



Effects of aminoethoxyvinylglycine treatment by vacuum infiltration method on postharvest storage and shelf life of tomato fruit



Elif Candir^{a,*}, Altan Candir^b, Fatih Sen^c

^a Mustafa Kemal University, Faculty of Agriculture, Department of Horticulture, 31034 Antakya, Hatay, Turkey

^b Republic of Turkey Ministry of Food, Agriculture and Livestock, Hatay Directorate of Provincial Food Agriculture and Livestock, 31000 Antakya, Hatay, Turkey

^c Ege University, Faculty of Agriculture, Department of Horticulture, 35040 İzmir, Turkey

ARTICLE INFO

Article history:

Received 22 July 2016

Received in revised form 19 October 2016

Accepted 1 November 2016

Available online xxx

Keywords:

Aminoethoxyvinylglycine

Tomato

Ripening

Vacuum infiltration

Storage

Shelf life

ABSTRACT

The aim of this study was to determine effects of postharvest aminoethoxyvinylglycine (AVG) treatment using vacuum infiltration method on retardation of ripening, storage and shelf life of tomato fruit. In the Experiment-1, beefsteak 'Grando F1' tomato fruit was harvested at breaker stage and treated with AVG at six different doses (0, 62.5, 125, 250, 500 and 1000 mg L⁻¹) and three different vacuum pressures (0 kPa, -20 kPa and -30 kPa) using vacuum infiltration method and kept at 20 °C for 8 d. The AVG treatment of 1000 mg L⁻¹ at -30 kPa reduced ethylene production rate by 45.53%, delayed color changes and extended the number of days reaching to red ripe stage from 6 to 8 d at 20 °C and was confirmed as the optimal treatment for the maximum retardation of tomato fruit ripening by response surface methodology. In Experiment-2, untreated and treated breaker 'Grando F1' tomato fruit with 1000 mg L⁻¹ at -30 kPa were kept at 12 °C for 0, 5, 10, 15 or 20 d and for 2 d at 20 °C after cold storage. AVG treated fruit had lower ethylene production rate, lycopene content, a* and C* values and higher fruit firmness, chlorophyll content, L* and h° values, compared to control during storage and shelf life period. For shipping to distant markets, storage and shelf life of untreated fruit were 10 d at 12 °C plus 2 d at 20 °C while AVG treatment extended storage and shelf life to 20 d at 12 °C plus 2 d at 20 °C.

© 2016 Elsevier B.V. All rights reserved.

1. Introduction

The ripening of tomato fruit, being a climacteric fruit, is regulated by ethylene (Lelievre et al., 1997) and characterized by degradation of chlorophyll, accumulation of lycopene and softening and changes in aroma and other compositional properties (Grierson and Kader, 1986). Postharvest life of tomato fruit is limited by the fast acceleration of changes related to ripening. Controlling tomato fruit ripening is essential for the fresh tomato industry. Tomatoes are susceptible to chilling injury below 10 °C and typical symptoms include failure to ripen and develop full color and flavor, premature softening, surface pitting, browning of seeds and increased susceptibility to fungal decay (Suslow and Cantwell, 1997). Tomato fruit is stored at relatively high temperatures (10–12.5 °C) depending on the maturity stage to avoid the occurrence of CI (Suslow and Cantwell, 1997), but a slight reduction or inhibition of the ripening process occurs at this temperature

range (Guillén et al., 2006). Thus, new tools are required to inhibit and/or delay the onset of ethylene production to extend postharvest period of tomato fruit (Guillén et al., 2007).

Aminoethoxyvinylglycine (AVG) is a naturally occurring amino acid that suppresses ethylene production in plant tissues by competitively inhibiting enzymatic activity responsible for the conversion of S-adenosylmethionine to 1-aminocyclopropane-L-carboxylic acid (Boller et al., 1979). ReTain[®] plant growth regulator is a commercial product containing 15% w/w AVG was registered for apples, pears, peaches and nectarines in several countries to delay fruit maturity, improve harvest management, reduce preharvest fruit drop, maintain fruit firmness and enhance storage potential (Rath and Prentice, 2004). Preharvest spray of AVG reduced ethylene production and delayed ripening at harvest and during cold storage for apple (Mir et al., 1999; Drake et al., 2005; Sigal-Escalada and Archbold, 2009), pear (Clayton et al., 2000; Andreotti et al., 2004; D'Aquino et al., 2010), plum (Jobling et al., 2003; Öztürk et al., 2012), peach (Çetinbaş et al., 2012), nectarine (McGlasson et al., 2005) and melon (Hung et al., 2010) fruit. Postharvest AVG dip treatment on apple (Fadhil and Al-Bamarny, 2010), pear (Andreotti et al., 2004; Tarabih, 2014), apricot (Palou

* Corresponding author.

E-mail addresses: ecandir@mku.edu.tr, elif.1026@hotmail.com (E. Candir).

and Crisosto, 2003; Valdés et al., 2009) and peach (Garner et al., 2001; Hayama et al., 2008), it reduced the rate of ethylene production and fruit softening during storage or shelf life period. AVG has been shown to inhibit ethylene production in tomato fruit slices by depending on the concentration of AVG and maturity stages of tomato fruit slices. Ethylene production reduced by about 50 to 91% in mature green, 15 to 83% in pink and 15 to 96% in ripe tomato tissue slices at the concentrations varied from 68 μM to 10 mM AVG (Baker et al., 1978; Atta-Aly et al., 1987; Saltveit, 2005). AVG uptake may occur directly through the fruit surface via the cuticle and/or lenticels. Saltveit (2005) suggested that applications of AVG might be limited in whole tomato with a very impermeable cuticle and epidermis. Cuticular penetration of AVG has been shown to be slow and low through isolated tomato fruit cuticles as a result of low partitioning of polar AVG into the lipophilic cuticle and absence of lenticel (Knoche and Petracek, 2013).

Vacuum infiltration has been used to increase uptake of chemicals that may improve postharvest life of the fruit or vegetables. The technique of vacuum infiltration has been reported to be effective in increasing the calcium content of tomatoes (Wills and Tirmazi, 1979; Senevirathna and Daundasekera, 2010). Wang and Mellenthin (1977), comparing vacuum infiltrated or dipped intact 'Anjou' pears with solutions of AVG found that the vacuum infiltration method was slightly more effective than the dipping method in inhibiting ethylene production and delaying ripening. Application of AVG using vacuum infiltration method was reported to be effective to inhibit ethylene production and delay respiratory climacteric and changes in skin color and flesh firmness during ripening of mature 'Bartlett' pear fruit at 20 °C (Ness and Romani, 1980). The aims of this study were to determine effective AVG dose and vacuum pressure to delay tomato fruit ripening and evaluate effects of postharvest AVG treatment by vacuum infiltration method on postharvest quality of beefsteak 'Grando F1' tomato fruit during storage at 12 °C for 20 d and subsequent 2 d of shelf life period at 20 °C.

2. Materials and methods

Effects of postharvest AVG treatment using vacuum infiltration method on retardation of ripening, storage and shelf life of tomato fruit were determined in two experiments carried out sequentially during the 2013–2014 season. In both experiments, beef steak tomatoes (cv. Grando F1) were harvested at the breaker stage according to the USDA tomato color chart (USDA, 1976) from a commercial greenhouse operation in Samandağ, Hatay, Turkey. After harvest, the tomatoes were immediately transported via a ventilated truck to the postharvest laboratory of the Department of Horticulture at Mustafa Kemal University (Antakya, Hatay) where they were sorted for uniform size and maturity and freedom from defects and blemishes.

2.1. Experiment-1

Fruit was subjected to postharvest AVG treatments at six different doses (0, 62.5, 125, 250, 500 and 1000 mg L^{-1}) and three different vacuum pressures (0 kPa, –20 kPa and –30 kPa). Fruit was vacuum infiltrated with distilled water or AVG solutions at 62.5, 125, 250, 500 or 1000 mg L^{-1} of active ingredient with ReTain[®] containing 15% AVG (w/w) at –20 kPa or –30 kPa using a laboratory type vacuum infiltration system as described by Tunçkal and Alibaş (2012). ReTain[®] was obtained from Valent BioScience Corporation (Libertyville, USA) via Sumitomo Corporation (İstanbul, Turkey). AVG solutions were prepared with distilled water at 20 \pm 1 °C. Fruit with a netted bag was immersed in vacuum chamber and subjected to vacuum pressures of –20 kPa or –30 kPa for 5 min. After release of the vacuum, the fruit was kept immersed

in the same solution for a further 5 min in order to facilitate a rapid influx of AVG solution (Senevirathna and Daundasekera, 2010). Control fruit was dipped in distilled water or AVG solutions at 20 \pm 1 °C for 10 min for the treatments at 0 kPa. Following treatments, the tomatoes were allowed to dry on a paper towel at room temperature for 1 h and kept at 20 °C until they reached red ripe stage. Fruit quality was assessed at two days interval at 20 °C by measuring weight loss, respiration rate, ethylene production rate and peel color.

2.2. Experiment-2

According to the results of Experiment-1, fruit was vacuum infiltrated with AVG solution (1000 mg L^{-1} of active ingredient with ReTain[®] containing 15% AVG) at –30 kPa using a laboratory type vacuum infiltration system as described above. Following treatment, the fruit was allowed to dry on a paper towel at room temperature for 1 h. The untreated fruit was served as control. Treated and untreated fruit were kept at 12 °C for 20 d and 2 d at 20 °C after cold storage. Fruit quality was assessed after 0, 5, 10, 15 or 20 d at 12 °C and 2 d at 20 °C following cold storage by measuring weight loss, respiration rate, ethylene production rate, peel color, total soluble solid (TSS), titratable acidity (TA), juice pH, fruit firmness, total lycopene, total chlorophyll, ascorbic acid and total phenolic content, antioxidant capacity, incidence of chilling injury and fungal decay. Sensory quality was evaluated after 20 d of storage at 12 °C plus 2 d shelf life period at 20 °C.

2.3. Postharvest quality evaluation

Fruit was numbered and individually weighted to determine weight loss. Weight loss was calculated as percentage loss of initial weight. Five fruit per replicate from each of the treatments were placed in 5 L glass containers equipped with septa and sealed for 3 h at 20 °C. CO₂ measurements were performed on using a Check Point model O₂/CO₂ analyzer (PBI-Dansensor America Inc., NJ, USA). The O₂/CO₂ analyzer was calibrated daily with ambient air and a calibration gas (4 kPa CO₂). A gas volume of 10 mL was taken from inside the glass containers by inserting a needle through a Teflon septum applied to the lid of the glass containers. The needle was attached to the sample port of the analyzer with a syringe and sampling wand. Ethylene was measured using 100 μL headspace samples withdrawn with a syringe. The sample was injected into a Shimadzu GC-2010 model gas chromatograph (Shimadzu Co., Kyoto, Japan) equipped with a flame ionization detector. The operating conditions were as follows, GS-GASPRO column (30 m \times 0.32 mm, 0.5 μm film thickness, Agilent J&W GC Columns, USA); splitless; column temperature of 40 °C for 5 min; injector temperature of 200 °C; and detector temperature of 250 °C. Nitrogen was used as the carrier gas at a flow rate of 40 mL min^{-1} . The concentrations of ethylene in the headspace were compared to standard gas mixtures of 1 to 10 $\mu\text{L L}^{-1}$ (Linde Gaz A.S., Turkey). Color measurements were performed on the surface of the tomatoes, around the equatorial region using the CIE L*a*b* color space with a Minolta Chroma Meter CR-300 (Osaka, Japan). From these values, hue angle (h°) and Chroma (C^*) values were calculated as $h^\circ = \tan^{-1}(b^*/a^*)$ and $C^* = (a^{*2} + b^{*2})^{1/2}$. Color values for each fruit were computed as means of two measurements taken from opposite sides at the equatorial region of the fruit. Flesh firmness was measured on two opposite sides of each fruit at the equatorial region, after the removal of a 1 mm thick disk of skin from each side of the fruit and the force in kg required to insert an Effegi penetrometer (Fruit Pressure Tester FT 011 model, Facchini, Italy) fitted with an 8 mm diameter probe was recorded and expressed as Newton (N). Fruit was blended in a homogenizer. The juice was filtered using cheese cloth and used for determination of

Download English Version:

<https://daneshyari.com/en/article/4517644>

Download Persian Version:

<https://daneshyari.com/article/4517644>

[Daneshyari.com](https://daneshyari.com)