Uluslararası Tarım ve Yaban Hayatı Bilimleri Dergisi (UTYHBD), 2019, 5(1): 1 - 10
International Journal of Agriculture and Wildlife Science (IJAWS)
doi: 10.24180/ijaws.436312

International Journal of Agriculture and Wildlife Science

http://dergipark.org.tr/ijaws

Araştırma Makalesi

Pomological and Chemical Attributes of Almond Genotypes Selected from Hatay Province

Ahmet Sümbül[1*], Safder Bayazit[2]

[1]Sivas Cumhuriyet University, Suşehri Timur Karabal Vocational School, Department of Plant and Animal Production, Suşehri/Sivas
[2]Hatay Mustafa Kemal University, Faculty of Agriculture, Department of Horticulture, Hatay

Received: 25.06.2018 Accepted: 05.10.2018

Keywords:
Prunus dulcis Mill., protein content, total oil, kernel ratio

***Corresponding author**
asumbul3188@gmail.com

Abstract. This study was conducted to determine some pomological and chemical characteristics of 19 almond genotypes in term of found to be promising in yield and quality attributes. Selected from natural almond populations of Hatay province and district (Belen, Antakya, Yayladağı, Altınözü, Hassa) and shelled fruit weights of selected promising genotypes varied between 1.55 g (HTY-28) - 6.34 g (HTY-67); kernel weights varied between 0.61 g (HTY-25) - 1.29 g (HTY-67); kernel ratios varied between 15.99% (HTY-17) - 50.46% (HTY-28); double-kernel ratios varied between 0.00% - 16.67%; empty fruit ratios varied between 0.00% - 13.33%; total oil contents varied between 44.65% (HTY-40) - 54.56% (HTY-14); protein contents varied between 19.59% (HTY-27) - 33.79% (HTY-57).

Hatay İlinden Seçilen Badem Gentoplerinin Pomolojik ve Kimyasal Özellikleri

Anahtar kelimeler:
Prunus dulcis Mill., protein içeriği, toplam yağ, iç meyve oranı

Özet. Bu çalışma, Hatay ili ve ilçelerindeki (Belen, Antakya, Yayladağı, Altınözü, Hassa) doğal badem popülasyonlarından seçilen verim ve kalite özellikleri bakımından ümitvar bulunan 19 badem genotipinin bazı pomolojik ve kimyasal özellikleri belirlenmiştir. Seçilen ümitvar genotiplerin kabuklu meyve ağırlıkları 1.55 g (HTY-28) - 6.34 g (HTY-67); iç meyve ağırlıkları 0.61 g (HTY-25) - 1.29 g (HTY-67); iç meyve oranı %15.99 (HTY-17) - %50.46 (HTY-28); çift meyve oranı %0,00 - %16,67; boş meyve oranları %0,00 - %13,33; toplam yağ içeriği %44.65 (HTY-40) - %54.56 (HTY-14); protein içerikleri %19.59 (HTY-27) - %33.79 (HTY-57) arasında değişmiştir.

ORCID ID (By author order)
0000-0001-9510-0992 0000-0003-4619-3891

INTRODUCTION

Almond belongs to *Prunus* genus of *Rosaceae* family. It has a natural widespread in India, Iran and Pakistan and spread in time from these countries to Mediterranean region. Almond botanically has a stone-fruit structure, but mesocarp dry-out at ripening period and fruits are considered as nut-fruits (Soylu, 2003).

Value of almond is always increasing since it is processed into various food stuff in food industry. Fruits are quite rich in protein, oils, fatty acids, vitamins and minerals, thus have several positive impacts on human health such as prevention of cholesterol and cardiovascular diseases. Previous studies on nut-fruits revealed that almond had the greatest protein content (20%) and did not contain cholesterol (Ahrens *et al.,* 2005).

Kernels are used as snacks year-long under proper preservation conditions. They are also used in candies, chocolates and pastry industry. Besides, kernels used in pharmaceutics, cosmetics and dye industries.

Almond is virtually a hot-climate fruit, thus is it grown almost in all regions of Turkey, except for highlands and cool and humid sections of Black Sea region since fruits requires high temperatures at ripening period. Winter dormant season is low in almonds and spring late-frosts are the most significant factors restricting almond growing in Turkey. Since almond is an early-blooming species, spring frosts can easily damage flowers, thus do not allow growers to get regular yields and constitute a significant factor in lagging of commercial almond growing. Therefore, orchards fully established with almond trees are scarcely any in Turkey. Almond trees are usually planted as border-line trees and growing is practices without any cultural practices (irrigation, fertilization, chemical applications, pruning) (Tosun, 2002).

Despite all these negative issues, there is an ever-increasing interest in almond growing since trees can grow stony and gravel soil conditions in which the other trees are not able to grow, fruits are served to markets early as unripe fresh almond, trees have early fruit set, fruits have quite long shelf life and high market value and trees are commonly used in forestation practices. Although almond trees have been grown as border trees along the field borders until recently, specialized almond orchards have started to be established in recent years because of high income generation potential of the fruits and farmer's consciousness about health benefits of almond.

Although specialized almond orchards have recently been established because of increasing significance and economic returns, almond trees in almost all regions of Turkey are seed-propagated trees. Since Turkey is quite rich in seed-propagated almond populations, there is a large variation in flowering periods as not the influenced from spring late frosts, resistance to pests and diseases, adaptation to various ecological conditions, tree and fruit quality attributes. Such a broad variation facilitates the works of breeders on almond selection. Thusly, most of the standard cultivars commonly grown worldwide were randomly selected from genotypes. Almond cultivars of Nonpareil, Texas, Ne Plus Ultra, IXL in the USA; Lauranne in France; Tuono, Genco, Cristomorto in Italy; Verdeal, Gama, Boa Casta in Portogul; Glorieta, Masbovera in Spain can be given as an example for these cultivars (Dokuzoguz *et al.,* 1968; Noronha Vaz, 1996; Dicenta *et al.,* 1999).

Almond selection studies were performed by researchers in different sections of Turkey (Dokuzoğuz *et al.,* 1968; Dokuzoğuz and Gülcan, 1973; Kalyoncu, 1990; Cangi and Şen, 1991; Aslantaş, 1993; Bostan *et al.,* 1995; Karadeniz *et al.,* 1996; Şimşek, 1996; Gerçekçioğlu and Güneş, 1999; Balta, 2002; Ağlar, 2005; Yıldırım, 2007; Köse, 2013; Bozkurt, 2017). Late flowering, high yield and superior quality attributes were mostly focused on these selection studies and promising genotypes were identified.

Today, almond breeding programs usually focus on collection of gene sources, selection and assessment of genotypes and breeding of late-flowering and self-pollinating genotypes (Ağlar, 2005). Hatay province has dominant sub-tropical climate conditions, but has temperate climate in high and inner sections. Thus, early and late genotypes adapted to these climate conditions should be selected. In this study, some pomological and chemical quality attributes of 19 almond genotypes selected from Hatay province and town were investigated.

MATERIAL AND METHOD

Plant Material

This study was conducted in Antakya province and Altınözü, Belen, Hassa and Yayladağı towns of Hatay province of these district with intense seed-propagated almond populations at yield-ages between 2010-2012 years. A total of 73 almond genotypes were selected within the aim of this study. Selected genotypes were subjected to weighted ranking based on selection breeding criteria. The 19 genotypes with the greatest scores from weighted ranking were identified as promising genotypes. UPOV criteria were considered in weighted ranking (Kalyoncu, 1990; Aslantaş, 1993; Balta, 2002).

Pomological Analyses

For each one of selected genotypes, 30 fruits were used for pomological analyses. As specified by Yıldırım *et al.* (2007), fruits were deshelled from green shells, kept at room temperature under shade for 2 weeks and finally dried in an oven 30°C for 24 hours for homogeneous drying. Then, relevant measurements and analyses were performed.

Shelled fruit and kernel weights were measured with a digital balance with a ±0.01 g sensitive. Shelled fruit and kernel dimensions (width, length, height and shell thickness) were measured with a digital caliper ±0.01 mm sensitive. Kernel ratio and the ratio of kernel weight to shelled fruit weight were determined as percentage. Double kernel and empty fruit ratios were determined by breaking all the fruits of each replicate one by one.

Kernel bulkiness was determined by the number of kernels fitted into 1 onz (28.3 g) international standard and kernel size groups were determined accordingly. The size groups were specified as follows (Table 1) (Aslantaş, 1993; Şimşek, 1996).

Table 1. The number of kernels fruit placed in 1 onz and kernel size group (28.3 g).
Çizelge 1. 1 onz (28.3 g) içerisine giren iç badem sayısı ve büyüklük grubu.

Number of Kernel Fruits	Kernel Size Group
1. >30	Small
2. 25-30	Medium
3. 20-25	Large
4. <20	Very large

In addition to subjective color classification (light – medium – dark), shelled fruit and kernel color was determined with the aid of a color-meter (Minolta CR-300). Color parameters of L*, a*, b*, Chroma (C) and hue (h°) angle were measured. In color parameters, L* indicates the brightness of the color (L* 0 black, L* 100 white), a* indicates color conversion from green to red (positive values indicating red and negative values indicating green), b* indicates color conversion from yellow to blue (positivevalues indicating yellow and negative values indicating blue), C indicates color intensity and h^o indicates angle value of the color (0; red-purple, 90°; yellow, 180°; blue-green, 270°; blue) (Zerbini and Polesollo, 1984).

Chemical Analyses

Total oil analysis was performed with the Soxholet method in accordance with Akyüz and Kaya (1992). Resultant values were expressed in percentages. Protein content was determined with Kjeldahl method by using %N contents (1) (Kaçar, 1984).

$$\% \, Protein = \% \, N \; x \; 6.25 \tag{1}$$

RESULTS AND DISCUSSION

Shelled fruit weights of the selected genotypes varied between 1.55 g (HTY-28) and 6.34 g (HTY-67) with an average value of 4.13 g (Table 2). Present findings were similar with the results reported by earlier studies carried out in Turkey. Kalyoncu (1990) carried out a study around the reservoir of Konya Apa Dam and reported shelled fruit weights as between 3.37-5.24 g, Gerçekçioğlu and Güneş (1999), reported shelled fruit weights of the almond genotypes selected from Tokat province and surroundings as between 2.18 g - 7.58 g, Ağlar and Balta (2007) carried out a study in Pertek location and reported shelled fruit weights as between 3.91 g - 8.99 g, Köse (2013) reported shelled fruit weights of the almond genotypes selected from İspir town as between 2.17 g - 5.79 g, Bozkurt (2017) reported shelled fruit weights of the almond genotypes selected from Datça peninsula as between 2.00 g - 7.97 g.

Present shelled fruit weights were not smaller than both the local types and cultivars and foreign cultivars. Kaşka *et al.* (1998) assessed the performance of Cristomorto, D. Largueta, Drake, Ferraduel, Ferragnes, Genco, Marcona, Nonpariel, Texas, Gülcan I, 101-9 and 101-13 cultivars under Southeastern Anatolia conditions and reported average shelled fruit weights as between 2.00 g -5.51 g. Atlı *et al.* (2005) reported shelled fruit weights of 101/23, 17-4, 48-5, 48-2, 300-1, 48-1, 101-13, Nonpareil, Ferragnes, Cristomorto, Picantili, D. Largueta, Garrigues, Drake, Tuono, Primorski, Nikitski, Texas, Yaltinski and Ferraduel almond cultivars under Gaziantep conditions as between 1.26 g- 3.91 g; Akçay and Tosun (2005) reported shelled fruit weights of Ferrstar, Nonpareil, Cristomorto, Tuono, Ferragnes, Picantili, Yaltinski and Garrigues cultivars as between 2.65 g- 4.80g.

Shelled fruit weights of promising almond genotypes were not also lower than both the shelled fruit weights of the genotypes obtained after selection breeding and the shelled fruit weights of the standard almond cultivars.

Shell thickness of promising genotypes varied between 0.93 mm (HTY-28) and 3.65 mm (HTY-65). Among the selected genotypes, while only 1 genotype had a shell structure classified as soft, 16 genotypes had hard shell and 2 genotypes had very hard shellstructure. According to Gülcan (1976), suture opening as an undesired attribute against the pests and diseases. Present study suture opening was not observed in promising almond genotypes (Table 2). In this sense, selected genotypes were found to be significant.

Table 2. Shelled fruit characteristics of selected genotypes.
Çizelge 2. Seçilen genotiplerin kabuklu meyve özellikleri.

Genotype	Shelled fruit weight (g)	Shell thickness (mm)	Shelled fruit width (mm)	Shelled fruit length (mm)	Shelled fruit height (mm)	Suture opening	Shell hardness
HTY-11	3.68±0.30	2.65±0.08	20.19±1.17	32.43±0.66	16.52±0.83	No	Hard
HTY-13	4.75±0.12	3.31±0.01	20.94±0.90	35.74±0.93	16.41±0.05	No	Hard
HTY-14	4.04±0.25	3.20±0.07	19.79±0.40	31.39±0.88	16.11±0.59	No	Hard
HTY-17	4.37±0.27	3.33±0.06	19.36±0.51	35.27±0.56	14.25±0.65	No	Hard
HTY-25	2.99±0.10	3.00±0.06	20.16±0.32	28.64±0.25	14.79±0.07	No	Hard
HTY-27	4.14±0.16	2.77±0.10	21.33±0.49	34.56±0.75	15.16±0.27	No	Hard
HTY-28	1.55±0.06	0.93±0.01	15.43±0.02	28.71±0.41	12.81±0.33	No	Soft
HTY-29	3.21±0.20	2.55±0.04	19.75±0.27	28.42±0.42	14.15±0.11	No	Hard
HTY-31	3.97±0.40	3.35±0.12	23.17±0.94	28.78±0.46	17.17±0.68	No	Hard
HTY-34	3.09±0.21	2.96±0.16	16.54±0.30	33.69±0.46	14.39±0.43	No	Hard
HTY-40	4.01±0.16	2.82±0.11	20.42±0.40	29.56±0.31	16.23±0.21	No	Hard
HTY-57	3.65±0.12	2.63±0.10	18.76±0.28	31.28±1.34	14.18±0.23	No	Very hard
HTY-60	4.52±0.10	2.51±0.10	23.51±0.27	32.78±1.05	16.74±0.51	No	Hard
HTY-62	4.31±0.30	3.58±0.16	24.44±0.66	29.65±0.59	16.61±0.59	No	Hard
HTY-64	3.53±0.17	2.91±0.14	19.23±0.41	32.09±0.44	14.63±0.26	No	Hard
HTY-65	5.73±0.29	3.65±0.15	25.84±0.88	35.37±0.25	17.94±0.54	No	Hard
HTY-66	4.96±0.38	2.46±0.18	24.15±0.74	33.55±0.42	17.02±0.45	No	Very hard
HTY-67	6.34±0.59	3.41±0.03	27.12±1.51	33.97±1.66	19.35±0.87	No	Hard
HTY-68	5.67±0.33	3.62±0.11	25.78±0.83	39.92±0.39	18.17±0.59	No	Hard
Minimum	1.55	0.93	15.43	28.42	12.81		
Maximum	6.34	3.65	27.12	39.92	19.35		
Mean	4.13	2.93	21.36	32.41	15.93		

* HTY: Hatay.

Kernel weights of selected genotypes varied between 0.61 g (HTY-25) and 1.29 g (HTY-67) with an average value of 0.93 g (Table 3). Kernel weights of thegenotypes were significantly different. Kernel weights of 7 genotypes were greater than 1.00 g present findings on kernel weights were generally similar with the results reported by earlier researches carried out in Turkey. Kalyoncu (1990) reported kernel weights of the almonds around the reservoir of Konya Apa Dam as between 0.64 g-1.00 g, Aslantaş (1993) reported kernel weights of the almond genotypes selected from Erzincan Kemaliye town as between 0.65 g-1.15 g, Beyhan and Bostan (1995) reported kernel weights of almonds in Darende locality as between 0.77 g- 1.23 g, Karadeniz and Erman (1996) reported kernel weights of the almond genotypes selected from Siirt province as between 1.01 g- 1.80 g, Yıldırım (2007) reported kernel weights of promising almond genotypes selected from Isparta province as between 0.99 g- 1.27 g, Göksu (2011) reported kernel weights of the almond genotypes selected from Adıyaman province as between 0.60 g- 1.04 g.

Present findings on kernel weights were parallel to the kernel weights obtained from earlier selection studies carried out in Turkey, but the present values were lower than the values of standard almond cultivars. Kaşka *et al.* (1998) carried out a study at Şanlıurfa Koruklu Research Station in 1996 with the local genotypes of 48-1, 48-2 and 48-5 and foreign cultivars of Drake, Nonpareil and Texas and reported kernel weights respectively as 1.56 g, 1.74 g, 1.34 g, 1.46 g and 1.73 g. Vargas (1998) carried out a study at IRTA (Spain) on fruit characteristics of 20 almond cultivars and reported kernel weights as between 1.0 g - 2.3 g. Akçay and Tosun (2005) worked with foreign almond cultivars of Ferrastar, Nonpareil, Cristomorto, Tuono, Ferragnes, Picantili, Yaltinski and Garrigues and reported kernel weights as between 1.35 g -2.00 g.

Kernel weights were determined through weighing and number of kernels placed into 1 onz (28.3 g) is provided in Table 3. The number of kernels placed in 1 onz standard size varied between 46.39 (HTY-25) and 21.99 (HTY-67) with an average value of 31.82. Of the present promising genotypes, kernels were classified as small in 11 genotypes, medium in 5 genotypes, large in 3 genotypes and there were not any very large kernels. It is remarkable that present number of kernels placed in 1 onz was little bit low. Gülcan (1976) investigated 200 almond genotypes and reported number of kernels in 1 onz as between 14- 49, Balta (2002) reported the number of kernels in 1 onz as between 21 - 35, Yıldırım (2007) reported the value of promising genotypesas between 22 - 32, Yeşilkaynak (2000) worked with standard almond cultivars of Drake, Yaltınski, Cristomorto, Ferragnes, Tuono, Garrigues 112, Nonpariel and 48-5 and reported the number of kernels in 1 onz respectively as 14, 14, 15, 16, 19, 20, 22 and 26.

Present kernel weights and the number of kernels in 1 onz were lower than the values of standard almond cultivars since cultural practices were not implemented on selected genotypes and they were naturally growing over dry and stony lands.

Table 3. Kernel characteristics of selected genotypes.
Çizelge 3. Seçilen genotiplerin iç meyve özellikleri.

Genotype	Kernel weight (g)	Kernel width (mm)	Kernel length (mm)	Kernel height (mm)	Number of kernels in 1 onz	Fruit bulkiness based on number of kernels in 1 onz
HTY-11	0.92±0.04	10.37±0.25	23.37±0.17	8.03±0.69	30.87±0.04	Small
HTY-13	1.01±0.02	11.54±0.03	25.66±0.66	6.75±0.08	28.02±0.02	Medium
HTY-14	0.81±0.04	11.57±0.60	21.04±0.54	7.04±0.08	34.80±0.04	Small
HTY-17	0.70±0.01	11.00±0.16	23.07±0.05	5.36±0.06	40.62±0.01	Small
HTY-25	0.61±0.02	11.62±0.37	19.79±0.35	5.47±0.10	46.39±0.02	Small
HTY-27	0.97±0.01	12.18±0.48	24.35±0.64	6.45±0.48	29.08±0.01	Medium
HTY-28	0.78±0.01	10.02±0.06	20.81±1.60	7.23±0.18	36.28±0.01	Small
HTY-29	0.69±0.04	10.51±0.56	20.11±0.55	6.62±0.08	41.21±0.04	Small
HTY-31	0.86±0.02	12.00±0.39	20.32±0.15	6.85±0.40	33.04±0.02	Small
HTY-34	0.77±0.04	11.76±0.79	20.99±1.47	6.37±0.80	36.59±0.04	Small
HTY-40	0.81±0.03	11.58±0.17	21.03±0.03	7.11±0.09	34.80±0.03	Small
HTY-57	0.89±0.04	12.23±0.28	20.77±0.45	7.42±0.20	31.68±0.04	Small
HTY-60	1.07±0.05	14.36±0.77	24.50±0.52	6.26±0.18	26.37±0.05	Medium
HTY-62	1.24±0.02	14.27±0.65	22.17±0.85	8.07±0.37	22.88±0.02	Large
HTY-64	0.85±0.06	11.53±0.45	21.97±0.71	6.69±0.50	33.29±0.06	Small
HTY-65	1.11±0.05	13.98±0.42	22.80±0.74	7.25±0.24	25.50±0.05	Medium
HTY-66	1.04±0.06	13.65±0.19	22.54±0.59	7.09±0.17	27.12±0.06	Medium
HTY-67	1.29±0.03	15.84±0.44	24.16±1.21	6.37±0.05	21.99±0.03	Large
HTY-68	1.18±0.02	14.02±0.55	25.23±0.31	6.90±0.16	23.98±0.02	Large
Minimum	0.61	10.02	19.79	5.36	21.99	
Maximum	1.29	15.84	25.66	8.07	46.39	
Mean	0.93	12.32	22.35	6.81	31.82	

* HTY: Hatay.

Since kernels constitute the primary edible part of almonds, selection studies mostly focus on kernel ratio which is expressed as the ratio of shelled fruit weight to kernel weight. Usually high kernel ratios are desired in almonds (Yıldırım, 2007). Present kernel ratios varied between 15.99% (HTY-17) and 50.46% (HTY-28) (Table 4). These values were similar with the findings of earlier selection studies carried out in Turkey. For instance, Cangi and Şen (1991) reported kernel ratio of the genotypes selected from Vezirköprü locality as between 18.20 - 30.00%, Balta (2002) carried out a study in Elazığ central and Ağın district and reported kernel ratios as between 12.98 -48.01%, Göksu (2011) in a selection study carried out in Adıyaman province, reported kernel ratios as between 46.67 -52.32%, Köse (2013) reported the kernel ratios of almond genotypes selected from İspir town as between 17.36-26.11%, Bozkurt (2017) reported the kernel ratios of the genotypes selected from Datça peninsula as between 21.76-66.50 %.

Kaşka *et al.* (1998) reported kernel ratios of some local and foreign almond cultivars as between 23.33% (Ferraduel) and 39.50% (Yaltinski); Atlı *et al.* (2005) reported kernel ratios of 20 local and thirteen foreign almond cultivars as between 25.90% (D. Largueta) and 59.10% (17-4). Akçay and Tosun (2005) reported kernel ratios of Ferrastar, Nonpareil, Cristomorto, Tuono, Ferragnes, Picantili, Yaltinski and Garrigues almond cultivars respectively as 33.30, 51.03, 33.85, 35.13, 38.41, 52.00, 47.58 and 33.85%.

Except for HTY-28 genotype, kernel ratios of present almond genotypes were lower than the kernel ratios of standard cultivars. However, present values were still within the normal limits. Generally there is an inverse relationship between shelled fruit weight and kernel ratio and hard-shell almonds have low, but soft-shell ones have high kernel ratios (Gülcan, 1976; Özbek, 1978). Endocarp thickness is greater in hard-shell almonds than in soft-shell ones. In this study, all of the selected promising genotypes had very hard shell structure. Relatively greater kernel ratios are expected from well-cared orchards.

Double kernel ratios of the selected genotypes varied between 0.00 - 16.67% with an average value of 8% andempty fruit ratios varied between 0.00 - 13.33% with an average value of 2.14 % (Table 4). Double kernel ratio is largely a cultivar-specific characteristic, but low temperatures at flowering period may increase double kernel ratios (Asensio *et al.,* 1996; Balta, 2002). Double kernel is not desired commercially, thus the genotypes with low ratios are preferred in practice. In this sense, present genotypes were considered as commercially valuable.

Recent researches have revealed significant effects of almonds on cholesterol levels and cardiovascular diseases. Especially the oil content, fatty acids and protein content play significant roles in human health. Total oil contents of the selected genotypes varied between 44.65% (HTY-40) and 54.56% (HTY-14) and protein contents varied between 19.59% (HTY-27) and 33.79% (HTY-57) (Table 4).

Present oil and protein contents of the genotypes were similar with the findings of earlier studies carried out in Turkey. Balta *et al.* (2001) reported total oil contents of the genotypes selected from Van province as between 48.70-69.90% and protein contents as between 22.20-24.30%, Yıldırım (2007) reported the total oil contents of the genotypes selected from Isparta province as between 44.25-54.68% and protein contents as between 21.23-35.27%, Şimşek and Demirkıran (2010) reported total oil contents of the genotypes selected from Diyarbakır province as between 43.50-54.81% and protein contents as between 21.18- 32.90%, Gülsoy and Balta (2014) reported total oil contents of the genotypes selected from Yenipazar, Bozdoğan and Karacasu towns of Aydın province as between 48.10 - 63.10% and protein contents as between 25.70 – 32.90%.

Similar findings were also reported for standard almond cultivars. For instance, Gradziel *et el.* (2001) worked with almond cultivars of Mission, Ne plus Ultra, Nonpareil, Sonora, Peerless, Carmel and Butte and reported total oil contents respectively as 49.6, 47.6, 43.6, 42.2, 41.6, 44.9 and 50.2%. Ahrens *et al.* (2005) indicated that almond was quite rich in protein, oil, minerals, fiber and vitamin E and reported oil contents of Texas, Nonpareil and Carmel almond cultivars as between 43.37 - 47.50% and protein contents as between 20.68 - 23.30%.

Oil and protein contents of almond genotypes are influenced by cultural practices.Besides, tree age and yield status also influence these attributes. Selected almond genotypes should be grown under the same conditions with the standard cultivars and then compared with them.

Light kernel colors are desired in commercial almond culture. On the other hand, hard shell color is not that much significant, but raise allure of the fruits and largely preferred in exports and imports. With regard to shelled fruit color, 8 genotypes were classified as light, 7 as medium and 4 as dark (Table 5). With regard to kernel color, 6 genotypes were classified as light, 9 as medium and 4 as dark (Table 6). Both shelled fruit and kernel color are significant quality parameters in almonds. Color can change with ripening duration, drying temperature and duration. It is also a hereditary attribute than can change from one genotype to another (Aslantaş, 1993; Ağlar and Balta, 2007). Present promising almond genotypes were mostly classified as medium with regard to both shelled fruit and kernel color. Since Hatay province has sub-tropical climate conditions with quite high temperatures at ripening periods. Thus, fruit colors might have been influenced by those hot temperatures. The subjective observations well complied with color-meter measurements.

Table 4. Kernel ratio and chemical attributes of selected genotypes.
Çizelge 4. Seçilen genotplerin iç meyve oranı ve biyokimyasal özellikleri.

Genotype	Kernel ratio (%)	Double kernel ratio (%)	Empty fruit ratio (%)	Total oil content (%)	Protein content (%)
HTY-11	25.05	16.67	0.00	52.84	24.40
HTY-13	21.27	0.00	0.00	45.31	22.57
HTY-14	20.17	13.33	0.00	54.56	23.97
HTY-17	15.99	6.67	0.00	51.85	24.73
HTY-25	20.44	0.00	13.33	48.42	21.84
HTY-27	23.51	0.00	3.33	45.20	19.59
HTY-28	50.46	3.33	6.67	51.10	24.95
HTY-29	21.43	16.67	3.33	49.27	24.78
HTY-31	21.76	16.67	0.00	50.61	20.51
HTY-34	25.04	0.00	0.00	46.81	25.08
HTY-40	20.31	13.33	3.33	44.65	28.76
HTY-57	24.52	3.33	0.00	51.17	33.79
HTY-60	23.72	0.00	0.00	53.41	28.63
HTY-62	28.80	12.00	4.00	46.75	23.44
HTY-64	24.14	0.00	0.00	50.03	24.71
HTY-65	19.42	6.67	3.33	54.25	22.83
HTY-66	21.07	10.00	0.00	51.18	21.73
HTY-67	20.44	16.67	0.00	49.06	23.73
HTY-68	20.84	16.67	3.33	45.27	27.80
Minimum	15.99	0.00	0.00	44.65	19.59
Maximum	50.46	16.67	13.33	54.56	33.79
Mean	23.60	8.00	2.14	49.57	24.62

* HTY: Hatay.

Table 5. Shelled fruit color characteristics of the selected genotypes.
Çizelge 5. Seçilen genotiplerin kabuklu meyve renk özellikleri.

Genotype	Shelled fruit color					
	Subjective Observation	L	a*	b*	*C*	*h°*
HTY-11	Light	67.99±1.08	8.52±0.23	24.74±0.60	26.18±057	70.96±0.67
HTY-13	Medium	60.86±0.39	9.02±0.07	28.34±0.21	29.75±0.22	72.34±0.03
HTY-14	Dark	58.49±0.65	9.85±0.18	29.78±0.53	31.37±0.54	71.69±0.25
HTY-17	Medium	62.39±0.75	7.74±0.07	24.32±0.24	25.53±0.23	72.34±0.24
HTY-25	Light	64.79±0.34	9.70±0.10	29.31±0.09	30.87±0.11	71.65±0.15
HTY-27	Light	63.99±0.53	7.98±0.17	27.29±0.24	28.45±0.26	73.65±0.23
HTY-28	Light	66.89±1.02	9.38±0.13	32.36±0.31	33.71±0.26	73.80±0.37
HTY-29	Light	64.10±0.85	8.46±0.09	25.71±0.26	27.08±0.25	71.77±0.23
HTY-31	Medium	63.95±0.47	8.58±0.97	27.91±1.18	29.22±1.42	72.90±1.10
HTY-34	Light	61.62±0.71	9.57±0.05	26.44±0.51	28.13±0.47	70.01±0.43
HTY-40	Medium	61.66±0.39	8.60±0.07	27.51±0.42	28.84±0.38	72.60±0.41
HTY-57	Light	63.04±0.80	9.83±0.27	26.64±0.44	28.40±0.50	69.74±0.21
HTY-60	Dark	56.33±0.80	10.79±0.17	29.28±0.19	31.22±0.12	69.73±0.42
HTY-62	Medium	65.01±1.11	9.02±0.23	26.65±0.51	28.14±0.48	71.26±0.59
HTY-64	Dark	56.01±1.39	10.71±0.26	29.92±0.80	31.79±0.84	69.12±2.05
HTY-65	Light	61.78±0.58	9.10±0.04	23.85±0.45	25.53±0.41	69.07±0.39
HTY-66	Medium	62.69±1.23	8.75±0.15	22.79±0.59	24.42±0.60	68.98±0.29
HTY-67	Medium	56.85±0.26	9.44±0.07	25.93±0.34	27.60±0.31	69.96±0.30
HTY-68	Dark	58.47±0.16	9.76±0.14	27.33±0.21	29.03±0.23	70.29±0.21
Minimum		56.01	7.74	22.79	24.42	68.98
Maximum		67.99	10.79	32.36	33.71	73.80
Mean		61.95	9.20	27.16	28.70	71.15

* HTY: Hatay.

Table 6. Kernel color characteristics of the selected genotypes.
Çizelge 6. Seçilen genotiplerin iç meyve renk özellikleri.

Genotype	Kernel color					
	Subjective observation	**L**	**a***	**b***	***C***	***h°***
HTY-11	Medium	44.61±0.46	14.88±0.21	30.96±2.66	34.45±2.50	63.64±1.04
HTY-13	Medium	45.03±0.21	16.15±0.75	33.63±0.70	37.56±0.48	63.88±1.09
HTY-14	Light	52.87±0.52	13.33±0.29	35.56±0.63	37.98±0.66	69.44±0.34
HTY-17	Light	49.06±0.62	15.87±0.09	36.35±0.62	39.67±0.53	66.39±0.93
HTY-25	Light	49.09±0.82	16.16±0.17	34.70±1.08	38.31±0.95	64.82±1.06
HTY-27	Light	52.01±0.48	14.19±0.15	36.93±3.60	39.69±3.40	68.07±0.80
HTY-28	Light	42.16±0.28	18.38±0.55	33.86±0.85	38.53±0.86	61.48±1.11
HTY-29	Medium	46.31±0.95	12.81±0.68	31.76±1.56	34.29±1.45	67.83±0.51
HTY-31	Medium	41.94±0.40	16.44±0.14	31.41±1.20	35.47±1.03	62.22±0.29
HTY-34	Medium	38.71±0.39	16.07±0.46	27.86±4.48	32.32±4.09	59.04±4.98
HTY-40	Medium	40.19±0.85	16.17±0.62	26.82±0.73	31.38±0.34	58.82±0.75
HTY-57	Medium	44.16±0.53	16.50±0.40	30.44±0.86	34.63±0.93	61.51±0.82
HTY-60	Dark	41.45±1.04	14.45±0.35	28.44±2.13	32.14±1.81	61.26±1.19
HTY-62	Dark	49.18±0.71	16.01±0.22	33.01±2.74	36.79±2.66	63.47±0.66
HTY-64	Light	41.74±0.34	17.17±0.67	32.32±0.57	36.61±0.72	61.97±0.20
HTY-65	Medium	46.18±1.28	16.01±0.16	33.30±0.06	36.96±0.13	64.28±0.64
HTY-66	Dark	45.90±0.32	15.97±0.18	35.65±1.11	39.12±0.98	65.57±0.70
HTY-67	Medium	50.11±1.01	15.58±0.34	31.58±1.39	35.23±1.37	63.64±0.83
HTY-68	Dark	42.09±2.24	19.38±7.51	30.16±6.93	41.99±7.92	65.12±0.50
Minimum		38.71	12.81	26.82	31.38	58.82
Maximum		52.87	19.38	36.93	41.99	69.44
Mean		45.41	15.87	32.35	36.48	63.81

* HTY: Hatay.

CONCLUSION

This study was conducted with almond genotypes selected from natural populations of Hatay province and present findings revealed that selected genotypes had a broad variation in fruit characteristics. Selected promising genotypes (19 genotypes) did not have smaller values for fruit quality attributes than both the standard cultivars and the genotypes selected in earlier breeding studies. A comparative adaptation study is recommended to be carried out with the present genotypes, standard cultivars and the genotypes selected from different regions. Such a study may have great contributions to both regional and national almond culture.

ACKNOWLEDGMENT

This study is a part of first author' Master Science theses, and it was supported by Scientific Research Projects Department of Hatay Mustafa Kemal University (with the project number of 1104 Y 0101).

REFERENCES

Ağlar, E. (2005). *Pertek (Tunceli) yöresi bademlerinin (Prunus amygdalus L.) seleksiyonu.* Yüksek LisansTezi, Yüzüncü Yıl Üniversitesi, Fen Bilimleri Enstitüsü, Van.

Ağlar, E., & Balta, F. (2007). *Pertek (Tunceli) Yöresi Badem Seleksiyonu*. V. Ulusal Bahçe Bitkileri Kongresi, Erzurum.

Ahrens, S., Venkatachalam, M., Mistry, A. M., Lapsley, K., & Sahte, S. K. (2005). Almond (*Prunus dulcis* L.) protein quality. *Plant Foods for Human Nutrition, 60,* 123-128.

Akçay, M. E., & Tosun, İ. (2005). Bazı geç çiçek açan yabancı badem çeşitlerinin Yalova ekolojik koşullarındaki gelişme ve verim davranışları. *Atatürk Üniversitesi Ziraat Fakültesi Dergisi, 36*(1), 1-5.

Akyüz, N., & Kaya, G. (1992). *Gıda Kimyası Laboratuarı.* Yüzüncü Yıl Üniversitesi Fen-Edebiyat Fakültesi, Yayın No: 2, Van.

Asensio, M. C., Socıas, I., & Company, R. (1996). Double kernel in almond. *An Open Question, Nucis, 5,* 8-9.

Aslantaş, R. (1993). *Erzincan ili Kemaliye ilçesinde doğal olarak yetişen bademlerin (Amygdalus communis l.) seleksiyon yoluyla ıslahı üzerinde bir araştırma.* Yüksek Lisans Tezi, Atatürk Üniversitesi, Fen Bilimleri Enstitüsü, Erzurum.

Atlı, H.S., Açar, İ., Arpacı, S., Akgün, A., Aydın, Y., & Bilim, C. (2005). *Yerli ve yabancı değişik badem çeşitlerinin Gap bölgesi sulu koşullarında gelişme, meyveye yatma, verim ve bazı kalite değerlerinin karşılaştırılması.* Gap IV. Tarım Kongresi, Şanlıurfa.

Balta, F., Yarılgaç, T., & Balta, F. (2001). Fruit characterstics of native almond selections from the lake Van region (Eastern Anatolia, Turkey). *Journal American Pomological Society, 55*(1), 58-61.

Balta, M. F. (2002). *Elazığ merkez ve Ağın ilçesi bademlerinin (Prunus amygdalus L.) seleksiyon yoluyla ıslahı üzerinde araştırmalar*. (MSc), Yüzüncü Yıl Üniversitesi, Fen Bilimleri Enstitüsü , Van.

Beyhan, Ö., & Bostan, S. Z. (1995). Darende bademlerinin seleksiyon yoluyla ıslahı üzerine bir araştırma. *Yüzüncü Yıl Üniversitesi Ziraat Fakültesi Dergisi, 5*(1), 91-100.

Bostan, S. Z., Cangi, R., & Oğuz, H. İ. (1995). *Akdamar adası bademlerinin (Prunus amygdalus L.) seleksiyon yoluyla ıslahı üzerine araştırmalar.* Türkiye II. Ulusal Bahçe Bitkileri Kongresi, Adana.

Bozkurt, T. (2017). *Datça (Muğla) ilçesinde doğal olarak yetişen bademlerin (Amygdalus communis l.) seleksiyonu.* Yüksek LisansTezi, Atatürk Üniversitesi, Fen Bilimleri Üniversitesi, Erzurum.

Cangi, R., & Şen, S. M. (1991). Vezirköprü ve çevresinde yetiştirilen bademlerin seleksiyon yoluyla ıslahı üzerine araştırmalar. *Yüzüncü Yıl Üniversitesi Ziraat Fakültesi Dergisi, 1,* 131-152.

Dicenta, F., Egea, J., & Berenguer, T. (1999). *Five years of observations of the grempa almond collection in cebascsıc, (Murcia, Spain).* XI. Grempa Meeting On Pistacios And Almonds, University of Harran, Faculty Of Agriculture-Pistacio Research And Application Center, Şanlıurfa, Turkey.

Dokuzoğuz, M., Gülcan, R., & Atila, A. (1968). *Ege Bölgesi Bademlerinin Seleksiyon Yoluyla Islahı Üzerinde Araştırmalar*. Ege Üniversitesi Ziraat Fakültesi Yayınları No:148, İzmir.

Dokuzoğuz, M., & Gülcan, R. (1973). E*ge Bölgesi Bademlerinin Seleksiyon Yoluyla Islahı Ve Seçilmiş Tiplerin Adaptasyonu Üzerinde Araştırmalar*. Tübitak, Toag Yayınları No:22, Ankara.

Gerçekcioğlu, R., & Güneş, M. (1999). *A Research on Improvement of Almond (Amygdalus communis L.) by Selection of Wild Plants Grown in Tokat Central District.* XI. Grempa Meeting on Pistacios and Almonds, University of Harran, Faculty of Agriculture-Pistacio Research and Application Center, Şanlıurfa, Turkey.

Gradziel, T. M., Martinez-Gomez, P., Dicenta, F., & Kester, D. E. (2001). The utilization of related prunus species for almond variety improvement. *Journal American Pomological Society, 55*(2), 100-108.

Gülcan, R. (1976). *Seçilmiş Badem Tipleri Üzerinde Fizyolojik ve Morfolojik Araştırmalar*. Ege Üniversitesi Ziraat Fakültesi Yayınları No: 310, Izmir.

Göksu, A. (2011). *Adıyaman merkez ilçe bademlerinin (Prunus Amygdalus L.) seleksiyonu* Yüksek LisansTezi, Gaziosmanpaşa Üniversitesi, Fen Bilimleri Enstitüsü, Tokat.

Gülsoy, E., & Balta, F. (2014). *Aydın ili Yenipazar, Bozdoğan ve Karacasu ilçelerinden selekte edilen badem (Prunus amygdalus Batch)* genotiplerinin protein, yağ ve yağ asidi bileşimlerinin belirlenmesi. *Iğdır Üniversitesi Fen Bilimleri Enstitüsü Dergisi, 4*(1), 9-14.

Kaçar, B. (1984). *Bitki Besleme ve Uygulama Kılavuzu.* Ankara.

Kalyoncu, I.H. (1990). *Konya Apa baraj gölü çevresinde yetiştirilen üstün özellikli badem (prunus amygdalusl.) tiplerinin belirlenmesi üzerine bir seleksiyon çalişmasi.* Yüksek LisansTezi, Ondokuz Mayıs Üniversitesi, Fen Bilimleri Enstitüsü, Samsun.

Karadeniz, T., Balta, F., Cangi, R., & Yarılgaç, T. (1996). *Adır Adası (Vangölü) bademlerinin (Amygdalus communis L.) seleksiyon yoluyla ıslahı.* I. Fındık ve Diğer Sert Kabuklu Meyveler Sempozyumu, Ondokuz Mayıs Üniversitesi, Samsun.

Karadeniz, T., & Erman, P. (1996). *Siirt'te yetiştirilen bademlerin (Amygdalus communis L.) seleksiyonu.* I. Fındık ve Diğer Kabuklu Meyveler Sempozyumu, Ondokuz Mayıs Üniversitesi, Samsun.

Kaşka, N., Küden, A. B., & Küden, A. (1998). *Performances of some local and foreign almond cultivars in South East Anatolia.* Advanced Course. Production And Economics of Nut Corps. Adana.

Köse, M. (2013). *Erzurum ili İspir ilçesinde doğal olarak yetişen badem (amygdalus communis l.) tiplerinin seleksiyon yolu ile ıslahı ve seçilen tiplerde rapd yöntemiyle genetik çeşitliliğin belirlenmesi*. Yüksek LisansTezi, Atatürk Üniversitesi, Fen Bilimleri Enstitüsü, Erzurum.

Noronha Vaz, M.T. (1996). Recent Portuguese development in the nut sector. *Ciheam- Iamz. FAO*, Zaragoza, Spain.

Özbek, S. (1978). *Özel Meyvecilik*. Çukurova Üniversitesi Ziraat Fakültesi Yayınları: 128, Adana.

Soylu, A. (2003). *Ilıman iklim meyveleri.* II. Uludağ Üniversitesi Ziraat Fakültesi Ders Notları, No:72, Bursa.

Şimşek, M. (1996). *Kahramanmaraş merkez ilçesi ve bağlı köylerinde badem (Amygdalus communis L.) seleksiyon yoluyla ıslahı üzerine bir araştırma.* Yüksek LisansTezi, Kahramanmaraş Sütçü İmam Üniversitesi, Fen Bilimleri Enstitüsü, Kahramanmaraş.

Şimşek, M., & Demirkıran, A. (2010). Determination of superior almond genotypes in Diyarbakır central districts. *Agricultral Journal, 5*(3)*,* 173-180.

Tosun, İ. (2002). *Badem Yetiştiriciliği.* Atatürk Bahçe Kültürleri Merkez Araştırma Enstitüsü Yalova.

UPOV 2011. International Union For The Protection of New Varieties of Plants. TG/56/4, Almond.

Vargas, F. J. (1998). *Almond: Choice and Breeding of Varieties.* Advanced Course Production and Economics of Nut Crops, Adana (Turkey).

Yeşilkaynak, B. (2000). *Değişik kökenli badem çeşitlerinin Kahramanmaraş ekolojik koşullarında büyüme, gelişme ve meyve verme durumlarının saptanması üzerine bir araştırma.* Yüksek LisansTezi, Kahramanmaraş Sütçü İmam Üniversitesi, Fen Bilimleri Enstitüsü, Kahramanmaraş.

Yıldırım, A. (2007). *Isparta yöresi bademlerinin (Prunus amygdalus L.) seleksiyonu.* Yüksek LisansTezi, Adnan Menderes Üniversitesi, Fen Bilimleri Enstitüsü, Isparta.

Yıldırım, A. N., Tekintaş, E., & Koyuncu, F. (2007). Isparta bölgesinde geç çiçeklenen ve üstün nitelikli meyve veren badem (*Prunus Amygdalus* Batsch.) genotiplerinin seleksiyonu. *Adnan Menderes Üniversitesi Ziraat Fakültesi Dergisi, 4*(1-2)*,* 39 – 48.

Zerbini, E., & Polesollo, A. (1984). Measuring the color of apple skin by two diffirent techniques. *Proceeding of the Workshop on Pome-Fruit Quality, 1,* 161-171.