Research article

Effect of Calcium Ascorbate Treatments on Juice Leakage of Fresh Cut Watermelon (*Citrullus lanatus*)

INTIRA LICHANPORN*
Faculty of Agricultural Technology, Rajamangala University of Technology Thanyaburi, Phathum Thani, Thailand
Email: lintira@yahoo.com

NUNCHANOK NANTHACHAI
Faculty of Agricultural Technology, Rajamangala University of Technology Thanyaburi, Phathum Thani, Thailand

PALIDA TANGANURAT
Faculty of Agricultural Technology, Rajamangala University of Technology Thanyaburi, Phathum Thani, Thailand

UNCHALIN SINGKHUM
Faculty of Agricultural Technology, Rajamangala University of Technology Thanyaburi, Phathum Thani, Thailand

Received 30 December 2013 Accepted 20 March 2014 (*Corresponding Author)

Abstract Before cutting, melons were washed with sodium hypochlorite (100 ml/l active ingredient) and water rinsed. Melons were cut longitudinally into four parts, cut into triangles 2 cm thick. A piece of watermelon was chosen from the center. Watermelon slice were dipped in calcium ascorbate (CaAsc; 0, 1, 5, 10 and 20%, w/w) for 2 minutes and drained. Fresh-cut watermelon was arranged in foam trays with 4 pieces per tray, covered with plastic polyethylene (LLDPE) film and stored at 10°C with relative humidity of 90-95%. At each storage interval, melon slices were evaluated for weight loss, changes in color (L*, a* and b*), total soluble solids and juice leakage. Dipping fresh-cut watermelon slices in 5, 10 and 20% CaAsc increased the weight loss up to 9.73 12.83 and 13.65% respectively, compared with watermelon dipped in 0 and 1% CaAsc, which only experienced 4.88 and 4.10% of weight loss after storage for 8 days. Percent juice leakage in fresh-cut watermelon dipped in 1 and 5% CaAsc was less than the other treatments. The effect of calcium ascorbate on the changes of color and total soluble solids were not significantly different. However, fresh-cut melon dipped in 1% CaAsc tended to reduce the changes of weight loss and juice leakage better than other treatments.

Keywords watermelon, calcium ascorbate, juice leakage

INTRODUCTION

Fresh-cut watermelon is sold as quarters and halves with rind, or as cubes without rind. Quality degradation of fresh-cut watermelon has been described as loss of texture, color, and sweetness (Rushing et al., 2001). Juice leakage in fresh cut watermelon can increase as a result of cube size, storage temperature, or modified atmosphere. Fonseca et al. (1999) found that cubes of length <1.9 cm had more juice leakage due to cut surface injury, while cubes >4 cm in length had more juice loss from compression. Water-soaked appearance of watermelon is an ethylene-induced phenomenon characterized by softening and maceration of the endocarp and the placenta tissues (Risse and Hatton, 1982; Elkashif and Huber, 1988a, 1988b). Water-soaked tissue is characterized by enhanced solute leakage, degradation of pectic polymers, cell separation, and loss of cell wall rigidity (Elkashif and Huber, 1988a, 1988b). The induction of water-soaking and the related increases in softening and cell leakage by ethylene parallel the role of this growth regulator in ripening; Calcium plays a pivotal role in cell signals related to AOS (Bhattacharjee, 2005). Calcium dips have been implicated in enhancing membrane stability, slowing senescence, and improving the retention of membrane integrity (Picchioni et al., 1996). The softening rate is related to Ca levels in the fruit tissue (Fallahi et al., 1997). For this reason, Ca dips have been used as firming agents to extend post harvest life of several products. Firmness and resistance to softening, resulting from addition of Ca, have been attributed to the stabilization of membrane systems and formation of Ca pectate, which increases rigidity of the middle lamella and cell walls, leading to increased resistance to polygalacturonase (PG) activity and to improved turgor pressure (Mignani et al., 1995). Ca ions form intermolecular bridges by interaction with free car- boxyl groups of pectic acid polymers to form insoluble salts with ionic linkages between pectin molecules (McFeeters and Fleming, 1991). Ca application often results in reduced incidence of physiological disorders and decay (Garča et al., 1996). Therefore, in this study we determine the effects of calcium ascorbate (CaAsc) dips, subsequent storage time and a maintained modified atmosphere condition on juice leakage of fresh-cut watermelon.

OBJECTIVE

The objective of this study was to determine effects of calcium ascorbate treatments on juice leakage of fresh cut watermelon (*Citrullus lanatus*).

METHODOLOGY

Watermelon (*Citrullus lanatus*) fruit was purchased from a commercial market in Phathumtani province in Thailand. Before cutting, melons were washed with sodium hypochlorite (100 ml-*l^{-1} active ingredient) and water rinse. Melons were cut longitudinally into four parts, and then cut into triangles 2 cm thick. A piece of watermelon was chosen from the center. Watermelon slices were dipped in calcium ascorbate (CaAsc; 0, 1, 5, 10 and 20%, w/w) for 2 minutes then removed. Fresh-cut watermelon was arranged in foam trays with 4 pieces per tray and covered with plastic polyethylene (LLDPE) film and stored at 10°C with relative humidity of 90-95%. At each storage interval, melon slices were evaluated for changes in color (L*, a* and b*), total soluble solids, juice leakage and weight loss.

Watermelons from each treatment were weighed individually before and during the storage period, and the percentage of weight loss was calculated using the equation by:

$$\text{Totalweight loss}(\%) = \left[\frac{\text{initial weight of fruit - initial weight of fruit}}{\text{initial weight of fruit}}\right] \times 100 \qquad (1)$$

Colorimeter measurements were made at days 0, 2, 4, 6 and 8 on eight random cubes per container replicate using a chromameter with an aperture of 8mm diameter, D65 illuminant, and CIE *L**, *a**, *b** color scale, (Minolta CR200, Ramsey, NJ).

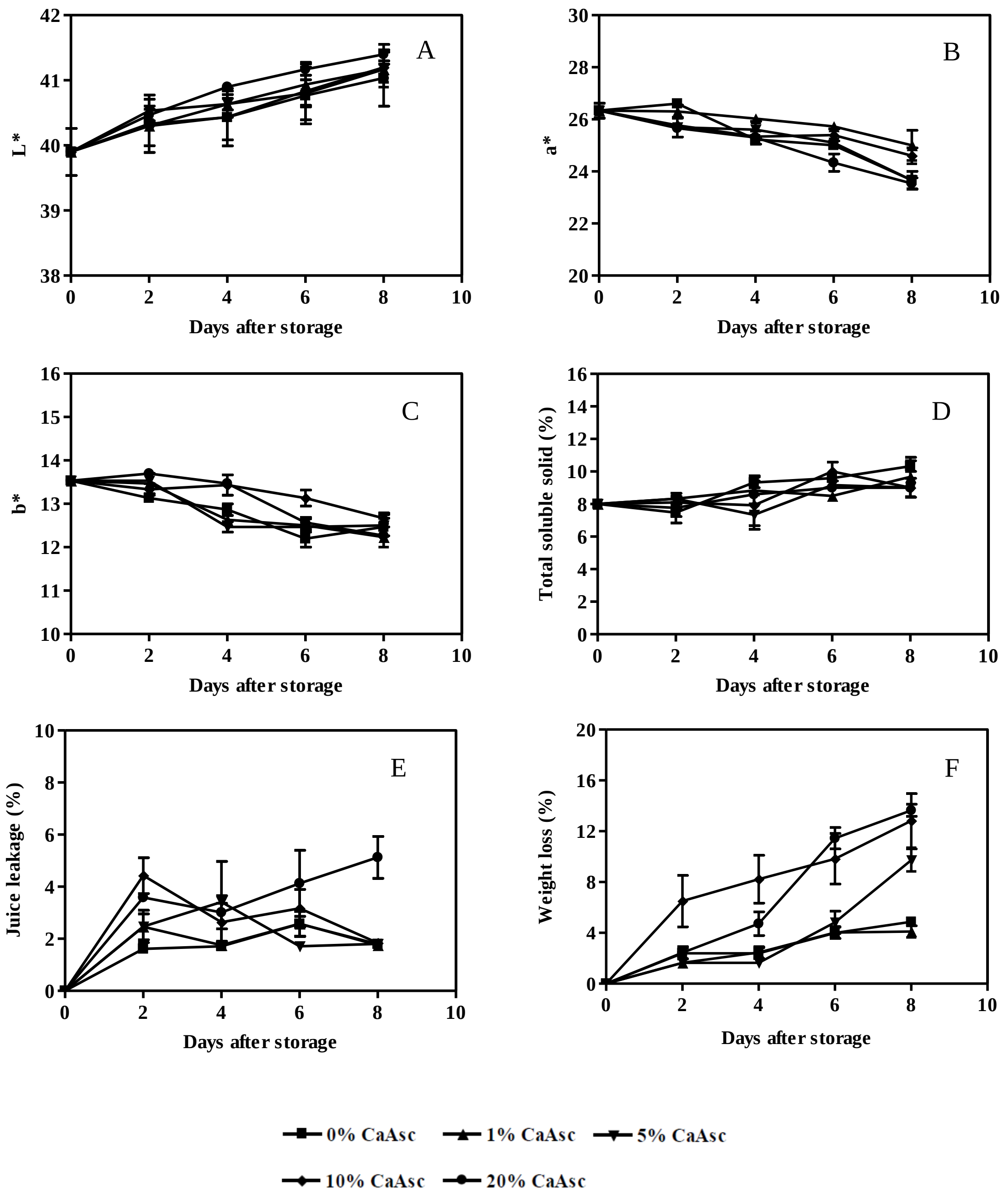
Percent juice leakage was determined by weight after each storage interval, using the formula

$$\text{Percent juice leakage}(\%) = \left[\frac{(\text{container + Juice wt.}) \text{ - container wt.}}{(\text{container +fruit wt.}) \text{ - container wt.}}\right] \times 100\ \% \quad (2)$$

Total soluble solid (TSS) from fruit juice was measured by a digital refractometer (PAL-1, Atago, Tokyo, Japan). The units of TSS were expressed as a percentage.

RESULTS AND DISCUSSION

Watermelon treatment dipped in 0, 1, 5, 10 and 20% CaAsc were not significantly different in regards to brightness (L*) throughout storage (Fig. 1A). The lack of predictive power using reflectance tristimulus colorimetry to determine lycopene content in watermelon flesh has been previously reported and is thought to be due to the lack of instrument sensitivity (Perkins-Veazie et al., 2001). While, a* value is the redness, which was found to have decreased slightly during storage (Fig. 1B). The b* values, the blueness was reduced slightly as a result of the oxidation process and deterioration (Perkins-Veazie and Collins, 2004) (Fig. 1C). Fresh cut watermelon dipped in 0, 1, 5, 10 and 20% CaAsc showed a slight increase in the total soluble solid throughout storage (Fig. 1D). The total soluble solids in the range from 7.33 to 10.33%, is consistent with the research of Perkins-Veazie and Collins (2004). They found that the total soluble solids of watermelons, cv Summer Flavor 800 and Sugar Shack, that were cut into 5 cm pieces were in the range of 11.4 to 12.2%. The juice leakage of fresh cut water melon increased rapidly in the first 2 days (Fig. 1E), this may be a consequence of the increase of tissue decomposition.



L (A), a* (B), b* (C), Total soluble solid (D), Juice leakage (E), Weight loss (F)*

Fig. 1 Effects of calcium ascorbate on quality of fresh cut watermelons

Juice leakage is not a desirable characteristic in fresh cut watermelons, as the juice gives the tissue a water-soaked appearance, and provides an excellent medium for microbial growth (Cartaxo and Sargent, 1997). Juice leakage in fresh cut watermelon can increase as a result of cube size, storage temperature, or modified atmosphere. Fonseca et al. (1999) found that cubes of length <1.9 cm had more juice leakage due to cut surface injury, while cubes >4 cm in length had more juice loss from compression. Sargent (1998) found that fresh cut watermelon cubes held at 1°C had 50% more leakage than those held at 3 °C, and concluded that this difference was due to chilling injury. Cartaxo and Sargent (1997) reported that juice leakage increased from 10 to 20% in fresh-cut watermelon stored 5 days at 3 °C under actively maintained atmospheres of O_2, 3 kPa, plus CO_2, 5–20 kPa, compared to that stored in an ambient environment. The percent leakage found in our study was similar to that reported by Fonseca et al. (1999) for non-compartmentalized Sangria watermelon cubes. Although the 5% CaAsc treatment slightly decreased the percent juice leakage in fresh -cut watermelon, fresh-cut watermelon dipped in 1% CaAsc tended to reduce the changes of weight loss and juice leakage better than other treatments. The weight loss of fresh cut watermelon dipped in calcium ascorbate concentration of 1% was not significantly different from the control (Fig.1F). However, fresh cut watermelon dipped in 1 and 5% CaAsc had more weight loss than controls during the first 2 days of storage. The properties of calcium increased the firmness. Dipping in calcium ascorbate will reduce the loss of firmness in apples stored by approximately 13 % after 3 weeks at 10 ºC (Fan et al, 2005).

CONCLUSION

Calcium ascorbate affected the changes of color (L* a* b*) and total soluble solids in fresh cut watermelon. Dipping with 1% calcium ascorbate decreased the weight loss and juice leakage. A dipping treatment in 5, 10 and 20% calcium ascorbate increased the weight loss and juice leakage more than the control of fresh cut watermelon.

ACKNOWLEDGEMENTS

This work was supported by Faculty of Agricultural Technology, Rajamangala University of Technology Thanyaburi (RMUTT).

REFERENCES

Bhattacharjee, S. 2005. Reactive oxygen species and oxidative burst: roles in stress, senescence and signal transduction in plants. Current Science, 89(7), 1113-1121.

Cartaxo, C.B.C. and Sargent, S.A. 1997. Controlled atmosphere storage suppresses microbial growth on fresh-cut watermelon. Proceedings of the Florida State Horticultural Society, 110, 252-257.

Elkashif, M.E. and Huber, D.J. 1988a. Enzymic hydrolysis of placental cell wall pectins and cell separation in watermelon (Citrullus lanatus) fruits exposed to ethylene. Physiologia Plantarum, 73, 432-439.

Elkashif, M.E. and Huber, D.J. 1988b. Electrolyte leakage, firmness, and scanning electron microscopic studies of watermelon fruit treated with ethylene. Journal of the American Society for Horticultural Science, 113, 378-381.

Fallahi, E., Conway, W.S., Hickey, K.D. and Sams, C.E. 1997. The role of calcium and nitrogen in postharvest quality and disease resistance of apples. HortScience, 32, 831-835.

Fonseca, J.M., Rushing, J.W. and Testin, R.F. 1999. Shock and vibration forces influence the quality of fresh-cut watermelon. Proceedings of the Florida State Horticultural Society, 112, 147-152.

Garcia, J.M., Herrera, S. and Morilla, A. 1996. Effect of postharvest calcium dips in calcium chloride on strawberry. Journal of Agriculture and Food Chemistry, 44, 30-33.

McFeeters, R.F. and Fleming, H.P. 1991. pH effect on calcium inhibition of softening of cucumber mesocarp tissue. Journal of Food Science, 56, 730-732, 735.

Mignani, I., Greve, L.C., Ben-Arie, R., Stotz, H.U., Li, C., Shackel, K. and Labavitch, J. 1995. The effects of GA3 and divalent cations on aspects of pectin metabolism and tissue softening in ripening tomato pericarp. Physiologia Plantarum, 93, 108-115.

Perkins-Veazie, P. and Collins, J.K. 2004. Flesh quality and lycopene stability of fresh-cut watermelon. Postharvest Biology and Technology, 31, 159-166.

Perkins-Veazie, P., Collins, J.K., Pair, S.D. and Roberts, W. 2001. Lycopene content differs among red-fleshed watermelon cultivars. Journal of the Science of Food and Agriculture, 81, 1-5.

Picchioni, G.A., Watatd, A.E., Whitaker, B.D. and Reyes, A. 1996. Calcium delays senescence-related membrane lipid components in shredded carrots. Postharvest Biology and Technology, 9, 235-245.

Risse, L.A. and Hatton, T.T. 1982. Sensitivity of watermelons to ethylene during storage. HortScience, 17, 946-948.

Rushing, J.W., Fonseca, J.M. and Keinath, A.P. 2001. Harvesting and postharvest handling. In: Maynard, D. (Ed.), Watermelons: Characteristics, Production, and Marketing. American Society for Horticultural Science Press, Alexandria, VA 22314.

Sargent, S.A. 1998. Fresh-cut watermelon. Citrus Vegetable Magazine, 44, 26-28.