, the problem of fighting diseases in organic apricot cultivation under highland conditions should be investigated by further researches. In terms of the characteristics examined in our research, Hasanbey variety was superior than Alyanak variety in Isparta ecological conditions (highland climate).

References

1. Bailey, C.H. and Hough, L.F. Apricots. *Advances fruit breeding;* Janick, J. & Moore, J. N. (Eds.): Purdue University Press: West Lafayette, Indiana, USA; 1975, pp. 367−383.
2. FAOSTAT, 2017. http://www.fao.org/faostat/en/#data/QC
3. Milosevic, T.; Milosevic, N.; Glisic, I. Influence of Stock on the Early Tree Growth, Yield and Fruit Quality Traits of Apricot (Prunus armeniaca L.). *Journal of Agricultural Sciences* 2011, 17, 167-176.
4. Akın, E.B; Karabulut, I; Topcu, A. Some compositional properties of main Malatya apricot (Prunus armeniaca L.) varieties. *Food Chemistry*, 2008, *107*, 939–948
5. The Ministry of Food, Agriculture and Livestock of Turkey. 2018, https://www.tarim.gov.tr/
6. Leccese, A.; Bartolini, S.; Viti, R. Total antioxidant capacity and phenolics content in apricot fruits. *Int. J. Fruit Sci.* 2007, *7 (2)*, 3–16.
7. Dragovic-Uzelac, V.; Levaj, B.; Mrkic, V.; Bursac, D.; Boras, M. The content of polyphenols and carotenoids in three apricot cultivars depending on stage of maturity and geographical region. *Food Chem.* 2007, *102*, 966–975.
8. Lila, M.A. Anthocyanin and human health: in vitro investigative approach. *J. Biomed. Biotechnol.* 2004, *5*, 306–313.
9. Çolak, A.M.; Topal, N. Organic Agriculture In Province of Usak In Turkey. *AGROFOR International Journal*, 2016, *1(3)*, 143-147.
10. Sartaj, A.; Masud, T.; Abbasi, K.S. Physico-chemical characteristics of apricot (Prunus armeniaca L.) grown in Northern Areas of Pakistan. *Scientia Horticulturae* 2011, *130*, 386–392.
11. Erdogan-Orhan, I. and Kartal, M. Insights into research on phytochemistry and biological activities of Prunus armeniaca L. (apricot). *Food Research International* 2011, *44*, 1238–1243.

12. Ruiz, D.; Egea, J.; Gil M.I.; Francisco, A. T. Characterization and Quantitation of Phenolic Compounds in New Apricot (Prunus armeniaca L.) Varieties. *J. Agric. Food Chem.* 2005, *53*, 9544−9552.
13. Ghasemnezhad, M.; Shiri, M. A.; Sanavi, M. Effect of chitosan coatings on some quality indices of apricot (Prunus armeniaca L.) during cold storage. Caspian *J. Env. Sci.* 2010, 8 (1), 25-33.
14. Leccese, A.; Bureau, S.; Reich, M.; Renard C. M.; Audergon J-M.; Mennone, C.; Bartolini, S.; Viti, R. Pomological and Nutraceutical Properties in Apricot Fruit: Cultivation Systems and Cold Storage Fruit Management. Plant Foods. *Hum Nutr.* 2010, *65*,112–120.
15. Bae, H.; Yun, S.K.; Jun, J.H.; Yoon, I.K.; Nam, E.Y.; Kwon, J.H. Assessment of organic acid and sugar composition in apricot, plumcot, plum, and peach during fruit development. *Journal of Applied Botany and Food Quality* 2014, *87*, 24 – 29.
16. Milosevic, T.; Milosevic, N.; Glisic, I. Tree growth, yield, fruit quality attributes and leaf nutrient content of 'Roxana' apricot as influenced by natural zeolite, organic and inorganic fertilizers. *Scientia Horticulturae* 2013, *156*, 131–139.
17. Scalzoa, J.; Politi, A.; Pellegrini, N.; Mezzetti, B.; Battino, M. Plant genotype affects total antioxidant capacity and phenolic contents in fruit. *Nutrition* 2005, *21*, 207–213.
18. Milosevic, T.; Milosevic, N.; Glisic, I. Apricot Vegetative Growth, Tree Mortality, Productivity, Fruit Quality and Leaf Nutrient Composition as Affected by Myrobalan Rootstock and Blackthorn Inter-Stem. *Erwerbs-Obstbau* 2015, *57*, 77–91.
19. Durmaz, G.; Alpaslan, M. Antioxidant properties of roasted apricot (Prunus armeniaca L.) kernel. *Food Chemistry* 2007, *100*, 1177–1181.
20. Dragovic-Uzelac, V.; Delonga, K.; Levaj, B.; Djakovic, S.; Pospisil, J. Phenolic Profiles of Raw Apricots, Pumpkins, and Their Purees in the Evaluation of Apricot Nectar and Jam Authenticity. *J. Agric. Food Chem.* 2005, *53*, 4836−4842.
21. Ruiz, D.; Egea, J.; Francisco A. T-B. Gil, A.I. Carotenoids from New Apricot (Prunus armeniaca L.) Varieties and Their Relationship with Flesh and Skin Color. *J. Agric. Food Chem.* 2005, *53*, 6368−6374.
22. Sochor, J.; Zitka, O.; Skutkova, H.; Pavlik, D.; Babula, P.; Krska, B.; Horna, A.; Adam, V.; Provaznik, I; Kizek, R. Content of Phenolic Compounds and Antioxidant Capacity in Fruits of Apricot Genotypes. *Molecules* 2010, *15*, 6285-6305.
23. Milosevic, T.; Milosevic, N. Response of young apricot trees to natural zeolite, organic and inorganic fertilizers. *Plant Soil Environ*. 2013, *59 (1)*, 44–49.
24. Caliskan, O.; Bayazit, S.; Sumbul, A. Fruit Quality and Phytochemical Attributes of Some Apricot (Prunus armeniaca L.) Cultivars as Affected by Genotypes and Seasons. *Not Bot Horti Agrobo*, 2012, *40(2)*, 284-294.
25. AOAC. Official Methods of Analysis. *Association of Official Analytical Chemists 15th ed.*, Arlington, VA, USA, 1990.
26. Singleton, V.L.; Rossi J.A.Colorimetry of total phenolics with hosphomolybdic-phosphotungstic acid reagents. *American Journal of Enology and Viticulture* 1965, *16*, 144–158.
27. Gulcin I. Comparison of in vitro antioxidant and antiradical activities of Ltyrosine and L-Dopa. *Amino acids* 2007, 32, 431-438.
28. MINITAB, 2018. http://www.minitab.com
29. Asma, B.M.; Kan, T.; Birhanlı, O. Characterization of promising apricot (Prunus armeniaca L.) genetic resources in Malatya, Turkey. *Genetic Resources and Crop Evolution* 2007, *54*, 205–212.

30. Perez-Pastor, A.; Ruiz-Sanchez, M.C.; Martınez, J.A.; Nortes, P.A.; Artes, F.; Domingo, R. Effect of deficit irrigation on apricot fruit quality at harvest and during storage. *J Sci Food Agric* 2007, *87*, 2409–2415.
31. Fathy, M. A.; Gabr, M. A.; El Shall; S.A. Effect of Humic Acid Treatments on 'Canino' Apricot Growth, Yield and Fruit Quality. *New York Science Journal* 2010, *3(12)*, 109-115.
32. Badenes, M.L.; Martinez-Calvo, J.; Llácer, G. Analysis of apricot germplasm from the European Eco-geographical group. *Euphytica* 1998, *102(1)*, 93-99.
33. Ruiz, D.; Egea, J. Phenotypic diversity and relationships of fruit quality traits in apricot (Prunus armeniaca L.) germplasm. *Euphytica* 2008, *163*, 143-158.
34. Milosevic, T.; Milosevic, N.; Glisic, I. Effect of tree conduce on the precocity, yield and fruit quality in apricot on acidic soil. *Revista Ciência Agronômica* 2012, *43 (1)*, 177-183.
35. Hussain, P.R.; Chatterjee, S.; Variyar, P.S.; Sharma, A.; Dar, M.A.; Wan, A.M. Bioactive compounds and antioxidant activity of gamma irradiated sun dried apricots (Prunus armeniaca L.). *Journal of Food Composition and Analysis* 2013, *30*, 59–66.
36. Wani, S.M.; Jan, N.; Wani, T.A.; Ahmad, M.; Masoodi Adil Gani, F.A. Optimization of antioxidant activity and total polyphenols of dried apricot fruit extracts (Prunus armeniaca L.) using response surface methodology. *Journal of the Saudi Society of Agricultural Sciences* 2017, *16*, 119–126.
37. Roussos, P.A.; Sefferou, V.; Denaxa, N-K.; Tsantili, E.; Stathis, V. Apricot (Prunus armeniaca L.) fruit quality attributes and phytochemicals under different crop load. *Scientia Horticulturae* 2011, *129*, 472–478.
38. Hernandez, F.; Pinochet, J.; Moreno, M.A.; Martınez, J.J.; Legua, P. Performance of Prunus rootstocks for apricot in Mediterranean conditions. *Scientia Horticulturae* 2010, *124*, 354–359.