Scientific Papers. Series B, Horticulture. Vol. LXII, 2018
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

EFFECTS OF PRE-HARVEST RETAIN TREATMENTS WITH MAP ON COLD STORAGE QUALITY OF SWEET CHERRY CV. '0900 ZIRAAT'

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Abstract

Effect of pre-harvest treatments of ReTain [active ingredient: Aminoethoxyvinlglycine (AVG) 15 %] on cold storage quality of sweet cherry cv. '0900 Ziraat' grafted on Gisela 5 (Prunus cerasus × Prunus canescens) rootstock was investigated. For this purpose ReTain within concentrations of 50, 100, and 150 mg/L was applied as a spray 25 days before harvest. Fruits were harvested at the optimum harvest date and stored in modified atmosphere packages (MAP) at 0°C temperature and 90±5% relative humidity conditions for 6 weeks. Weight loss, fruit skin colour, fruit firmness, total soluble solid and titratable acidity content were determined during the storage period. In addition, sensory analysis was performed. Weight loss increased in all treatments during storage. Titratable acidity of fruit decreased with increasing storage period, but the highest average acidity was determined in fruit treated with 100 mg/L ReTain. The treatment of 50 mg/L of ReTain maintained fruit firmness better than those of others. These results indicated that pre-harvest ReTain treatment can be a tool for maintaining some quality attributes of sweet cherry during cold storage.

***Key words**: '0900 Ziraat', sweet cherry, MAP, ReTain, cold storage.*

INTRODUCTION

Sweet cherry is one of the most important crops of Turkey, constituting approximately 20-25% of world production with the production capacity of 599,650 tons (2016 year) (FAO, 2018). In addition to production, sweet cherry, cv. '0900 Ziraat', is an important species for export of Turkey (Eştürk et al., 2012). But fruit losses after harvest are still high depending on the species, harvest methods, transporting and marketing conditions and length of storage. Sweet cherry decays rapidly after harvest, so the consumption period is short and limited. The main causes of fruit deterioration are water loss, stem browning, softening, colour changes and pitting (Bernalte et al., 2003). Water loss and firmness are important quality attributes of cherries, and are directly related to storability (Martinez-Romero et al., 2006). Increase in these postharvest losses can cause great economic losses (Esti et al., 2002).

Many pre- and post-harvest technologies have been used to delay these losses, but the use of chemicals has been limited in some countries. So, alternative technologies for preservation are needed, which have to be considered as healthy and environmentally friendly (Serrano et al., 2005). Among these technologies, the use of modified atmosphere packaging (MAP) has been reported to be effective in cherry storage (Spotts et al., 2002; Tian et al., 2004; Kupferman et al., 2005). The MAP is used for keeping the postharvest quality of fruit by lowering the respiration rate of fruit (decreasing O_2 and increasing CO_2) (Kader et al., 1989). MAP extends the postharvest life of cherry and decreases decay resulting from softening, and maintain green stem colour (Kupferman et al., 2005). As in other fruit, plant growth regulators are used to increase quality and to extend post-harvest life of sweet cherries (Onursal et al., 2013). ReTain is, a commercial product that includes 15% AVG, a plant growth regulator, and effects harvesting criteria (Clayton et al., 2000). Aminoethoxyvinylglycine (AVG) is a natural compound produced in plant tissues (Rath et al., 2006). Researchers have shown that pre-harvest AVG treatment has maintained skin colour and firmness of some fruits (Jobling et al., 2003; McGlasson et al., 2005; Çetinbaş et al., 2012). This research was carried out to determine the effects of pre-harvest ReTain (AVG) treatment on quality of '0900 Ziraat' sweet cherry during cold storage.

MATERIALS AND METHODS

Plant material and retain treatment

The study was conducted at Fruit Research Institute, Isparta-Turkey. The uniform trees, cv. '0900 Ziraat' sweet cherry, on Gisela-5 (*Prunus cerasus* × *Prunus canescens*) rootstock, were used. Standard cultural practices including, thinning and pesticide sprays were provided to the trees.

For pre-harvest treatment, 50, 100 and 150 mg/L Retain and Tween-20 (0.01%) (as a surfactant) were sprayed on sweet cherry trees as well as distilled water with Tween-20 (pre-harvest control group) 25 days before commercial harvest (when fruits turned to straw-color). Cherries were harvested at commercial harvest maturity from an orchard and transported to the laboratory immediately. Harvested cherries were dipped in cool water (0-2°C) for 8-10 minutes for pre-cooling. After pre-cooling, cherries were placed on the MAP (Xtend) and stored at 0°C and 90±5% relative humidity for 6 weeks.

Chemical and physical analysis

Weight loss of cherries was measured over 5 kg fruits in each replicate and expressed as the percentage of loss of weight with respect to the initial weight. Weight loss was determined by the formula; [(First weight - Last weight) / First weight] × 100.

Fruit skin color was determined using a colorimeter (CR400, Minolta Co., Japan) over 15 fruits in each replicate. Minolta color measurement apparatus was calibrated according to the standard white calibration plate (Y: 92.3, x: 0.3136 and y: 0.3194). The values were expressed by the CIEL^* (brightness-darkness), a^* (+ a^*: red, ** - a^*: green) and b^* (+ b^*: yellow, - b^*: blue).

Fruit firmness was determined using a texture analyzer (Guss FTA Type GS14, Strand, South Africa). It was defined as the maximum load required to penetrate the probe (5 mm diameter) into the fruit flesh (6 mm). The results were expressed in Newton (N).

Total soluble solids (TSS) content was measured using a digital refractometer (HI 96801, Hanna, UK) and expressed as a percentage (%). Titratable acidity (TA) was determined by an automatic titrator (Mettler Toledo T50, Switzerland) and expressed as grams of malic acid equivalent per 100 g fresh weight.

Overall acceptability was rated on a hedonic scale of 0-2 (0: good commercial quality, 1: some damage but still commercially salable, 2: not commercially salable), described by Feng et al. (2004). Taste was rated on a scale of 1-5 (1: very bad, 2: bad, 3: medium, 4: good, 5: very good), described by Erbaş and Koyuncu (2016).

The experiment was set up according to the factorial randomized design with 3 replications (5 kg fruit per replication). Data were subjected to analysis of variance (ANOVA, JMP7), means were separated by means of LSD test (P<0.05, 0.01, 0.001).

RESULTS AND DISCUSSIONS

Weight loss which is the most important factor limiting the storage period, increased during storage in all treatments, especially in control treatment (Table 1). In this study, the weight loss of cherries was low levels because of the water vapour permeability properties of the MAP. The effects of storage periods on weight loss were statistically significant but there was no significant effect of treatments (P<0.01) (Table 4). At the end of storage, the weight loss of cherries was between 2.36% (control) and 2.07% (100 mg/L) (Table 1). The results found in this research agree with those of previous studies (Üstünel et al., 2008; Machado et al., 2010).

Table 1. Effect of pre-harvest ReTain treatment on weight loss of '0900 Ziraat' cherries stored at MAP

	1 w	2 w	3 w	4 w	5 w	6 w	Means
Control	1.69	2.04	2.05	2.19	2.78	3.38	2.36^{ns}
50 mg/L	1.10	1.66	1.87	2.64	2.92	2.97	2.19
100 mg/L	1.57	1.61	2.22	2.27	2.34	2.42	2.07
150 mg/L	1.64	2.01	2.03	2.21	2.81	3.18	2.31
Means	1.50C*	1.83C	2.04BC	2.33ABC	2.71AB	2.99 A	

*Means followed by different letters with in the same row is significantly different at P<0.01; ns: nonsignificant; w: weeks.

Softening of cherries reduces both market value and consumer acceptability. Changes in fruit firmness during cold storage are presented in

Table 2. The effect of storage time and treatments on the fruit firmness were statistically significant (P<0.01) (Table 4). Fruit firmness decreased with increasing storage periods but generally, fruit softening were minimized by ReTain treatment regardless of doses. At the end of the storage, 100 mg/L doses of ReTain was the best treatment for maintaining of firmness compared to other treatments. The positive effects of ReTain treatment combined with the MAP on fruit firmness were recorded in this study. In previous studies, pre- and post-harvest ReTain treatments maintained fruit firmness better than control groups during the storage (Drake et. al., 2006; Kharoshaki et. al., 2008; Lara, 2013). These results can be explained by delaying water loss and maintaining pectin level in the cell wall of fruit related to ReTain.

A large part of the TSS is composed of sugars, and change of TSS during the storage is due to changes in fruit carbohydrate structure. The water loss of fruit affects fruit TSS content, and generally it increase (Kader, 1989). But in this study, the weight loss of cherries was very low (Table 1) so the increasing of TSS was low, too. The TSS of fruit increased at the end of 42 days compared to initial values, with fluctuation during storage (Table 3). No significant interaction existed between treatments and storage periods, but differences between storage periods and treatments for TSS values were significant (Table 4). The lowest change in TSS value according to initial values was obtained from dose of 150 mg/L (Table 3). Similar observations were recorded by Remon et al. (2000) and Onursal et al. (2013) for cherries. The main factor of taste formation in fruit and vegetables are TA (Karaçalı, 2009). Storage periods and treatments significantly affected TA contents of cherries (Table 4). During the 6-weeks cold storage, the lowest average (0.65%) TA value was obtained from 50 mg/L dose of ReTain, and the highest (0.68%) in 100 mg/L dose of ReTain. 150 mg/L dose of ReTain treatment was the best treatment for maintaining the TA. During storage, TA values were continuously decreased (Table 3). Our results are in agreement with Khorshidi et al. (2011) who reported that sweet cherries, a nonclimacteric fruit, use sugars and acids for respiration, so TA can decrease depending on storage period.

The colour of sweet cherries is probably the main quality attribute considered by consumers. Changes in fruit skin color during cold storage are given in Figure 1. L^* values, which shows fruit brightness-darkness, decreased throughout storage. Fruit in control group lost their brightness more than ReTain treatments. While the highest mean L^* value was obtained from the dose of 100 mg/L (31.55), the greatest decrease (27.09) occurred in control group at the end of the storage. Similar trend was also observed for a^* and b^* values of skin colour. The a^* ($+a^*$: redness, $-a^*$: greenness) and b^* ($+b^*$: yellowness, $-b^*$: blueness) values steadily decreased during the storage. However, the amount of decrease in ReTain-treated cherries less than control treatment (Figure 1). ReTain treatments have been reported to be beneficial in maintaining fruit colour (Onursal et al., 2013).

The results of the sensory analyses are presented in Figure 2. Overall acceptability and taste decreased during storage. Storage period and treatments affected significantly the external appearance and taste scores of cherries during storage (p<0.01) (Table 4). ReTain-treated cherries (especially 100 mg/L dose) preserved their taste scores better than control fruit. The better taste was obtained from 100 mg/L dose during 5 weeks, while control fruit had a bad taste after 3 weeks of storage. Similar results were reported by Drake et al. (2006) and Olmstead et al. (2012).

Table 2. Effect of pre-harvest ReTain treatment on fruit firmness of '0900 Ziraat' cherries stored at MAP

	0 w	1 w	2 w	3 w	4 w	5 w	6 w	Means
Control	2.65	2.55	2.47	2.45	2.39	2.17	1.68	2.34b*
50 mg/L	2.65	2.60	2.59	2.57	2.49	2.48	2.52	2.56a
100 mg/L	2.70	2.34	2.71	2.71	2.75	2.67	2.37	2.61a
150 mg/L	2.52	2.43	2.39	2.40	2.35	2.30	1.99	2.34b
Means	2.64A*	2.48AB	2.54A	2.53A	2.50AB	2.41BC	2.14C	

*Means followed by different letters with in the same row and column are significantly different at P<0.01; w: weeks.

Table 3. Effect of pre-harvest ReTain treatment on total soluble solid content and titratable acidity of ‘0900 Ziraat’ cherries stored at MAP

		0 w	1 w	2 w	3 w	4 w	5 w	6 w	Means
TSS	Control	15.81	16.07	16.37	17.00	16.50	16.07	15.93	16.25 b*
	50 mg/L	15.43	15.80	16.67	16.77	17.97	16.98	15.70	16.34 a
	100 mg/L	16.83	17.40	17.83	17.87	18.07	17.97	17.43	17.63 a
	150 mg/L	15.60	16.37	16.80	17.43	17.23	16.63	15.63	16.53 b
	Means	15.92AB*	16.41BC	16.92B	16.25C	17.27BC	16.91A	16.17BC	
TA	Control	0.79	0.72	0.68	0.63	0.63	0.60	0.57	0.66 bc
	50 mg/L	0.76	0.72	0.65	0.64	0.60	0.59	0.58	0.65 c
	100 mg/L	0.80	0.75	0.69	0.68	0.65	0.61	0.60	0.68 a
	150 mg/L	0.78	0.74	0.67	0.65	0.64	0.61	0.61	0.67 ab
	Means	0.78A*	0.73B	0.67C	0.65C	0.63D	0.61D	0.59D	

*Means followed by different letters with in the same row and column are significantly different at P<0.01; w: weeks.

Table 4. Anova for dependent variables for treatments, storage period and their interactions for cherries

	Weight loss	Firmness	Overall acceptability	Taste	L*	a*	b*	TSS	TA
SP	**	**	**	**	**	**	**	**	**
T	ns	**	**	**	**	**	**	**	**
SP × T	ns	ns	ns	ns	**	**	**	ns	ns

SP: Storage period; T: Treatments; ns: represents non-significance at P< 0.05; **Represents significance at the 0.01; TA: Titratable acidity; TSS: Total soluble solid.

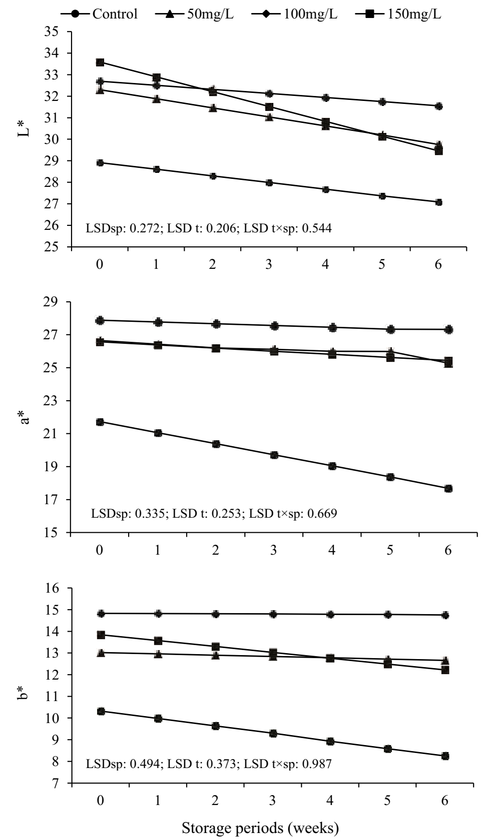

Figure 1. Effect of pre-harvest ReTain treatment on fruit skin color (L^*, a^* and b^*) of ‘0900 Ziraat’ cherries stored at MAP (SP: Storage period; T: Treatments)

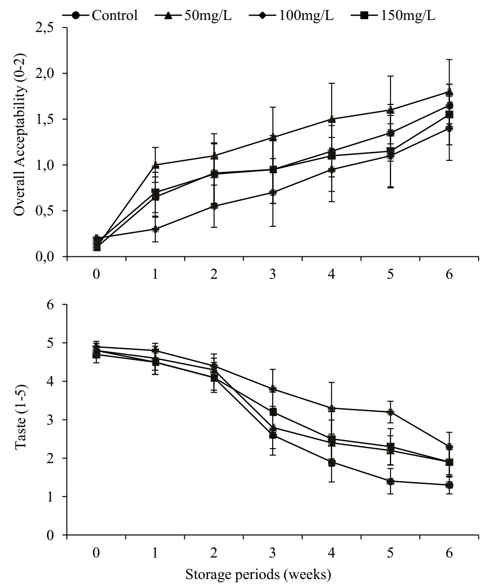

Figure 2. Effect of pre-harvest ReTain treatment on sensory analysis of ‘0900 Ziraat’ cherries stored at MAP Vertical bars represent the standard error of the mean (n=3). Overall acceptability: 0: good commercial quality, 1: some damage but still commercially salable, 2: not commercially salable; Taste scores: 1: very poor, 2: poor, 3: mild, 4: good, 5: excellent

CONCLUSIONS

At the end of the 6 weeks of storage, AVG treatment was more effective for maintaining postharvest quality of cherries compared to control treatment. Treated cherries with AVG delayed colour changes, softening and loss of acidity. In addition, AVG treatment was effective in the maintaining sensory quality during the storage. Especially 100 mg/L AVG as pre-harvest treatment was the most effective dose and it can be used to maintain sweet cherry postharvest quality during storage of 35 days at 0°C.

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