Araştırma Makalesi
(Research Article)

Ege Üniv. Ziraat Fak. Derg., 2014, 51 (2): 191-199
ISSN 1018 – 8851

Burçak İŞÇİ[1]
Fatih ŞEN[1]
Aylin GÜÇLÜ ÖZDEMİR[2]
Ege KAÇAR[1]
Aşkın ALTUN[1]

[1] Ege University, Faculty of Agriculture, Department of Horticulture,İzmir/Türkiye
e-posta:burçak.isci@ege.edu.tr

[2] MSc, Atatürk Soil, Water and Agricultural Meteorology Research Station, Kırklareli/Türkiye

Effects of Modified Atmosphere Packing (MAP) and Cold Treatment on Organically Grown Table Grape Cultivars

Soğuk ve Modifiye Atmosferli Paketleme (MAP) Koşullarının Organik Yetiştirilen Sofralık Üzüm Çeşitlerine Etkileri

Alınış (Received):10.09.2013 Kabul tarihi (Accepted): 15.05.2014

Key Words:

Turkish grape varieties, organic agriculture, storage, modified atmosphere packaging (MAP), quality, total phenolic content

ABSTRACT

This study was conducted to determine changes in storage of organically grown table grape cultivars; *Vitis vinifera* L. cv. Buca Razakı, *Vitis vinifera* L. cv. Çeşme Pembesi, *Vitis vinifera* L. cv. Siyah Gemre, *Vitis vinifera* L. cv. Kırmızı Şam, and *Vitis vinifera* L. cv. Pek Üzümü. Each cultivar was harvested at optimum time and pre-cooled at 0°C for 24 hours. Samples in MAP were placed in plastic cases and kept at -0.5°C and 90% relative humidity (RH) for 60 days. Quality changes that took place throughout the storage period were assessed at 15- days intervals through weight loss, stem browning, fruit removal force, berry surface color (CIE L*, a*, b*), total soluble solids content, titratable acidity, sensory properties, and total phenolic content. Due to the increase in decayed berries and adverse effects on the quality, all tested cultivars could be stored successfully for 30 days. Distinctive levels of stem browning in all varieties except *Vitis vinifera* L. cv. Çeşme Pembesi on the 60th day of storage are effective in limiting the marketability of these grapes. MAP technology could be proven as an economical application for organic grapes. MAP was aimed to investigate as an alternative mean for chemical based treatment such as SO_2.

Anahtar Sözcükler:

Türk üzüm çeşitleri, organic tarım, depolama, modifiye atmosferpaket (MAP), kalite, toplam fenol içeriği

ÖZET

Bu çalışma, organik olarak yetiştirilen sofralık üzüm çeşitleri; *Vitis vinifera* L. cv. Buca Razakı, *Vitis vinifera* L. cv. Çeşme Pembesi, *Vitis vinifera* L. cv. Siyah Gemre, *Vitis vinifera* L. cv. Kırmızı Şam, and *Vitis vinifera* L. cv. Pek Üzümü'nün. depolamadaki değişikliklerini belirlemek amacıyla yapılmıştır. Her bir çeşit optimum zaman hasat edilmiştir ve 24 saat için 0°C'de ön soğutulmuştur. Örnekler modifiye atmosferli paketler içine (MAP) konulup, plastik kasalar içinde -0.5°C ve % 90 bağıl nem (RH)'de 60 gün için muhafaza edildi. Depolama süresi boyunca 15 günde bir gerçekleşen kilo kaybı, salkım iskeleti kararması, meyve sapı kopma kuvveti, tane yüzey rengi (*, a *, b * CIE L), toplam suda çözünebilir kuru madde içeriği, titre edilebilir asit, duyusal özellikleri ve toplam fenolik madde içeriği değişimi değerlendirildi. Test edilen tüm çeşitler tanelerin çürümesi ve kalite üzerine ters etkisindeki artış nedeniyle 30 gün boyunca başarılı bir şekilde saklanabildi. *Vitis vinifera* L. cv. Çeşme Pembesi hariç tüm çeşitlerin salkım kararmasındaki ayırt edici seviyesi bu çeşitlerin pazarlanabilmede 60 günde sınırlayıcı etkilidir. MAP teknolojisi organik üzüm için ekonomik bir uygulama olarak kanıtlanmıştır. MAP SO_2 gibi kimyasal temelli uygulamalara alternatif bir araç olarak araştırılmak için amaçlanmıştır.

INTRODUCTION

Grape is one of the most widely produced fruit crops of the world and, Turkey in which grape is also used for producing raisins, wine, juice, juice concentrate, jams and marmalades is the center of the origin of grapevines and posses the oldest grape-growing culture. Turkey has advantages in viniculture compared to many other countries due to its ecologic condition and geographic location in the world.

Grape is considered as a natural source of antioxidants due its high phenolic and anthocyanin contents. Due to its positive impact on human health with high antioxidant content and its rich nutrition capacity receive attention with an increasing tendency each year (Ames et al., 1993; Macheix et al., 1990). Grape which cannot preserve its quality under normal room conditions can be stored for longer periods under low temperatures and high relative humidity conditions since quality loss is slowed down. Storing fresh grape fruit at proper storage conditions will prevent shrinkage, slow down water loss and respiration, and prevent decaying and help to maintain its nutritional value (Ağaoğlu, 1986).

In storage, deterioration occurs in the form of weight loss stem browning, softening, shattering and decaying (Crisoto and Mitchell 2002; Perkins-Veazie et al., 1992). Today, the postharvest quality losses which adversely affect grape quality are tried to be prevented by various chemical applications in pre and postharvest periods. However, the possible harmful residues of these chemicals and/or ban or limitations in organic production have channeled researches to develop safer alternative control methods (Wilson et al., 1994; Nigro et al., 1998) among which moisturizing the storage environment and the use of modified atmosphere (MA) storage techniques can be cited (Carlos et al., 1991).

The performance grapes produced according to the rules and regulations of organic agriculture in storage may be affected by varieties, ecological conditions at pre-harvest and harvest stages, cultural practices, harvest maturity, pre-cooling and temperature and relative humidity at storage. In this study, quality of organically grown *Vitis vinifera* L. cv. Buca Razakı, *Vitis vinifera* L. cv. Çeşme Pembesi, *Vitis vinifera* L. cv. Siyah Gemre, *Vitis vinifera* L. cv. Pek Üzümü, and *Vitis vinifera* L. cv. Kırmızı Şam grape varieties during storage was studied in order to allow an optimum marketing period.

MATERIALS and METHODS

Plant Material and Growth Conditions

The study was implemented at Ege University, Faculty of Agriculture, Horticulture Department. Five *Vitis vinifera* L genotypes were chosen: a white grapes *Vitis vinifera* L. cv. Buca Razakı (BR), and *Vitis vinifera* L. cv. Pek Üzümü (PÜ); a red grapes *Vitis vinifera* L. cv. Çeşme Pembesi (ÇP), *Vitis vinifera* L. cv. Siyah Gemre (SG), and *Vitis vinifera* L. cv. Kırmızı Şam (KŞ) produced organically. Organic methods and inputs allowed in Turkish and EU regulations were applied in soil fertility and pest and disease management (TR 5262; EC 882/2004).

Sampling and Storage Conditions

BR, ÇP, SG, PÜ, KŞ varieties were harvested at 19.08.2010, 01.09.2010, 07.09.2010, 07.09.2010, 07.09.2010, respectively. All grape varieties put in MA packages in weights of 5 kg per package which were placed in 30x40x15 cm cases.

Modified atmosphere packaging (MAP used was manufactured by StePac Company, Israel and vapor permeability of 2203 cm^3/m^2.day. atm at 23 °C). MAP packages used in this study were passive type (commodity-generated) in terms of air conditioning inside the packages.

The grape cases containing the open MA packages were exposed to pre-cooling with air (-0.5°C, 95% RH) for 24 hours to reduce the temperature to storage temperatures. Later, MA packages were closed with clips and grapes were conserved for 2 months at -0.5°C and 90-95% relative humidity (Kader, 2002; Karaçalı, 2009).

Grapes were taken out of cold storage rooms after the harvest and at the 15th, 30th, 45th, and 60th days of storing periods to be analyzed.

The study was planned to have 4 replications based on the Coincidence Plots Experiment Design and each case was accepted as a replication.

Quality Attributes

Weight loss was determined by weighing the clusters before and at the 15th, 30th, 45th and 60th days of the storage and calculating the loss as % of the initial weight.

Berry removal force was measured with a penetrometer (Somyf tec, France) on 30 berries taken from different bunches. Results are given as Newton (N).

The external berry color was measured at the equatorial area of each side of 30 berries using a colorimeter (CR-300, Minolta Co, Osaka, Japan), Average scores were recorded in terms of CIE-L* a* b* values. The colorimeter had an 8 mm diameter viewing area and was calibrated with a white tile (L*=97.26, a*=+0.13, b*=+1.71).

The total soluble solids (TSS) content in the juice was determined with a digital refractometer (PR-1, Atago, Tokyo, Japan) and expressed as percentage. Titratable acidity was measured by titration with 0.1 N NaOH to pH 8.1, the results expressed as g tartaric acid/100 mL fruit juice (Karaçalı, 2009).

Sensory analyses

The decay incidence in clusters and the distribution of decay were determined according to Anonymous (1996). The stem browning of the clusters was assessed visually using a 0-5 scale: the scores were 0, 1, 2, 3, 4, and 5 for stem browning being <10%, 10–30%, 30–50%, 50–70%, 70–90%, and >90%, respectively (Chervin et al., 2005).

Total Phenolic Content

Total phenolic content was measured in methanol extract of fruit prepared as recommended in Swain and Hillis (1959) and Waterman and Mole (1994) with an incubation period of 120 min to have better color development. Total phenolic content was determined by Folin-Ciocalteu method. The absorbance was measured at 725 nm using a spectrophotometer (Varian 100 Bio, Australia), and results were expressed as mg gallic acid equivalent (GAE)/100 g fresh weight (FW) using a gallic acid (0-0.1 mg/ml) standard curve.

Statistical Analysis

The study was designed as 4 replications based on the Coincidence Plots Experiment Design and each plastic case was accepted as a replication. The performance of each variety was evaluated during storage separately. The data were subjected to analysis of variance by IBM® SPSS® Statistics 19 statistical software (IBM, NY, USA) and differences between means at each sampling date were determined by Duncan's multiple range test ($p \leq 0.05$).

RESULTS

Quality attributes

Weight loss rates were significant and displayed a constant increase rate in *Vitis vinifera* L. cv. Çeşme Pembesi, *Vitis vinifera* L. cv. Siyah Gemre and *Vitis vinifera* L. cv. Kırmızı Şam varieties during the storage. Weight loss was calculated as 2.07% for *Vitis vinifera* L. cv. Çeşme Pembesi (the lowest) and 4.14% for Siyah Gemre (the highest) at the end of 60 days (Figure 1).

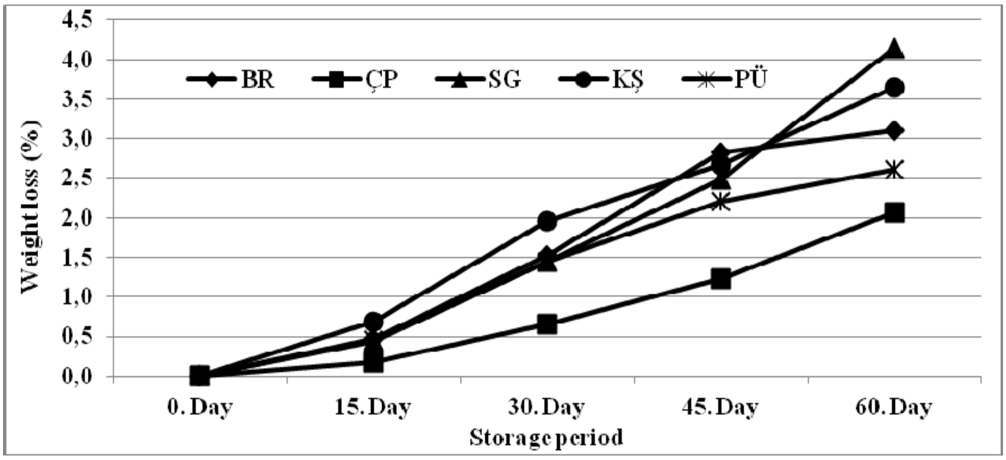

Figure 1. Weight loss in different grape varieties during storage

Effect of storage periods on berry removal force was not statistically significant. During the 60-days of storage, berry removal force ranged between 3.8-4.3 N in *Vitis vinifera* L. cv. Buca Razakı, 3.3-3.9 N in *Vitis vinifera* L. cv. Çeşme Pembesi, 3.6-4.1 N in *Vitis vinifera* L. cv. Siyah Gemre, 3.6-4.0 N in *Vitis vinifera* L. cv. Kırmızı Şam and 2.9-3.6 N in *Vitis vinifera* L. cv. Pek Üzümü (Table 1).

Table 1 .Effects of storage period on berry removal force (N) of different grape varieties

Storage period (days)	BR	ÇP	SG	KŞ	PÜ
0	4.3	3.8	3.9	3.8	3.4
15	4.5	3.9	4.2	3.7	3.4
30	3.9	3.5	4.1	4.0	3.6
45	3.8	3.7	3.6	3.6	2.9
60		3.3			
Time	NS	NS	NS	NS	NS

NS, *, Nonsignificant

Effect of storage period on L* color value of berry was found significant for *Vitis vinifera* L. cv. Buca Razakı and *Vitis vinifera* L. cv. Çeşme Pembesi (P≤0.05) whereas the variations were nt statistically significant in other varieties. The L* color value decreased constantly with the increase in storage period. There was a decrease in L* color value of *Vitis vinifera* L. cv. Çeşme Pembesi on the 30th day of storage, whereas the changes were insignificant during the subsequent periods (Table 2).

Table 2. Effects of the storage period on L* color values of different grape varieties

Storage period (days)	BR	ÇP	SG	KŞ	PÜ
0	46.02 a^z	47.88 a	40.60	43.95	50.69
15	45.09 a	47.01 a	38.47	39.04	48.89
30	43.38 b	41.64 b	41.64	41.25	47.82
45	40.52 c	41.80 b	40.87	43.16	49.06
60		44.18 b			
Time	*	*	NS	NS	NS

^{z} Means separation within columns by LSD test, *P*≤0.05, LSD: 2.86.
NS, *, Nonsignificant or significant at *P* ≤0.05.

Increases in a* color value during the storage period were significant (at % level) in tested varieties except *Vitis vinifera* L. cv. Kırmızı Şam even if the significantly different periods varied according to the varieties. In *Vitis vinifera* L. cv. Çeşme Pembesi and *Vitis vinifera* L. cv. Pek Üzümü varieties, a* color value increased on the 30th day, in *Vitis vinifera* L. cv. Buca Razakı on the 45th day, in *Vitis vinifera* L. cv. Siyah Gemre for the 15th day and the changes in the subsequent storage periods were found to be insignificant (Table 3).

Table 3. Effects of storage period on a* color values of different grape varieties

Storage period (days)	BR	ÇP	SG	KŞ	PÜ
0	-6.47 b^z	-4.20 b	4.76 b	5.13	-7.03 b
15	-5.58 b	-3.91 b	8.78 a	5.93	-7.36 b
30	-5.66 b	-0.24 a	7.57 a	5.17	-2.33 a
45	-1.40 a	0.87 a	7.11 a	5.15	-3.73 a
60		1.05 a			
Time	*	*	NS	NS	*

^{z} Means separation within columns by LSD test, *P*≤0.05, LSD: 3.04.
NS, *, Nonsignificant or significant at *P* ≤0.05.

Significant changes were observed in berry b* color value (excluding the *Vitis vinifera* L. cv. Buca Razakı variety) during the course of storage. Increases in b* color value in *Vitis vinifera* L. cv. Çeşme Pembesi, *Vitis vinifera* L. cv. Siyah Gemre, *Vitis vinifera* L. cv. Kırmızı Şam and *Vitis vinifera* L. cv. Pek Üzüm varieties were distinctive when storage period was terminated (60th day for *Vitis vinifera* L. cv. Çeşme Pembesi and 45th days for *Vitis vinifera* L. cv. Siyah Gemre, *Vitis vinifera* L. cv. Kırmızı Şam and *Vitis vinifera* L. cv. Pek Üzüm, respectively) and varied between 22% and 82% during the last 15 days of storage (Table 4).

Table 4 . Effects of storage period on b* color values of different grape varieties

Storage period (days)	BR	ÇP	SG	KŞ	PÜ
0	14.30	10.33 bz	7.06 b	8.64 b	15.31 b
15	14.89	11.89 b	6.48 b	8.74 b	15.23 b
30	12.48	12.78 b	7.65 b	8.08 b	16.61 b
45	12.91	11.72 b	11.71 a	14.69 a	20.31 a
60		16.99 a			
Time	NS	*	**	**	*

^{z} Means separation within columns by LSD test, *P*≤0.05, LSD: 3.7.
NS, *, ** Nonsignificant or significant at *P* ≤0.05, or *P* ≤0.01, respectively.

Effects of storage period on TSS contents were not significant. The average TSS contents varied according to the grape variety and the initial TTS contents were calculated as 17.9% in *Vitis vinifera* L. cv. Buca Razakı whereas 13.3% in *Vitis vinifera* L. cv. Kırmızı Şam (Table 5).

Changes in TA content during the storage was found to be significant only in *Vitis vinifera* L. cv. Buca Razakı variety (P≤ 0.01). A decrease of 28% in TA content on the 30th day of storage was significant in *Vitis vinifera* L. cv. Buca Razakı grape variety. TA contents were determined as 0.42, 0.43, 0.32, 0.31 g tartaric acid/100 ml for *Vitis vinifera* L. cv. Pembe Gemre, *Vitis vinifera* L. cv. Siyah Gemre, *Vitis vinifera* L. cv. Kırmızı Şam and *Vitis vinifera* L. cv. Pek Üzümü varieties respectively (Table 6).

Table 5. Effects of storage period on TSS content (%) in different grape varieties

Storage period (days)	BR	ÇP	SG	KŞ	PÜ
0	17.9	17.4	16.3	13.3	16.0
15	18.3	17.5	15.8	13.1	16.6
30	18.0	16.3	15.6	13.4	16.6
45	19.5	15.7	16.1	13.4	15.3
60		15.8			
Time	NS	NS	NS	NS	NS

NS, Nonsignificant

Table 6. Effect of storage period on titratable acidity content (mg tartaric acid/100 grape juice) in different grape varieties

Storage period (days)	BR	ÇP	SG	KŞ	PÜ
0	0.55 a	0.42	0.42	0.31	0.33
15	0.58 a	0.41	0.43	0.31	0.33
30	0.42 b	0.43	0.43	0.33	0.32
45	0.34 b	0.44	0.45	0.33	0.28
60		0.39			
Time	**	NS	NS	NS	NS

z Means separation within columns by LSD test, *P*≤0.05, LSD: 0.13.
NS, **, Nonsignificant or significant at *P* ≤0.01.

Sensory Analyses

In the study, *Vitis vinifera* L. cv. Çeşme Pembesi grape variety performed the best during the 60 days storage period with no decay development, however, the average decay levels in *Vitis vinifera* L. cv. Buca Razakı, *Vitis vinifera* L. cv. Siyah Gemre, *Vitis vinifera* L. cv. Pek Üzümü and *Vitis vinifera* L. cv. Kırmızı Şam grapes on the 60th day of storage were high (spotted or decayed up to 20-60 % of the bunch). The dacay agent was identified as *Botrytis* cinerea, a major fungus in grapes. Since these grapes lost their marketing properties, no further analyses were carried out.

Effects of storage period on stem browning were significant (P≤0.05) in all tested grape varieties. All varieties except *Vitis vinifera* L. cv. Çeşme Pembesi reached to the highest browning value at the end of 60 days of storage (5.0). On the other hand, 60th day of storage *Vitis vinifera* L. cv. Çeşme Pembesi variety had a score of 1.0 for stem browning revealing very levels (10-30 %) of stem browning in the bunch (Table 7).

Effects of storage period on the phenoliccontent of the Turkish organically grown table grapes were not significant (Table 8).

Table 7. Effect of storage period on stem browning scores (1 to 5 scale) of different grape varieties

Storage period (days)	BR	ÇP	SG	KŞ	PÜ
0	0.0 cz	0.0 b	0.0 c	0.0 c	0.0 c
15	2.8 b	0.3 b	2.3 b	0.70 c	0.8 c
30	3.0 b	0.3 b	1.8 bc	2.50 b	1.0 bc
45	3.5 b	0.3 b	2.5 b	0.5 c	2.0 b
60	5.0 a	1.0 a	5.0 a	5.0 a	5.0 a
Time	*	*	*	*	*

z Means separation within columns by LSD test, *P*≤0.05, LSD: 1.5.
* Significant at *P* ≤0.05.

Table 8. Effect of storage period on total phenol content (mg GAE/100 g FW) of different grape varieties

Storage period (days)	BR	ÇP	SG	KŞ	PÜ
0	64.04	68.03	64.22	60.58	68.87
15	63.99	63.27	62.90	64.08	67.57
30	70.30	62.06	65.79	60.51	63.64
45	67.14	67.30	67.37	56.28	65.78
60		60.12			
Time	NS	NS	NS	NS	NS

NS, Nonsignificant

DISCUSSION

Grape that it should be harvested only when the berries are fully ripened on the vine itself is a non-climacteric fruit. The optimum stage for harvesting of grape bunches is indicated by the characteristic colour of fruits, variety, change in colour of bunch stalk from green to yellow or brown, aroma/flavour, softening of berries, sweetness of pulp and thickening of juice.

Worldwide studies in postharvest extension of table grapes still rely on the methodology based on sulphur dioxide (SO_2) applications. The use of SO_2 which storaged grapes is dangerous to people allergic to sulphites. Thus present interest focuses on the use of healthy materials with simple, sustainable technology and organically growing. Many studies on SO_2 replacement were conducted on various cultivars using tools such as hot water (Fallik, 2004), modified atmosphere packaging, controlled atmosphere (Eris et al., 2000), ethanol (Lichter et al., 2002), chlorine dioxide (Ahvenainen, 1996; Soliva-Fortuny and Belloso, 2003), carbonate/ bicarbonate salts, pulsated ultraviolet, ozone, and chitosan (a natural polysaccharide) (Xu et al., 2007).

One of the most important factors that limit storage of table grapes is the loss of water through the lenticels at the stems of the harvested grapes (Zoffoli et al., 2009). During the 45 days of storage, weight loss in tested grape varieties was over 2%, except *Vitis vinifera* L. cv. Çeşme Pembesi. Loss of water in the grapes may occur rapidly or slowly according to grape varieties and environmental conditions (Karaçalı, 2009). In a study, which reported by Sabir et al., (2010) suitability of 13 cultivars and 14 types for minimal processing was aimed to investigate,the weight loss values of stemless berries varied from 0.65% to 1.69% after 10-d storage at 4 °C (Ergun et al., 2008). In the previous studies using clusters of different cultivars without processing, weight loss values of Alphonse Lavallée and Razaki cultivars reached around 8.4% after 100 days at 0 °C (Eris et al. 1993). Similarly, Al-Bachir (1999) reported that weight loss of Baladi grape clusters after 4 weeks at 1–2 °C were between 6.3% and 7.1%, while they varied from 2.8% to 3.4% for Helwani, depending on the dose (kGy) of gamma irradiation tested.

Berry removal force decreases in grape bunches as a consequence of senescence. This condition is accepted to be an indicator of aging and creates negative impressions in the market. The decreases in the berry removal force during storage period Turkish grape varieties are rather limited due to the original properties of the tested varieties and short duration of the storage period. On the other hand, berry removal force of Sultana grapes dropped back substantially when storage periods were increased (Yıldız et al., 2009).

The tested varieties are classified as light green (*Vitis vinifera* L. cv. Buca Razakı, *Vitis vinifera* L. cv. Pek Üzümü), deep pink (*Vitis vinifera* L. cv. Çeşme Pembesi, *Vitis vinifera* L. cv. Siyah Gemre, and *Vitis vinifera* L. cv. Kırmızı Şam), and purple, according to their original colors. The length of the storage period was effective on berry color (L*, a*, b*), in general, however the all except *Vitis vinifera* L. cv. Buca Razakı, a* was affected in *Vitis vinifera* L. cv. Buca Razakı, *Vitis vinifera* L. cv. Çeşme Pembesi and *Vitis vinifera* L. cv. Pek Üzümü, and L* only in *Vitis vinifera* L. cv. Buca Razakı and *Vitis vinifera* L. cv. Çeşme Pembesi. The effect was variable according to the variety and/or color value. *Vitis vinifera* L. cv. Buca Razakı of berry color is pinky yellow; *Vitis vinifera* L. cv. Pek Üzümü, green-yellow; *Vitis vinifera* L. cv. Çeşme Pembesi, red-pink; *Vitis vinifera* L. cv. Siyah Gemre, blue-black, and *Vitis vinifera* L. cv. Kırmızı Şam, red (Çelik 2006). The major factor seems to be the natural color of the grape variety. Color values did not change in some varieties or displayed decreases or increases in others during storage. In addition to the varietal properties, low storage temperatures (-0.5°C) are also effective on the insignificant color changes (Kader 2002; Karaçalı, 2009).

During storage, the TSS and titratable acidity contents of grapes did not show stable changes. The senescence of fruits during storage, and observed changes were in harmony (Karaçalı,2009). This is in general agreement with the results of various studies conducted on different cultivars such as Sultanina (Athanasopoulos and Thanos, 1998), Thompson seedless (Crisosto et al., 2002). The gradual decrease in acid level during the storage may physiologically be attributed to increase in membrane permeability allowing acids stored in cell vacuoles to be respired and transformation of acids to sugars (Winkler et al., 1974; Sabir et al., 2010) besides certain other processes occur inside the cells. Storaged period in MAP did not affect pH changes during storage as previously indicated in several studies (Takeda et al., 1983; Sanchez-Ballesta et al., 2006; Sanchez-Ballesta et al., 2007).

There is a relationship between stem browning of the grape and water loss. In many table grape varieties, 2% of water loss causes shriveling and stem browning (Crisosto and Mitchell 2002). Extension of the storage period was found to distinguish the varieties in respect to stem browning and thus, all varieties other than *Vitis vinifera* L. cv. Çeşme Pembesi reached to unmarketable stage at 60th day of storage. The stem browning rate can be accepted as a parameter that the storage period of the tested varieties. The low rate of stem browning in *Vitis vinifera* L. cv. Çeşme Pembesi even at the end of storage period (the 60th day) was found to be related to the physical and metabolic properties of the variety itself. The water loss was only 2% and the lowest at the end of storage which is in accordance with this result. Higher levels of water loss in the varieties with higher stem browning rate confirm previous reportings on the relationship between water loss and stem browning (Crisosto et al., 2001). It is widely accepted that modified atmosphere packaging (MAP) helps to retard tissue senescence and consequently. MAP is also proven as a good water vapour barrier and is able to maintain a relative humidity inside the pack (Philips, 1996).

The aim of this work is to study quality of organically grown *Vitis vinifera* L. cv. Buca Razakı, *Vitis vinifera* L. cv. Çeşme Pembesi, *Vitis vinifera* L. cv. Siyah Gemre, *Vitis vinifera* L. cv. Pek Üzümü, and *Vitis vinifera* L. cv. Kırmızı Şam grape varieties during storage was studied in order to allow an optimum marketing period.

Grape (*Vitis vinifera* L.) has proven to be among the fruits with the highest content of polyphenols: a large amount of these compounds is present in skin, pulp and seeds, and undergo a partial extraction during winemaking (Revilla and Ryan, 2000) and juice production processes. On the other hand, the secondary aim of this work is study the effects of storage conditions as MAP on total phenolic content of *Vitis vinifera* L. cv. Buca Razakı (BR), Çeşme Pembesi (ÇP), Siyah Gemre (SG), Pek Üzümü (PÜ), and Kırmızı Şam (KŞ) produced organically. Very few works have been published on total phenolic content of Buca Razakı (BR), Çeşme Pembesi (ÇP), Siyah Gemre (SG), Pek Üzümü (PÜ), and Kırmızı Şam (KŞ) made from *V. vinifera* L.

We can observe that total phenolic content of a white grapes; Buca Razakı (BR),and Pek Üzümü (PÜ), a red grapes Çeşme Pembesi (ÇP), Siyah Gemre (SG), and Kırmızı Şam (KŞ) has to be considered stable during this storage period in MAP. No statistically significant differences concerning the total phenolic content were detected when the storaged period in MAP were considered. On the other hand, there were no significant differences between the red and white grapes analyzed in this study with regard to total phenolic content, a result which is in contrast to the claim set forth by Giuseppe et al., (2012) who obtained a higher amount of total phenolic content in red cultivars.

Giuseppe et al., (2012) was reported that the content of phenolic compounds observed in Muscat of Alexandria (an ancient aromatic vine grape that is a member of the Muscat family) juices was lower if compared to the results obtained by Kovacevic Ganic et al., (2006) in another white GJ variety (Malvasia Istriana, *V. vinifera* L.). They reported a phenolic concentration in Malvasia Istriana five times higher than that Giuseppe et al., (2012) measured in Muscat of Alexandria juices, highlighting the effects of genotypes in determining the phenolic content of grape. A red GJ of V. *lambrusca* L. cv. Concord was analysed by Morris et al., (1980). The phenolic content of Concord juices was around the half of the one Giuseppe et al. (2012) found in a red grape Sangiovese (SG; F9 A5 48 clone). Comparable values of phenolic content (around 250 mg GAE L)1) to Concord juices can be found in the work of Threlfall et al., (2007) in which red GJ of V. *rotundifolia* Michx. (Muscadine) was studied.

Phenol contents of grapes may vary according to the harvest maturity, harvest methods, climate and storage temperatures (Cornelli, 2009; Moure, 2000).

Giuseppe et al., (2012) was reported that temperature and storage effects affected the content of phenolic compound in white and red grape varieties. When statistical analysis was focused on each cultivar, a white grape Muscat of Alexandria was found to be more sensible to storage conditions and a significant reduction in total phenolics (-20%) and flavonoids (-53%) content and in the ONOO) scavenging potential (-32%) was evident after 2 weeks at 4 C^0 (when compared with the same storage temperature after 24 h). On the contrary, a red grape Sangiovese (SG; F9 A5 48 clone) juices did not show significant differences among the four storage treatments investigated. These results could be explained suggesting that anthocyanins presence in red grape plays a key role in juice stability.

Similar growth environments of the varieties, application of similar cultural practices and harvesting at optimum harvest date may have result in similar phenolic contents. Differences in the total phenolic contents are thus due to the properties of the varieties. The limited changes observed in the total phenol content during storage are believed to be related to the implementation of immediate pre-cooling right after harvest, storage under suitable conditions and shorter storage periods hence unsuitable storage conditions and storage durations cause significant losses in phenolic content (Pellegrini, 2009; Ratnam et al., 2006).

Deterioration of grapes during storage is observed as weight loss, stem browning, softening, shattering and decaying (Crisoto et al., 2001; Perkins-Veazie et al., 1992). Deterioration of grapes after the harvest is caused by physical, physiological and pathological factors (before and after harvest) (Zoffoli et al., 2009). The results displayed that organically grown *Vitis vinifera* L. cv. Çeşme Pembesi variety did not lose its marketability during 60 days of storage however the other grape varieties could keep their marketability for 45 days at tested storage conditions. Since *Vitis vinifera* L. cv. Çeşme Pembesi was the least affected variety in decay caused by *Botrytis cinerae*, it can be recommended as a variety suitable for organic production under the experimental conditions.

This study provides valuable information for further understanding the marketability and total phenol changes that occur in some grape cultivars which produced organically during the storage. Therefore, these results will be useful for future research on the organically stored grape.

ACKNOWLEDGEMENT

This study was submitted as a oral presentation to the 35th World Congress of Vine and Wine 10th General Assembly of the OIV in İZMİR/TURKEY, June 18th - 22nd 2012.

REFERENCES

Ağaoğlu, Y.S. 1986. Üzümsü Meyveler. Ankara Üniv. Ziraat Fak. Yay. No: 984 (Turkish).

Al-Bachir, M. 1999. Effects of gamma irradiation on storability of two cultivars of Syrian grapes (Vitis vinifera L.). Radiat Phys Chem 55: 81–85.

Ames, B.N., M.K. Shigena, and T.M. Hagen. 1993. Oxidants, antioxidants and the degenerative diseases of aging. The Proceedings of the National Academy of Sciences (U.S.A). 90: 7915-7922.

Anonymous. 2010. FAOSTAT FAO Statistics Division 2012. 22 April 2012.

Athanasopoulos, P. and A. Thanos. 1998. Quality characteristics of Sultanina table grapes stored in a pilot plant scale. Fruits, 53: 199206.

Benzie, I.F.F. and J.J. Strain. 1996. The ferric reducing ability of plasma (FRAP) as a measure of "antioxidant power": the FRAP assay. Analytical Biochemistry. 239: 70–76.

Carlos, R.N., P.J.M. Jean, L.G. Marcela, and A.S. Jaime. 1991. Control de *Botrytis cinerea* en Possosecha en uva de mesa Madiante Fungicidas Sublimables. Fitapatologia. 26 (2): 81-85.

Çelik, H. 2006. Grape Cultivar Catalog. University of Ankara, Faculty of Agriculture, Department of Horticulture. Sunfidan A.Ş. Mesleki Kitaplar Serisi ISBN 975-96656-1-1, 3: 165 (Turkish).

Crisoto C.H., Smilanick, J. L. and N. K. Dokoozlian. 2001. Table grapes suffer water loss, stem browning during cooling delays. *California Agricultura*. 1: 39–42.

Cornelli, U. 2009. Antioxidant use in nutraceuticals. Clin Dermatol. 27: 175–94.

Crisosto, C.H., and F.G. Mitchell. 2002. Postharvest Handling Systems: Table grapes. In: Kader, A.A. (Ed.), Postharvest Technology of Horticultural Crops. University of California Agricultural and Natural Resources. Publication 311, USA. pp. 357-363.

Crisosto, C.H., Garner, D., Crisosto, G. 2002. Carbon dioxide-enriched atmospheres during cold storage limit losses from Botrytis but accelerate rachis browning of 'Redglobe' table grapes. Postharvest Biol Tech 26: 181–189.

Ergun, M., Akaya, O., Ergun, N. 2008. Suitability of some mid-season table grape cultivars and types for minimally processed produce. *J Int Sci Vigne Vin* 42: 99–106.

Eris, A., Turkben, C., Ozer, MH. 1993. A research on CA-storage of grape cultivars 'Alphonse Lavallée' and 'Razaki'. In: Proceedings of the Sixth International CA Research Conference (June15-17, 1993) 'NRAES-71'. Cornell University, Ithaca, pp 705–710, İtalyanca (İtalya).

Giuseppe, G., Patrizia, I., Massimiliano, B., Annamaria, R., Paolo, S., and Luca, S. 2012. Temperature and storage effects on antioxidant activity of juice from red and white grapes. International Journal of Food Science and Technology. 47: 13–23.

Kader, A.A. 2002. Postharvest Technology of Horticultural Crops. University of California Agricultural and Natural Resources. Publication 3311, USA.

Karaçalı, İ. 2009. Bahçe Ürünlerinin Muhafazası ve Pazarlanması. Ege Üniversitesi Ziraat Fakültesi Yayınları No: 494, Bornova-İzmir (Turkish).

Macheix J.-J., Fleuriet, and A. J. Billot. 1990. *Fruit* Phenolics. CRC, Boca Raton, FL, 1-25, Fransızca (Fransa).

Morris, J.R., Cawthon, D.L., and Fleming, J.W. 1980. Effects of high rates of potassium fertilization on raw product quality and changes in pH and acidity during storage of Concord grape juice. American Journal of Enology and Viticulture, 31: 323–328.

Moure, A., Cruz J M., and JD. Franco. 2000. Natural antioxidants from residual sources. Food Chem. 172: 145–71.

Nigro, F., A. Ippolito, and G. Lima. 1998. Use of UV-C Light to Reduce *Botrytis* Storage Rot of Table Grapes. Postharvest Biology and Technology. Vol. 13: 171-181.

Pellegrini N, Miglio C, and D. Del Rio. 2009. Effect of domestic cooking methods on the total antioxidant capacity of vegetables. *Int J Food Sci Nutr.* 60 (Suppl 2): 12–22.

Perkins-Veazie, P. 1992. Physiological Changes during Ripening of Raspberry Fruit. HortScience. 27(4): 331-333.

Philips, C. A. 1996. Review: Modified atmosphere packaging and its effects on the microbiological quality and safety of produce. International Journal of Food Science and Technology, 31: 463-479.

Ratnam, D V, Ankola, and D D, Bhardwaj V. 2006. Role of antioxidants in prophylaxis and therapy: A pharmaceutical perspective. J Control Release. 113: 189–207.

Revilla, E., and Ryan, J.M. 2000. Analysis of several phenolic compounds with potential antioxidant properties in grape extracts and wines by high-performance liquid chromatography–photodiode array detection without sample preparation. Journal of Chromatography A, 881, 461–469.

Sabir, A., E. Kafkas and S. Tangolar. 2010. Distribution of major sugars, acids and total phenols in juice of five grapevine (*Vitis* spp.) cultivars at different stages of berry development. Spanish Journal of Agricultural Research. 8(2): 425-433, Türkçe.

Sanchez-Ballesta, M. T., J. B. Jimenez, I. Romero, J. M. Orea, R. Maldonado, A. Gonzalez-Urena, M. I. Escribano and C. Merodio. 2006. Effect of high CO_2 pretreatment on quality, fungal decay and molecular regulation of stilbene phytoalexin biosynthesis in stored table grape. Postharvest Biology and Technology, 42: 209216, Türkçe.

Sanchez-Ballesta, M. T., I. Romeroa, J. B. Jimenez, J. M. Orea, A. Gonzalez-Urena, M. I. Escribano and C. Merodio. 2007. Involvement of the phenylpropanoid pathway in the response of table grapes to low temperature and high CO_2 levels. Postharvest Biology and Technology, 46: 2935.

SPSS Inc. 1999. SPSS Base 10.0 for Windows User's Guide. SPSS Inc., Chicago IL.

Swain, T., and W.E. Hillis. 1959. The phenolic constituents of Prunus domestica I- the quantitative analysis of phenolic constituents. Journal of Science of Food and Agriculture. 10: 63–68.

Takeda, F., M. S. Saunders and J. A. Saunders. 1983. Physical and chemical changes in 'Muscadine' grapes during postharvest storage. American Journal of Enology and Viticulture, 34: 180185.

Threlfall, R.T., Morris, J.R., Meullenet, J.F. and Striegler, R.K. 2007. Sensory characteristics, composition, and nutraceutical content of juice from *Vitis rotundifolia* (Muscadine) cultivars. American Journal of Enology and Viticulture, 58: 268–273.

Zoffoli, J.P., Latorre, B.A., and P. Naranjo. 2009. Preharvest applications of growth regulators and their effect on postharvest quality of table grapes during cold storage. Postharvest Biology and Technology. 51(2): 183–192.

Waterman, P.G., and S. Mole. 1994. Analysis of phenolic plant metabolites. Oxford, Blackwell. Scientific Publications. 238 p.

Wilson, C.L., A. El Ghaouth, E. Chalutz, S. Droby, C. Stevens, J.L. Lu, V. Khan, and J. Arul. 1994. Potential of Induced Resistance to Control Postharvest Diseases of Fruits and Vegetables. Plant Disease. 78: 837-844.

Winkler, A. J., Cook, J.A., Kliewer, W.M., and Lider, L.A. 1974. General viticulture. Uni Cal Press, Berkeley, p 639.