The Journal of Animal & Plant Sciences, 22(2): 2012, Page: 363-368
ISSN: 1018-7081

USE OF *ALOE VERA* GEL AS BIOPRESERVATIVE FOR 'GRANNY SMITH' AND 'RED CHIEF' APPLES

M. Ergun and F. Satici*

Department of Horticulture, Bingol University, Bingol, Turkey
*Yerkoy District Agriculture Directorate, Yerkoy, Sivas, Turkey
Corresponding author email: muharrem.ergun@yahoo.com

ABSTRACT

The aim of this work was to study effects of *Aloe vera* gel (0, 1, 5 and 10% w/v) coating on green-coloured 'Granny Smith' and red-coloured 'Red Chief' apples those were stored at 2 °C for 6 months. *Aloe vera* gel treatments substantially suppressed the increase in weight loss for 'Granny Smith' apples but did not affect weight loss for 'Red Chief' apples. Apples from both cultivars softened at definite rates over time, and these rates were not affected from any of the gel treatments. *Aloe vera* gel treatment suppressed the green colour loss for 'Granny Smith' but remained unaffected for 'Red Chief' apples. Soluble solids content and percentage titratable acidity was recorded higher for 'Granny Smith' apple fruit treated with *Aloe vera* gel (5 and 10%) during most of the storage period while no *Aloe vera* gel effects on colour for 'Red Chief' apples was recorded. The pH values for 'Granny Smith' fruit slightly decreased while slightly increased for 'Red Chief' fruit over time, yet values for both cultivars remained unaffected by *Aloe vera* gel treatments. The results indicated that *Aloe vera* gel treatment may be used as biopreservative on 'Granny Smith' apples for retarding quality losses.

Key words: *Aloe vera* gel coating, 'Granny Smith', 'Red Chief', biopreservation, apple fruit quality.

INTRODUCTION

Biopreservation is a novel food preservation method defined for extension of shelf life and enhanced safety of foods by the use of natural or controlled microbiota and/or antimicrobial compounds (Ananou *et al*., 2007). In postharvest technology, biopreservation takes aim at extending storage/shelf life of fruits and vegetables by utilizing plant-based products those have been used in food engineering for a long time. Recently, these plant-based products have been started to use in fresh fruits and vegetables as biopreservatives. *Aloe vera* gel is one of the promising biopreservative which has a great potential to become a common use for most fresh fruits and vegetables.

Aloe vera has been used as an herbal remedy for regeneration and rejuvenation of human skin since ancient time in China, Japan and India (Boudreau and Beland, 2006). Today, *Aloe vera* gel derived from its leaves is commonly used for medical studies and cosmetic products. Although mostly used for medical studies (Shamin *et al*., 2004; Rosca-Casian *et al*., 2007), the gel has been tested for few fresh fruits by a postharvest research group from Spain since 2005 (Valverde *et al*., 2005). This research group registered that *Aloe vera* extracts suppressed/retarded postharvest quality losses in 'Crimson Seedless' grapes and 'StarKing' cherries (Valverde *et al*., 2005; Serrano *et al*., 2006; Martínez-Romeroa *et al*., 2006; Castillo *et al*., 2010). Furthermore, *Aloe vera* extracts were reported to be useful for 'Kensington Pride' mangoes (Dang *et al*., 2008) and 'Artic Snow' nectarines (Ahmed *et al*., 2009) for retaining quality losses after harvest.

Aloe vera gel is applied to fruits as an edible coating which has been widely used for most fruits and vegetables. Edible coatings have a various favourable effect on fruits such as imparting a glossy appearance and better colour, retarding weight loss, or prolonging storage/shelf life by preventing microbial spoilage (Dang *et al*., 2008). The performance of *Aloe vera* gel as edible coating is dependent on its composition (Dang *et al*., 2008). Its use offers an option to film packaging owing to their environmentally friendly characteristic (Rojas-Argudo *et al*., 2005). *Aloe vera* leaves are rich in bioactive compounds some of which are antioxidants those are broadly used in food engineering as preservative such as mannans, antrachinon, c-glycoside, antron, antrakuinon and lectine (King *et al*., 1995; Eshun and He, 2004).

Considering *Aloe vera*'s success on biopreservation of table grapes, cherries, mangos and nectarines, and increasing demands for environmentally friendly postharvest handling procedures, we investigated the use of *Aloe vera* jel as biopreservative for 'Granny Smith' and 'Red Chief' apples. The main reason choosing these apple cultivars in our study is their distinctive fruit colouration which is frequently used as a quality index (Khanizadeh, Cousineau, 1998).

MATERIALS AND METHODS

Plant material: 'Granny Smith' and 'Red Chief' apples were harvested by hand at optimum maturity based on colour and soluble solids concentrations (harvest values as month 0 are given in the result section) from two commercial orchards at Goksun city in Southern Turkey. The orchard with 'Red Chief' trees are located on latitude 38° 1' 42.74" N and on longitude 36° 30' 40.82" W, and 1344 m above sea level; the orchard with 'Granny Smith' on latitude 38° 03' 18.41" N and on longitude 36° 33' 43.15" W, and 1351 m above sea level.

***Aloe vera* gel coating treatments:** *Aloe vera* gel was obtained from Forever Living Products for Health and Beauty Ltd. Istanbul, Turkey. Fruit of uniform size, free from visual blemishes and diseases were employed in this work. Apples were randomly divided into 4 batches having approximately 125 fruit. The apples were then treated with *Aloe vera* gel dilutions, prepared with distilled water, (0% as control, 1, 5 or 10%) by dipping for 2-3 sec. After letting dry, apples were placed in plastic trays (36 fruit per tray) in commercial cardboard boxes (29.5 cm wide by 50.00 cm long by 10.0 high; one tray per box). The boxes were stored in a cold room at 2 °C for 6 months. Two-degree refrigeration temperature was selected over 0 °C that is a common storage temperature for various apples due to the probability of uncontrolled temperature fall below 0 °C which could have jeopardized the experiment.

Weight loss and firmness: Weight loss was determined considering the fresh weight at harvest using a balance with an accuracy of 0.01 g. Weight loss was then calculated from the weight of each apple measured initially before storages and after 1, 2, 3, 4, 5 and 6 months. Fruit firmness was measured on the equatorial zone of the both cheeks after removing fruit skin using a hand penetrometer (McCormick, FT 327, USA) with a convex probe tip (1 cm diameter). Randomly selected, a set of 10 fruit from each gel treatment after every removal from the cold room was used to measure firmness and other measurements indicated below.

Instrumental colour and visual assessment: Fruit skin colour was periodically measured on the equatorial zone of the both cheeks from the same fruit (10 fruit per treatment) using a Minolta CR-400 colorimeter, calibrated with a white reference plate. Measurements were recorded using standard CIE L* a* b* colour space coordinates. Moreover, digital pictures (12 Mpx) of selected apples were periodically taken to keep track visual changes including storage scald that can be seen by naked eyes.

Soluble solids content, pH, titratable acidity: Whole fruit were passed through an electric juicer (King P-110, China) and filtered through cheesecloth for the measurement of soluble solids content (SSC), pH and titratable acidity (TA). SSC was measured by a digital refractometer (Atago NI, Japan) and pH a digital pH meter (WTW 526, Germany). TA was determined by titration of 5 ml juice diluted with 25 ml distilled water to pH 8.2 with 0.1 N NaOH and expressed as percentage malic acid.

Treatment design and statistical analyses: The experimental design was arranged as Completely Randomized Design with 10 replicates. Analysis of variance (ANOVA) and LSD test of significant difference ($p \leq 0.05$) was performed using SAS software (release 9.1.3, SAS Institute Inc., Cary, North Caroline, USA).

RESULTS AND DISCUSSION

Weight loss and firmness: Fruit from both cultivars lost weight throughout the storage period (Fig-1). Fruit from 'Granny Smith' treated with 0% *Aloe vera* gel as control had statistically higher weight loss compared to fruit treated with 1, 5 or 10% *Aloe vera* gel during most of the storage period. The percentage of cumulative weight loss for 'Granny Smith' apples increased to 2.20% from control, to 1.90% 1.70% 1.90% from treatments of 1% 5% and 10% *Aloe vera* gel respectively by the end of the storage period. Weight loss for 'Red Chief' apples also increased as storage time passed irrespective of the gel treatments and no statistical differences from the treatments were noted. The percentage cumulative weight loss for control 'Red Chief' apples increased to 2.10%, for both 1 and 5% *Aloe vera* gel-treated 'Red Chief' apples to 2.00%, and for 10% *Aloe vera* gel-treated 'Red Chief' apples to 1.90% by the end of the storage period. Fruit size, stage of ripeness and fruit surface greatly affected fresh weight loss occurring mostly in the form of water vapour. In the present experiment, *Aloe vera* gel suppressed the increase in weight loss for 'Granny Smith' but not for 'Red Chief', which may be attributed to differences between fruit surface structure and/or fruit size. Similar to our results in the case of 'Granny Smith', *Aloe vera* gel suppressed the increase in weight loss Ahmed *et al*.(2009) reported for 'Arctic Snow' nectarines (treated with 2.50%, stored at 20°C;, 'StarKing' cherries (treated with 33%, stored at 1°C; Martinez-Romero *et al*., 2006) and 'Autumn Royal' table grapes (treated with 33%, stored at 2°C; Castillo *et al*., 2010).

Fruit firmness from each treatment for both cultivars gradually decreased during the storage period (Fig-1). Initial firmness value for 'Granny Smith' apples was 4.41 kg force before the storage, after the storage the firmess declined to 3.94 kg force for control fruit, to 3.72 kg force for 1% *Aloe vera* gel-coatred fruit, to 3.95 kg force for 5% *Aloe vera*-coated fruit and to 3.80 kg force for 10% *Aloe vera* gel-coated fruit. Initial firmness value

for 'Red Chief' apples was 4.00 kg force before the storage, after the storage the firmness declined to 2.82 kg force for control fruit, to 2.73 kg force for 1% *Aloe vera* gel-coated fruit, to 2.76 kg force for 5% *Aloe vera* gel-coated fruit and to 2.91 kg force for 10% *Aloe vera* gel-coated fruit. There were no statistical differences among treatments for both cultivars. In contrast to our findings, *Aloe vera* gel treatment (100%) suppressed the firmness loss in 'Kensigton Pride' mangoes ripened at 21°C for 19 d (Dang *et al*., 2009). This marked affect could be due to the higher *Aloe vera* gel ratio and/or higher storage temperature employed for the mangoes compared to our experiment.

Instrumental colour: Fruit from each treatment for both cultivars registered some changes in chromatic L*, a* and b* colour values during the storage period (Fig-2). L* values from 'Granny Smith' fruit increased over time irrespective of the treatments from 58.50 to 62.32 for control, from 58.50 to 63.15 for 1% *Aloe vera* gel-coated fruit, from 58.50 to 63.65 for 5% *Aloe vera* gel-coated fruit and from 58.50 to 61.62 for 10% *Aloe vera* gel-coated fruit while no significant variations were recorded from any of the gel treatments. Chromatic a* value from 'Granny Smith' fruit also increased over time irrespective of the treatments. Before the storage, the a* value for 'Granny Smith' apples was -15.57, and after the storage the value reached to -12.47 for control fruit, to -11.80 for 1% *Aloe vera* gel-coated fruit, to -13.26 for 5% *Aloe vera* gel-coated fruit and to -13.93 for 10% *Aloe vera* gel-coated fruit. The increase in a* value was however slower for fruit treated with 5 or 10% *Aloe vera* compared to control or 1% *Aloe vera* gel treatments, resulting a significant differences among the treatments. Chromatic b* value similar to L* and b* value for 'Granny Smith' fruit slightly increased over time regardless of the treatments, and no marked differences were registered from any of the gel treatments. Initial b* value for 'Granny Smith' apples was 27.98, afterwards the value gradually increased, reaching to 30.05 for control fruit, to 30.64 for 1% *Aloe vera* gel-coated fruit, to 30.26 for 5% *Aloe vera* gel-coated fruit and to 31.07 for 10% *Aloe vera* gel-coated fruit.

Chromatic L^* value for 'Red Chief' apples increased with time irrespective of the treatments from 25.46 to 27.84 in control, from 25.46 to 27.43 in 1% *Aloe vera* gel-coated fruit, from 25.46 to 28.26 in %5 *Aloe vera* gel-coated fruit and from 25.46 28.50 in 10% *Aloe vera* gel-coated fruit while no marked differences form the gel treatments were recorded. Changes in chromatic a* value of 'Red Chief' apples treated with or without *Aloe vera* gel showed similar patterns over time; first slightly increased then decreased but no marked differences were recorded from any the treatments throughout the cold storage period. Before the storage chromatic a* value for 'Red Chief' apples was 22.75, afterwards changed to 23.73 for control, to 24.08 for 1% *Aloe vera* gel-coated fruit, to 24.01 for 5% *Aloe vera* gel-coated fruit and to 22.50 for 10% *Aloe vera* gel-coated fruit. Chromatic b* value of 'Red Chief' apples showed very subtle changes in the course of storage, therefore, no statistical differences recorded from the treatments. Initial b* value for 'Red Chief' was 6.96, afterwards changed to 7.62 in control, to 8.14 in %1 *Aloe vera* gel-coated fruit, to 8.50 5% in *Aloe vera* gel-coated fruit and to 8.07 10% *Aloe vera* gel-coated fruit at the end of the storage period.

No visual disparity for 'Granny Smith' or 'Red Chief' due to the treatments was observed during and after the storage period. Very sensitive to storage scald, 'Granny Smith' never showed even any diminutive scald incidences during and after the storage period regardless of the treatments. This probably resulted from the continuous circulation of fresh air throughout the cold room, which prevented the increase in the proportion of aromatic substances causing storage scald.

Both apple cultivars showed an increase in chromatic L* values on the fruit skin. This increase indicated apple fruit skin became brighter irrespective of the treatments, which most likely resulted from lower water loss percentages on the fruit skin. Regarded as greenness (-)/redness (+), the increase in chromatic a* value for 'Granny Smith' was suppressed by *Aloe vera* gel treatment, which indicated that *Aloe vera* gel treatment delayed the green colour loss on the fruit skin. This may be attributed to modified atmospheric conditions created by *Aloe vera* gel coating, in return delaying chlorophyll degradation and carotenoid synthesis (Carillo-Lopez *et al*., 2000; Hoa *et al*., 2002).

Soluble solids concentration, titratable acidity, pH: Fruit SSC for both cultivars irrespective of the treatments slightly declined from 13.20% to 10.90% in control, from 13.20% to 11.94% in 1% *Aloe vera* gel-coated fruit, from 13.20% to 12.76% in 5% *Aloe vera* gel-coated fruit and from 13.20% to 12.72% in 10% *Aloe vera* gel-coated fruit for 'Granny Smith' apples; from %14.16 to 13.52% in control, from %14.16 to 12.90% in 1% *Aloe vera* gel-coated fruit from %14.16 to 13.38% in 5% *Aloe vera* gel-coated fruit and from %14.16 to 13.74% in 10% *Aloe vera* gel-coated fruit for 'Red Chief' apples (Fig-3). Except for the last month of the storage period, 'Granny Smith' apples subject to 5 or 10% *Aloe vera* gel treatment had higher SSC relative to 0 or 1% *Aloe vera* gel treatment while no significant *Aloe vera* gel effect was recorded for 'Red Chief' apples. The decrease in SSC for both cultivars irrespective of the treatments was subtle, which indicated that 2-°C refrigerated storage regime is very suitable for 'Granny Smith' and 'Red Chief' apples in terms of retarding internal quality characteristics. Higher concentrations of *Aloe vera* gel treatments suppressed the decrease in SSC for 'Granny Smith' apples. *Aloe vera* gel treatment (2.5%) on the other hand

suppressed the increase in SSC for 'Artic Snow' nectarines during ripening at 20°C (Ahmed *et al*., 2009).

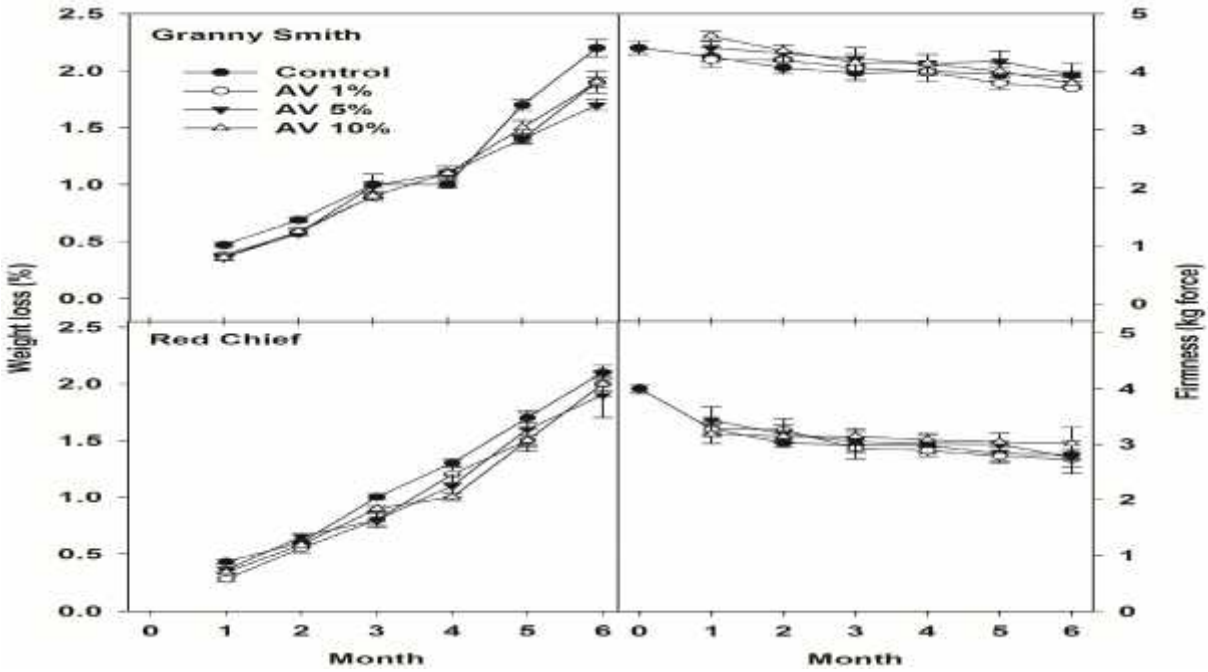

Fig-1 Changes in weight loss (%) and fruit flesh firmness for 'Granny Smith' and 'Red Chief' apples treated with *Aloe vera* gel coating (1, 5 and 10%) or without (control) during cold storage.

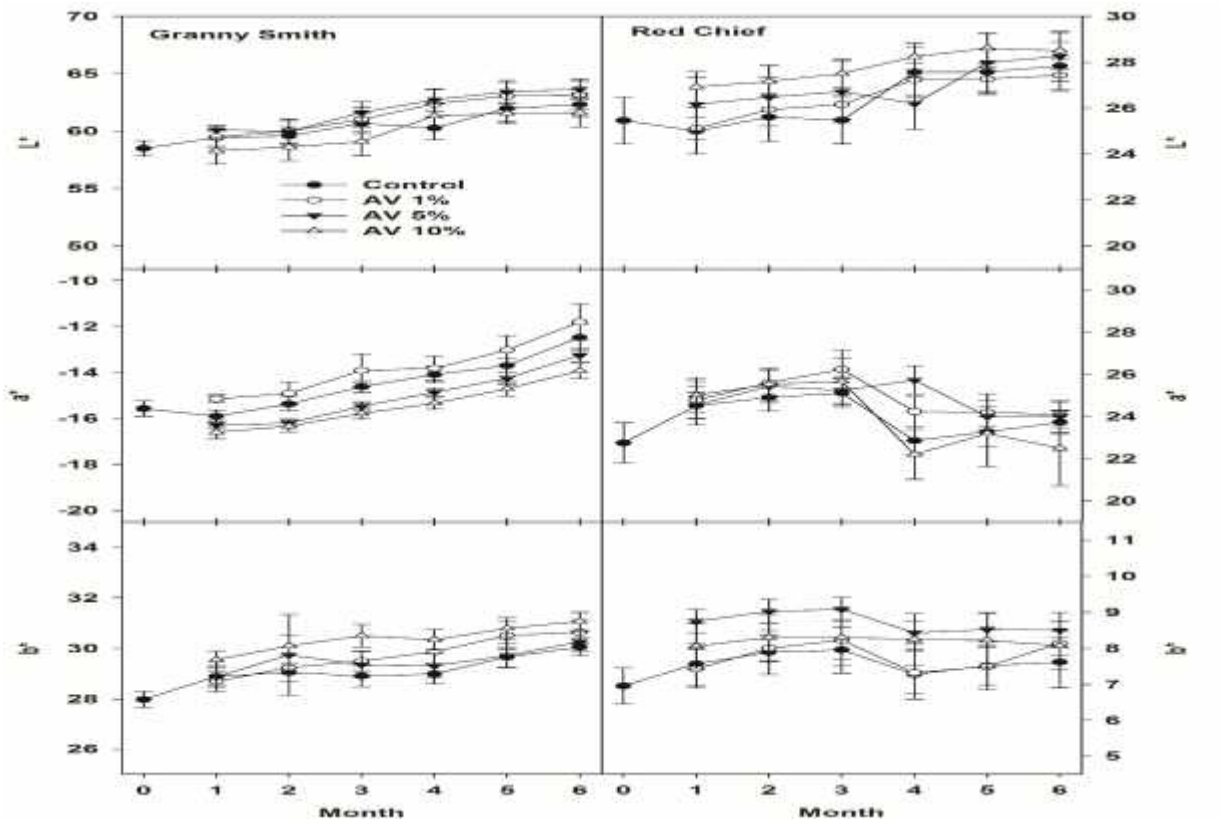

Fig-2 Changes in chromatic L*, a* and b* colour values of 'Granny Smith' and 'Red Chief' apples treated with *Aloe vera* gel coating (1, 5 and 10%) or without (control) during cold storage..

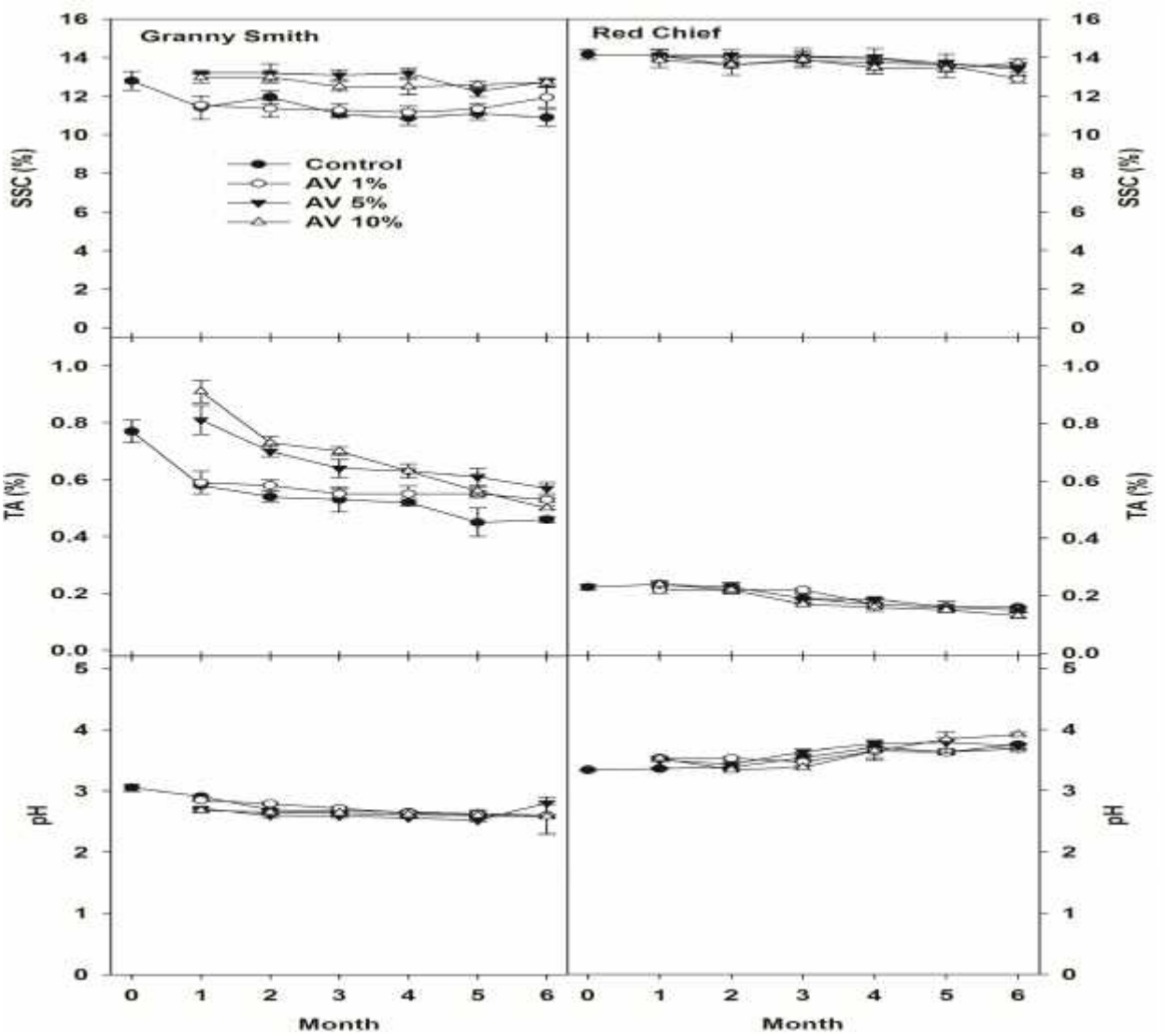

Fig-3 Changes in soluble solids content (SSC), titratable acidity (TA) and pH values of 'Granny Smith' and 'Red Chief' apples treated with Aloe *vera gel* coating (1, 5 and 10%) or without (control) during cold storage.

Similar to fruit SSC, fruit TA for both cultivars decreased in the course of the storage from 0.77% to 0.46% with control fruit, from 0.77% to 0.53% in 1% Aloe *vera* gel-coated fruit, from 0.77% to 0.57% in 5% *Aloe vera* gel-coated fruit and from 0.77% to 0.50% in 10% *Aloe vera* gel-coated fruit for 'Granny Smith' apples; from 0.23% to 0.16% in control fruit, from 0.23% to 0.15% in both 1% and 5% Aloe *vera* gel-coated fruit, and from 0.23% to 0.13% in 10% *Aloe vera* gel-coated fruit for 'Red Chief' apples (Fig-3). Higher *Aloe vera* gel concentrations delayed the decrease in TA for 'Granny Smith' apples during first 4 months of the storage period but *Aloe vera* jel treatments had no effects for 'Red Chief' apples. The decrease in both SSC and TA for 'Granny Smith' was repressed higher concentrations of *Aloe vera* gel treatments. This may be again due to modified atmospheric conditions created by *Aloe vera* gel coating, which may decrease respiration and eventually catabolism of soluble solids including sugars and organic acids. Suppressed TA loss due to *Aloe vera* gel treatment was also reported for the nectarines (Ahmed *et al*., 2009).

Values of pH slightly decreased for 'Granny Smith' while slightly increased for 'Red Chief' apples over time regardless of the treatments, and no *Aloe vera* gel treatment effects were registered for either cultivar (Fig-3). 'Granny Smith' apples had lower pH values (2.50 – 3.05) than 'Red Chief' apples (3.34 – 3.92) during and after the storage period.

Conclusions: It may be concluded that *Aloe vera* gel coating (5 or 10%) is effective in suppressing weight loss, delaying the reduction of soluble solids and titratable acidity, and impeding change of appearance 'Granny Smith' fruit during cold storage. Having no adverse

effects on fruits or the environment, *Aloe vera* gel could easily and safely be applied to 'Granny Smith' apples subject to a refrigerated storage regime for delaying some quality losses and eventually increasing storage/shelf life.

REFERENCES

Ahmed, M. J., Z. Singh, and A. S. Khan (2009). Postharvest *Aloe vera* jel-coating modulates fruit ripening and quality of 'Arctic Snow' nectarine kept in ambient and cold storage. Int. J. Food. Sci. Tech. 44: 1024-1033.

Ananou, S., M. Maqueda, M. Martínez-Bueno, and E. Valdivia (2007). Biopreservation, an ecological approach to improve the safety and shelf-life of foods. In: A. Mendez-Vilas (Editor), Communicating Current Research And Educational Topics And Trends In Applied Microbiology. Formatex, Spain. 475-486 pp.

Boudreau, M. D. and F. A. Beland (2006). An evaluation of the biological and toxicological properties of *Aloe barbadensis* (Miller), *Aloe vera*. J. Environ. Sci. Health. C Environ. Carcinog. Ecotoxicol. Rev. 2(1): 103-154.

Carillo-Lopez, A., F. Ramirez-Bustamente, J. B. Valdez-Torres, R. Rojas-Villages, and E. Yahia (2000). Ripening and quality changes in mango fruit as affected by coating with edible film. J. Food Qual. 23(5): 479-486.

Castillo, S., D. Navarro, P. J. Zapata, F. Guillen, D. Valero, M. Serrano, and D. Martinez-Romero (2010). Antifungal efficacy of *Aloe vera in vitro* and its use as a preharvest treatment to maintain postharvest table grape quality. Postharvest Biol. Tech. 57: 183-188.

Dang, K. T., Z. Singh, and E. E. Swinny (2008). Edible coatings influence fruit ripening, quality and aroma biosynthesis in mango fruit. J. Agri. Food Chem. 56: 1361-1370.

Eshun, K. and Q. He (2004). *Aloe vera*: a valuable ingredient for the food, pharmaceutical and cosmetic industries-a review. Crit. Rev. Food. Sci. Nut. 44(2): 91-96.

Hoa, T., M-N. Ducamp, M. Lebrun, and E. A. Baldwin (2002). Effect of different coating treatments on the quality of mango fruit. J. Food Qual. 25(6): 471-486.

Khanizadeh, S. and J. Cousineau (1998). Our Apples. Agriculture and Agri-Food Canada, St-Jean-sur-Richelieu, Quebec, Canada.

King, G. K., K. M. Yates, P. G. Greenlee, K. R. Pierce, C. R. Ford, B. H. Mcanalley, and I. R. Tizard (1995). The effect of *Acemannan immunostimulant* in combination with surgery and radiation therapy on *Spontaneous canine* and *Feline fibrosarcomas*. J. Am. Anim. Hosp. Assoc. 31(5): 439-447.

Martínez-Romero, D., N. Alburquerqu, J. M. Valverde, F. Guillén, S. Castillo, D. Valero, and M. Serrano (2006). Postharvest sweet cherry quality and safety maintenance by *Aloe vera* treatment: a new edible coating. Postharvest Biol. Tech. 39: 93-100.

Rosca-Casian, O., M. Parvu, L. Vlase, and M. Tamas (2007). Antifungal activity of *Aloe vera* leaves. Fitoteropia 78: 219-222.

Royas-Argudo, C., M. B. Perez-Gago, and M. A. del Rio (2005). Postharvest quality of coated cherries 'Burlat' as affected by coating composition and solids content. Food Sci. Tech. Int. 11(6): 306-311.

Serrano, M., J. M. Valverde, F. Guillen, S. Castillo, D. Martinez-Roero, and D. Valero (2006). Use of *Aloe vera* gel coating preserves the functional properties of table grapes. J. Agr. Food Chem. 54(11): 3882-3886.

Shamim, S., S. W. Ahmed, and I. Azhar (2004). Antifungal activity of *Allium*, *Aloe*, and *Solanum* species. Pharm. Biol. J. 42(7): 491-498.

Valverde, J. M., D. Valero, D. Martínez-Romero, F. Guillén, S. Castillo, and M. A. Serrano (2005). Novel edible coating based on *Aloe vera* gel to maintain table grape quality and safety. J. Agr. Food Chem. 53(20): 7807-7813.