Temperature and ethephon effects on storability to postharvest decay of 'sceptar' red rasberries

Gerasopoulos D., Stavroulakis G.

in

Gerasopoulos D. (ed.).
Post-harvest losses of perishable horticultural products in the Mediterranean region

Chania : CIHEAM
Cahiers Options Méditerranéennes; n. 42

1999
pages 49-56

TEMPERATURE AND ETHEPHON EFFECTS ON STORABILITY OF 'SCEPTAR' RED RASPERRIES

D. Gerasopoulos
G. Stavroulakis
Mediterranean Agronomic Institute of Chania, Chania, Greece

Abstract

'Sceptar' red raspberries were harvested at salmon red maturity stage, treated with 0 or 1 % ethephon and stored at 20, 11 and 0 °C for 2-15 days. Fresh mass, firmness, soluble solids content, pH, titratable acidity and anthocyanin content were measured during storage. Storage of untreated fruit at 11 or 20 °C enhanced ripening while ethephon-treated fruit differed very little compared to the control. Storage of control fruit at 0 °C delayed ripening; ethephon-treated fruit ripened earlier. Firmness and fruit mass decreased and anthocyanin content increased compared to the control. The soluble solids content of untreated or ethephon-treated and stored at 0 °C fruit, was not increased above the harvest level.

1. INTRODUCTION

Red raspberry fruit retain firmness, red coloration and flavor for about 3-5 days when stored at 0 °C and 90-95 % RH. Enhancement of ripening of red raspberries has been reported to occur during storage at >7.5 °C (Tomalin and Robinson, 1971) in addition to decay due to *Rhizopus sp* infection (Salunkhe and Desai, 1984). Red raspberries subjected to prolonged storage soften and change color to dark red (Sjulin and Roberts, 1984). Color change is an index of quality deterioration (appearance) at rates determined by the cultivar and storage temperature (Varseveld and Richardson, 1980).

Preharvest ethephon application, an ethylene releasing compound, has been reported to promote ripening while postharvest application causes fast quality deterioration. In red raspberries particularly, exogenous ethylene application result in fruit softening and deep red color development (Burdon and Sexton, 1990). Red raspberry ripening is not related to ethylene production; however, red raspberries are considered climacteric fruit (Blanplied, 1972; Jennings, 1988), or non-climacteric fruit based on color development only (Kader, 1985).

The purpose of the study was to evaluate the ability of ethephon to promote ripening of 'Sceptar' red raspberries at three storage temperatures (0, 10 and 20 ° C).

2. MATERIALS AND METHODS

'Sceptar' red raspberries grown at Chania-Greece were harvested at salmon red color during August. The fruit were screened for uniformity and sprayed with 600 mg L^{-1} benomyl, followed by 0 or 1 % (V/V) ethephon (30 fruit per treatment). The berries were then placed in 5-L jars, inside covered with wet filter paper to keep the relative humidity at high levels. Jars, six per treatment, were placed at storage temperatures of 0 and 11 °C. The fruit were removed from storage three times (3, 7, 10 and 15 days). Additional fruit were held at 20 °C for 0, 0.5, 1.0 and 1.5 days. The following parameters were measured in 10 fruit-replicates: Firmness was measured on every fruit using a Correx penetrometer equipped with a flat 17 mm tip. Total soluble solids were measured from juice samples using an ATAGO hand refractometer. A 1:1 fruit to juice ratio was used for pH and titratable acidity measurements using a 702 SM Titrino automatic titrator to pH 8.2 with 0,1 N NaOH (expressed in g L^{-1} of citric acid). Total anthocyanins were determined according to Torre and Baritt (1977), in 10 mL acidified ethanol following homogenization, filtration and dilution to 100 mL. Absorbance was measured at 512 nm using a Hewlett Packard 8452A spectrophotometer. The results were expressed in mg cyanidin-3-galctoside per 100 g $^{-1}$ fresh fruit mass.

LDS of ripening data were obtained using the SAS statistical system.

3. RESULTS

Effects of temperature.

Average fruit mass at harvest was 2.4 g (Fig. 3A) and reduced to <2.0 g after 1.5 days at 20 ° C storage. Average fruit mass gradually reduced to 1.9 and 1.6 g on the 15th day of 0 and 11 °C storage, respectively (Fig. 1, 2A). Fruit firmness at harvest was 420 g. During storage at 0 °C firmness remained constant for 10 day and reduced to 400 g on the 15th day (Fig. 1A). Firmness of red raspberries held at 11 °C reduced drastically (by 100 g) during the first 3 days reaching to 220 g at the end of the experiment (Fig. 2A). Fruit stored at 20 °C lost their initial firmness within 1.5 days. TSS at harvest was 6.0 % and remained unchanged during storage at 0 °C (Fig. 1C) while it increased to 7.5 and 8.3 % at 11 and 20 °C, respectively (Fig. 2, 3C). Juice pH remained unchanged the first 7 d of 0 °C storage, increasing to 3.15 thereafter (Fig. 1D). pH of red raspberry juice during storage at 11 °C increased to 3.17 (Fig. 2D); No change was recorded during 20 °C storage (Fig. 3D). Juice pH remained unchanged the first 7 d of 0 °C storage, increasing to 3.15 thereafter (Fig. 1D). TA of red raspberry juice showed only a slight decrease (from 11.5 to 11.2 g L^{-1}) during storage at 0 or 11 °C (Fig. 1, 2A) and a higher increase (from 1.5 to 10.7 g L^{-1}) in fruit stored at 20 °C (Fig. 3A.

Anthocyanin content at harvest was 6 mg 100 g^{-1} and slightly increased during storage of berries at 0 °C (Fig. 1F). Berry anthocyanin content increased during storage at 11 °C (Fig. 2F) by 2 mg 100 g^{-1} as opposed to berries that stored at 20

°C which showed and increase by 1.5 mg 100 g^{-1} at the end of the experiment (Fig. 3F).

Effects of ethephon

The application of 1 % ethephon to red raspberries resulted in gradual decrease of average berry mass during 0 °C storage reaching 60% of initial weight on the 10th day of the experiment. Control berries held at 0 °C showed weight loss of only 20% of initial weight. Control or sprayed berries held at 11 °C showed a gradual decrease of 40 % of initial mass without significant differences among them. A small decrease of berry mass of 15-20 % was observed during storage at 20 °C of ethephon-sprayed similarly to control berries (Fig. 1, 3A).

Ethephon application to red raspberries resulted in decrease of firmness 4 days later, showing the greatest difference (70 g) compared to the control on day 11 of 0°C storage (Fig. 1A). Ethephon-treated berries immediately after harvest did not show any difference in the rate of firmness loss during storage at 11 or 20 °C compared to the control (Fig. 2, 3A). Ethephon spray also, did not resulted in significant differences of berry-TSS increase stored at 0, 11 or 20 °C (Fig. 1, 2, 3C). Also very small were the effects of ethephon to berry pH held at 11 °C (Fig. 2D) or 0°C (Fig.1D). However, storage at 20 °C increased pH by 0.03 compared to the control which showed an increase by day 3 to pH 3.13 (Fig. 3D).

Ethephon sprayed fruit held for 15 at 11 and 0 °C or 3 days at 20 °C, showed increased TA by 0.5 g L^{-1} during the experiment compared to the control (Fig. 1, 2, 3A). Ethephon sprayed fruit did not show any differences in anthocyanin content compared to the control at 20 °C (Fig. 3F) similarly to 11 or 0 °C (Fig. 2, 3F).

4. DISCUSSION

Red raspberries are very susceptible to 20 °C storage with maximum life of less than 2 days (Fig. 3), due to drastical decrease in firmness and decay (Salunkhe and Desai, 1984). However, fruit held at 0 or 11 °C showed delayed ripening and retained commercial characteristics for 15 and 10 days, respectively (Fig. 1, 2). During storage at 0 °C, the decrease in firmness was indepentend of the increase in TSS even though storage at 11 or 20 °C both firmness and TSS changed in opposite rates previously observed to apples (Sfakiotakis and Stavroulakis, 1989) and kiwi (Stavroulakis and Sfakiotakis, 1992). Softened fruit had a significant loss in fruit mass while TSS content and anthocyanin content was low and without difference from the correlated content at harvest (Fig. 1).

Post harvest firmness decrease rate was not affected by ethephon application at 20 or 11 °C compared to the control. Evolved ethylene affected the berries held at 0 °C, particularly in decreasing firmness (Robbins et al., 1989; Burton and Sexton, 1990) and contributing to the berry mass loss similarly to the increase in fruit coloration and without affecting TSS which remained at harvest levels (Fig. 1A, A, F). Ethylene is a well known ripening promoting agent (Awad and Yang, 1979).

Frederic et al. (1992), reported that the loss in fresh mass during storage may be due to the respiratory activity which in turn is enhanced by ethylene (Fig. 1, 3A). Ethylene evolved from ethephon resulted in increased anthocyanin content leading to the improvement of berry red coloration held at 20 or 11 °C similarly to the control. However, berries held at 0 °C had very little increase in anthocyanin content similarly to ethephon-sprayed berries; the final berry coloration was not satisfactory at the end of the experiment. This may be due to the low ethylene concentration for the activation of PAL since at temperatures lower 15 °C ethylene is evolved from ethephon at slower rates (Wilde and Edgerton, 1975). Further, ethephon absorption by berry tissue may be lower at low temperatures or the sensitivity of the tissue- PAL activity-is decreased at low temperatures. Sas (1993), reported that the tissue reaction to ethylene depends on the stage of maturation of the berry in addition to genetical factors.

Prematurely harvested red raspberries followed by ethephon spray then held at 11 °C had a commercially acceptable gradual ripening characterized by softening, coloration improvement and increase in TSS. Ethephon treated berries held at 0 °C had faster softening than coloration.

REFERENCES

Awad, M. and R.E. Young. 1979. Postharvest physiology in cellulase polygalacturonase and pectin methylesterase in avocado fruit (*Pesrea amaricana* Mill cv. Fuerte) in relation to respiration and ethylene production. Pant Physiol. 64:306-308.

Blanpied, G.D. 1972. A study of ethylene in apple, red raspberry and cherry. Plant Physiol. 49: 627-630.

Burton J.N. and R. Sexton. 1990. Fruit abscission and ethylene production of red raspberry cultivars. Scientia Hort. 43: 95-102.

Frederic, B.A., M.W. Page and E.S. Mikal. 1992. Ethylene in plant biology Academic Press INC.

Jennigs, D.L. 1988. Raspberries and Blackberries: their breeding, diseases and growth. Academic press, New york.

Kader, A.A. 1985. Post-harvest technology of horticultural crops. Coop. Ext. Univ. Of California. Div. Agri. And Natural Res. Spec Publ. 3311:3-11.

Nestby, R. 1978. Soluble solids and titratable acidity in berries, cultivars and cross populations of raspberries. Sci. R. Pt. Agr. Univ. Of Norway, Hermansverk. 57 (8): 1-9.

Torre, L.C. and H. Baritt. 1977. Quantitative evaluation of Rubus fruit anthocyanin pigments. J. Food Sci. 42:488-490.

Salunkhe, D.K. and B.B. Desai. 1984. Small fruits-berries. In Salunkhe D.K. 1984 Postharvest Biotechnology of Fruits.Vol 1. CRC Press Inc. Boca Raton Florida.

Sas, P. 1993. Fruit storage. Postharvest International symposium. 100-104. (Keacakemet).

Sfakiotakis, E.M. and G. Stavroulakis. 1989. Effect of CA and Ultra low oxygen on superficial scald and quality preservation of Starcking Delicious apples In: CA Lagersymposium fur Obstfruchte mit Internationaler Beteiligung H.H.Sculz et al., Helt 1:31-38.

Sjulin T.M. and J.A. Robbins. 1984. Progress in extending raspberry shelf life. Fresh market studies of red raspberries. Proc. 74th Ann. Mtg West. Wash. Hort. Assn. P. 96-98.

Sjulin T.M. and J.A. Robbins. 1987. Effects of maturity, harvest date and storage time on postharvest quality of red raspberry fruit. J. Amer. Soc. Hort. Sci. 112.: 481-487.

Stavroulakis, G. and E. Sfakiotakis. 1992. Regulation by temperature of the propylene induced ethylene biosynthesis and ripening in "Hayward" kiwifruit. In: Proceedings of the International Symposium on Cellular and Molecular Aspects of the Plant Hormone Ethylene. Agen. France.

Tomalin A.J.W. and A. Robinson. 1971. Cold storage only suitable for top class fruit. The grower. 76: 42:488-490.

Varseveld G.W. and D.G. Richardson. 1980. Evaluation of storage and processing of mechanically and hand harvested *Rubus spp*. Acta Hortic. 112: 265-272.

Wilde, M.H. and L.J. Edgerton. 1975. History of ethephon injury on Montmorency cherry branches. Hort Sci. 10:79-81.

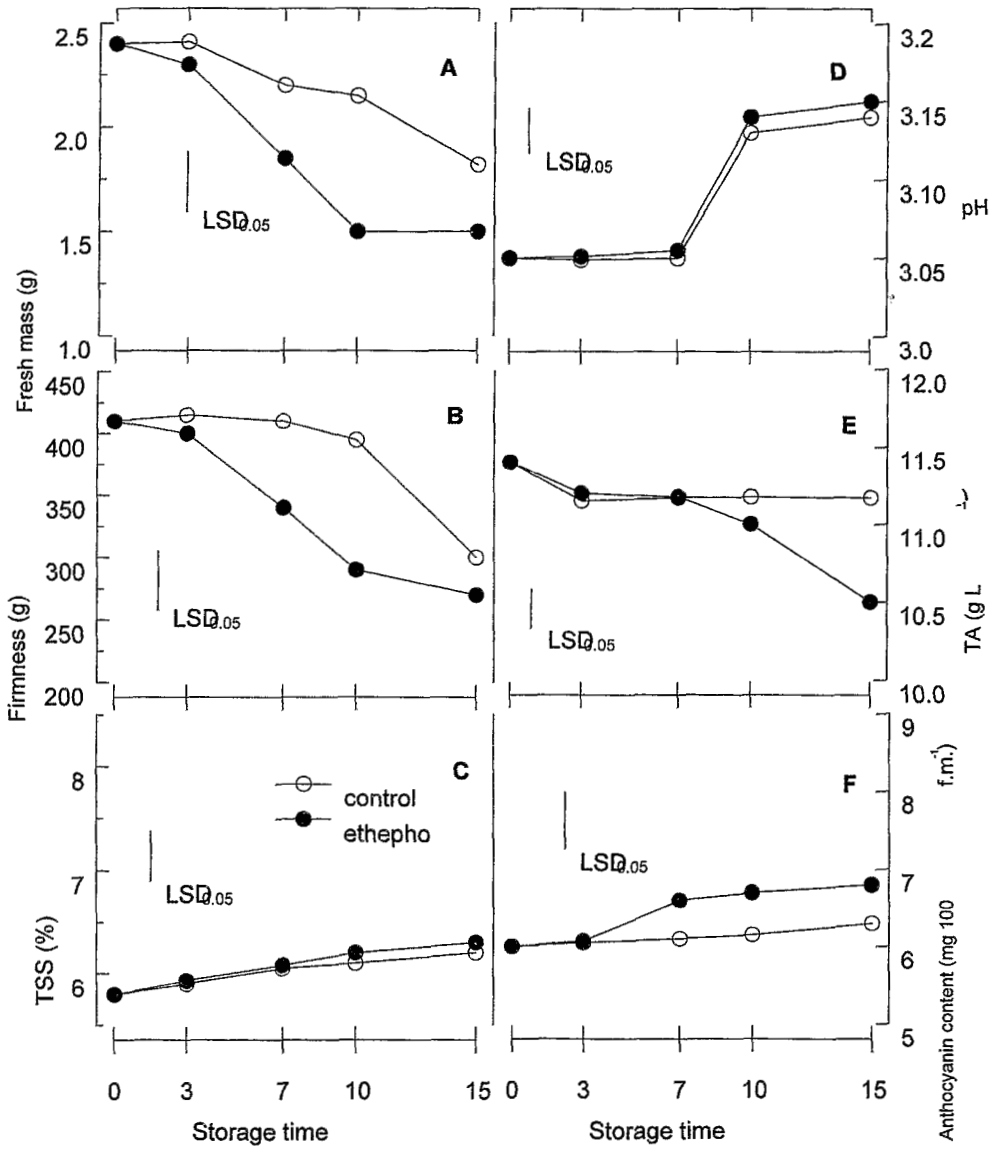

Fig. 1. Fresh mass (A), firmness (B) TSS (C), pH (D), TA (E) and anthocyanin content of red raspberries during storage at 0 °C for 15 days.

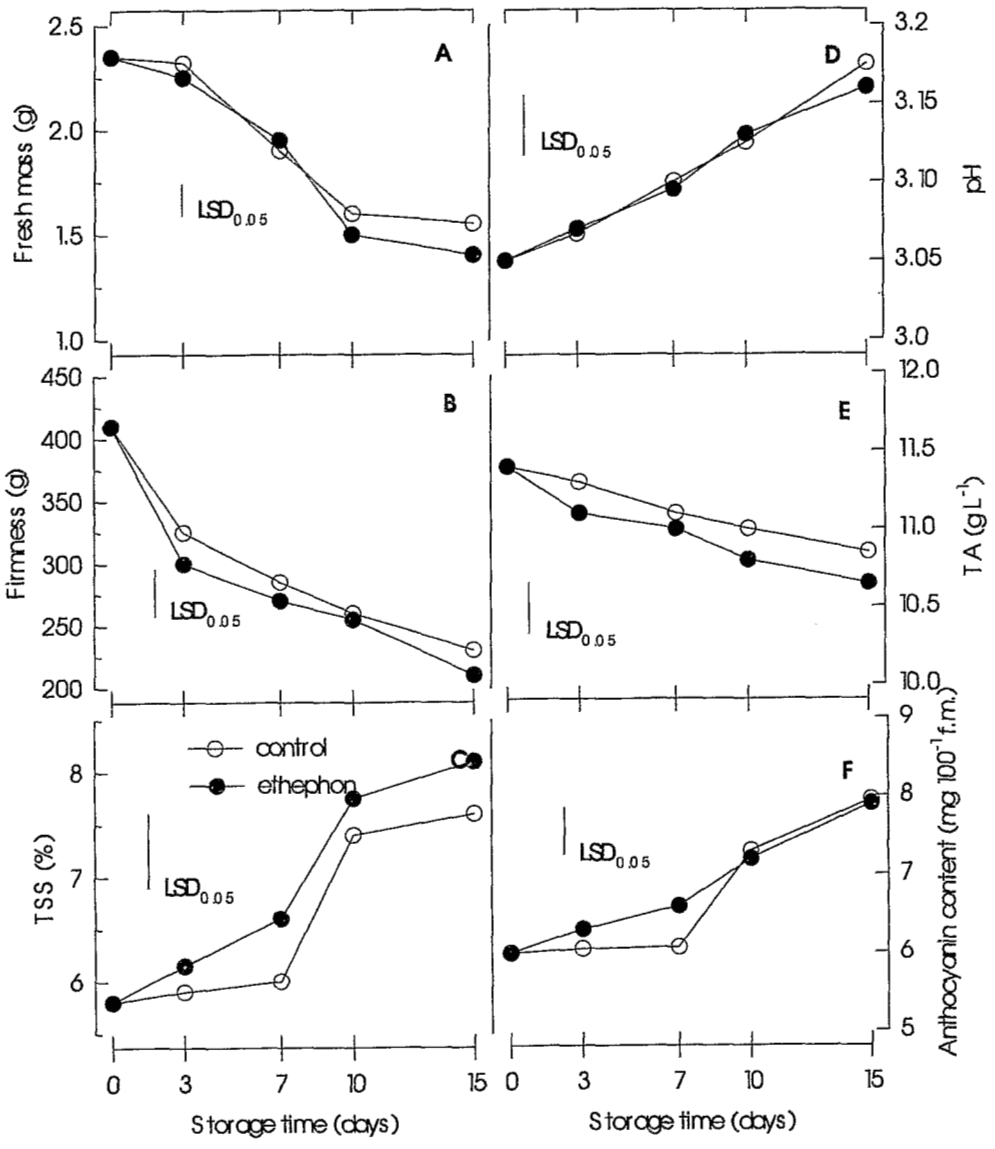

Fig. 2. Fresh mass (A), firmness (B) TSS (C), pH (D), TA (E) and anthocyanin content of red raspberries during storage at 11 °C for 15 days.

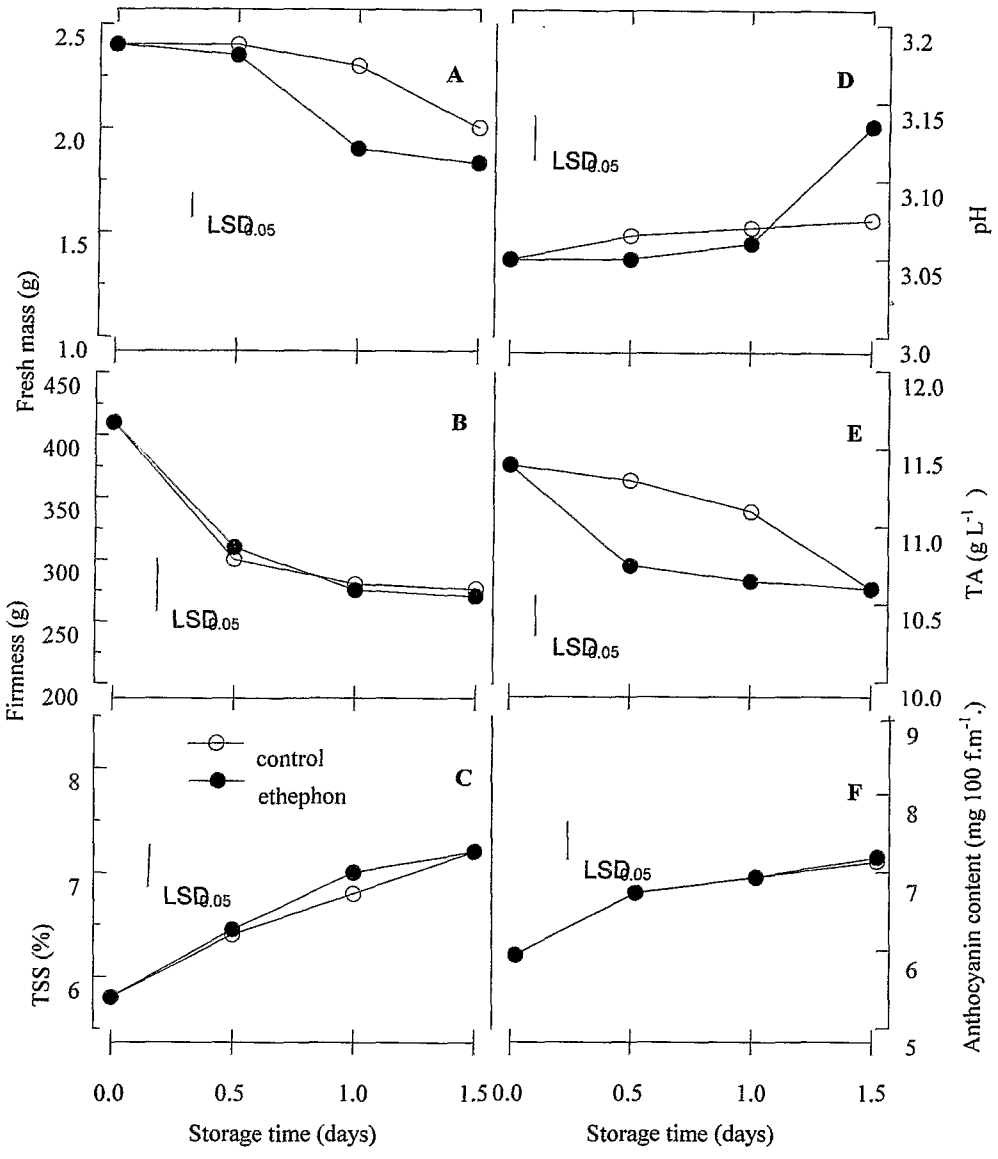

Fig. 3. Fresh mass (A), firmness (B) TSS (C), pH (D), TA (E) and anthocyanin content of red raspberries during storage at 20 °C for 1.5 days.