

Natural Coating Application

Subjects: [Agriculture](#), [Dairy & Animal Science](#)

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anthocyanin

coating

flavonoid

plumcot

respiration

1. Introduction

Plumcot (*Prunus salicina* Lindl. × *P. armeniaca* L.) trees are likely a naturally interspecific hybrid originating between Japanese plum (*Prunus salicina* Lindl.) and apricot (*P. armeniaca* L.) trees a long time ago [\[1\]\[2\]\[3\]\[4\]\[5\]\[6\]](#). There has been an increasing consumer demand for plumcot fruit due to their high bioactive compound content, total flavonoid content, total phenol content, abundance of vitamins A and C, and abundance of mineral nutrients considered important to human health and prevention of disease [\[5\]\[7\]](#). New plumcot cultivars have been actively selected, from 'Harmony' varieties in 2007, 'Tiffany' in 2010, and 'Symphony' in 2011, by The National Horticultural Research Institute of South Korea. However, the post-harvest handling and storage of plumcot fruit has proven difficult for farmers due to its typical climacteric type as a prunus fruit species [\[2\]\[3\]\[5\]](#).

'Harmony' plumcots are widely cultivated in S. Korea and typically harvested at 30–50% red skin coloration in July [\[3\]\[8\]](#). The fruits soften and decay rapidly at room temperature within two to five days due to accelerating internal concentrations of ethylene and CO₂ [\[3\]\[4\]\[8\]\[9\]\[10\]\[11\]\[12\]\[13\]\[14\]\[15\]](#); however, 1-methylcyclopropene has been effective in controlling fruit ripening and the resulting softening, skin color change, and acidity in 'Harmony' fruits [\[8\]](#), but is not seen as a desirable additive by consumers, with additive-free food in increasing global demand [\[12\]](#). Cold storage for several days at temperatures lower than 8 °C has been seen to increase the risk of chilling injury in stone fruits, resulting in internal browning, breakdown, and discoloration of the flesh [\[16\]](#), with fruits requiring novel post-harvest care at room temperature to prevent post-harvest loss.

The components of edible films are mainly based on natural biopolymers, protein, polysaccharide, and lipid compounds, which create a thin layer on the fruit surface and have been shown to extend the shelf-lives of early apple cultivars as well as those of citrus, European pears, pineapple, papaya, grapes, strawberry, and stone fruit [\[10\]\[11\]\[12\]\[13\]\[14\]\[15\]\[17\]\[18\]\[19\]\[20\]\[21\]\[22\]\[23\]\[24\]\[25\]\[26\]\[27\]\[28\]\[29\]\[30\]\[31\]\[32\]](#). The natural coatings limit moisture and solute

migration into the fruit tissue but do not consistently regulate diffusion of CO₂ gas across various fruit species [10][11][12][13][14][15][17][18][19][20][21][22][23][24][25][26][27][28][29][30][31][32], with no data available for the the post-harvest behavior of coated plumcots. A sucrose monoester coating mixed with palmitate and stearate has been observed to form a semi-permeable modified atmosphere, successfully reducing fruit quality loss in early apple cultivars for up to 28 days, mitigating anaerobic conditions and off-flavors [22][25].

This study was carried out to investigate fruit quality in coated 'Harmony' plumcots by examining the plants' morphological characteristics, antioxidant levels, and susceptibility to physiological disorders, as well as examining sucrose ester application during storage to effectively slow the fruit ripening process.

2. Research Methods

Approximately 500 'Harmony' plumcot samples were collected at harvest with a 30% to 50% red skin coloration from a packing house in a commercial orchard located in Yeongcheon, South Korea, on 30 June 2021 (**Figure 1** A,B). The fruit samples were immediately transferred to a laboratory at an agricultural experiment station at Daegu Catholic University in Gyeongsan, South Korea. Two methods of applying coating were adopted and evaluated for their effectiveness in prolonging post-harvest fruit quality after room temperature (25.0 ± 0.5 °C/ $60 \pm 5\%$ relative humidity (RH)) storage for 12 days, using two fruit sample groups; one group was from fruit immediately transferred from the packing house (after 0 d CS), while the other was kept for seven days in commercial cold storage (5.0 ± 0.5 °C/ $80 \pm 5\%$ RH; after 7 d CS) and then coated.



Figure 1. 'Harmony' plumcot trees grown on a Y-trellis (panel **A**) and the fruits prior to harvest (panel **B**).

An analysis of all quality parameters was conducted using five fruits from the control and coated groups at each sampling time at three-day intervals throughout 12 days of room temperature storage (12 DAS) typical of when fruit is exhibited to consumers in supermarkets. This was done for both groups, those treated with coating after 0 d CS, and for those coated after 7 d CS, using 300 fruit samples from each group. All fruits were kept without packaging during the storage.

Each fruit was kept in a 3000-mL plastic film bag containing a digital CO₂ electronic sensor capable of measuring between 0–1000 mL -1 kg -1 h -1 (XE-2000 Multi-function, XEAST Co., Ltd., Shenzhen, China) that was placed inside for one hour to monitor concentrations of CO₂ inside the fruit tissue [25].

The sensory quality of each fruit was evaluated by four semi-trained persons on a hedonic scale (1–5 scale from worst to best) for sweetness, sourness, and fruit overall acceptability according to Novianti et al. [29].

3. Discussion

A porous surface was observed in the microstructure of the control fruits at 14 DAS via SEM (**Figure 2 A,C,E**). The coated fragments of sucrose monoester did not completely retain cohesive films for lenticel and stomata on the epidermal cells (**Figure 2 B,D,F**). This lack of adhesion was most likely due to an uneven application of the coating due to the hairy skin of the fruit, along with strong climacteric behavior, and substantial physical changes from fruit shrivel, which consequently reduced adhesion of the fragments at 14 days after storage [18][19][20]. The sucrose monoester with palmitate had previously been observed to be effective in studies on the smooth peel of bananas and apples over 30 days, as it uniformly covered the surface with small fragments [19][25][27].

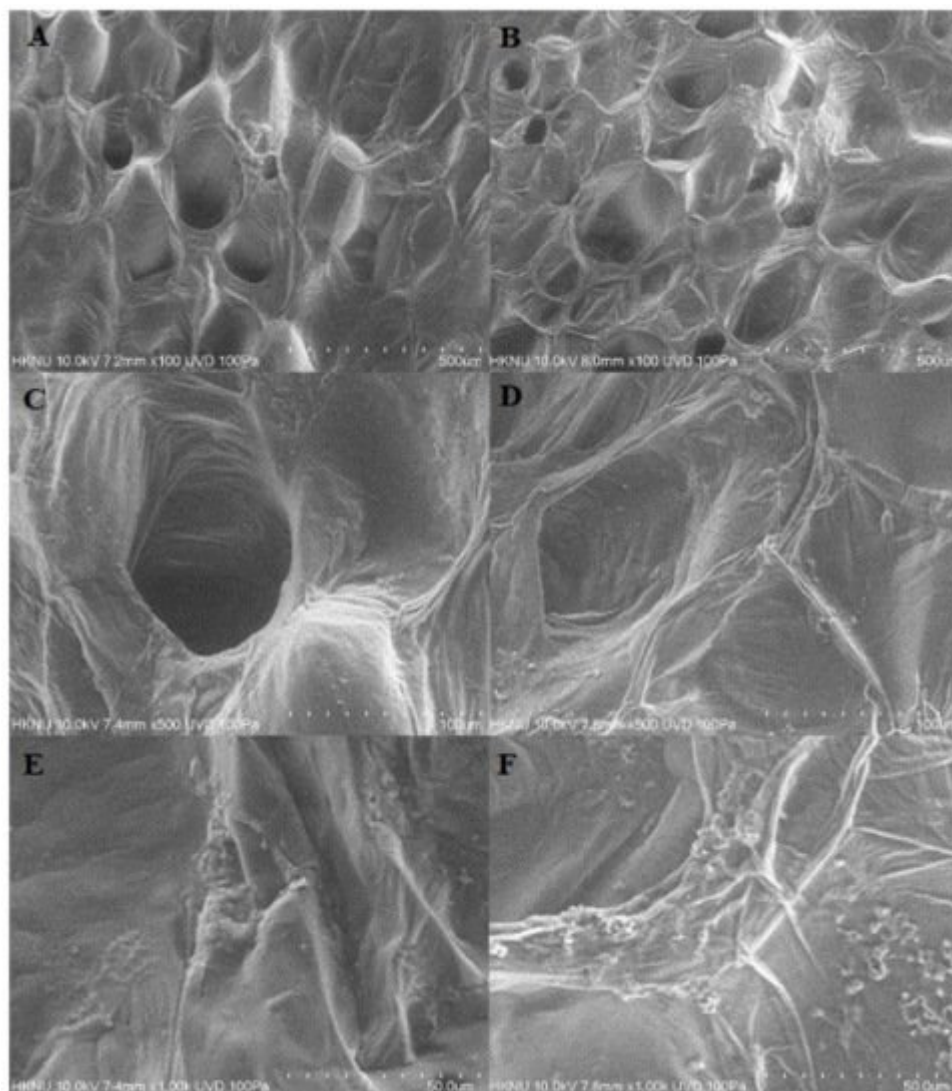


Figure 2. Scanning electron microscope images showing cuticles of control (uncoating) ‘Harmony’ plumcot fruit with 50× (panel A), 100× (panel C), and 500× (panel E) zoom and of coating fruit with 50× (panel B), 100× (panel D), and 500× (panel F) zoom.

Flesh firmness is the prime factor in determining consumer acceptance and freshness of stone fruits [12][33]. The coated fruits retained significantly higher flesh firmness than those of control fruits from 3 DAS to 12 DAS after 0 d CS (**Figure 3 A**) by limiting oxygen levels that degrade enzymes in cell walls of the stone fruits [12][34], previously reported for studies with apple, banana, and pear fruits coated with sucrose esters [19][20][24][22][25][27]. However, the coating did not maintain the fruit firmness after 7 d CS from 6 DAS to 12 DAS (**Figure 3 B**), mostly due to the elevated respiration rate at 0 DAS and the delayed treatment of the coating. Flesh weight loss did not significantly differ between the treated fruits during storage either after 0 d CS (**Figure 3 C**) or after 7 d CS (**Figure 3 D**), although the edible coating has typically reduced weight loss in many other stone fruits through blocking fruit surface pores and reducing transpiration [10][11][12][13][14][15]. Flesh weight loss in all fruits rapidly increased between 26 and 32% at 12 DAS and promoted active respiration and transpiration, consequently reducing the treatment's effect during storage time, previously addressed in the literature [10][11][12][13][14][15].

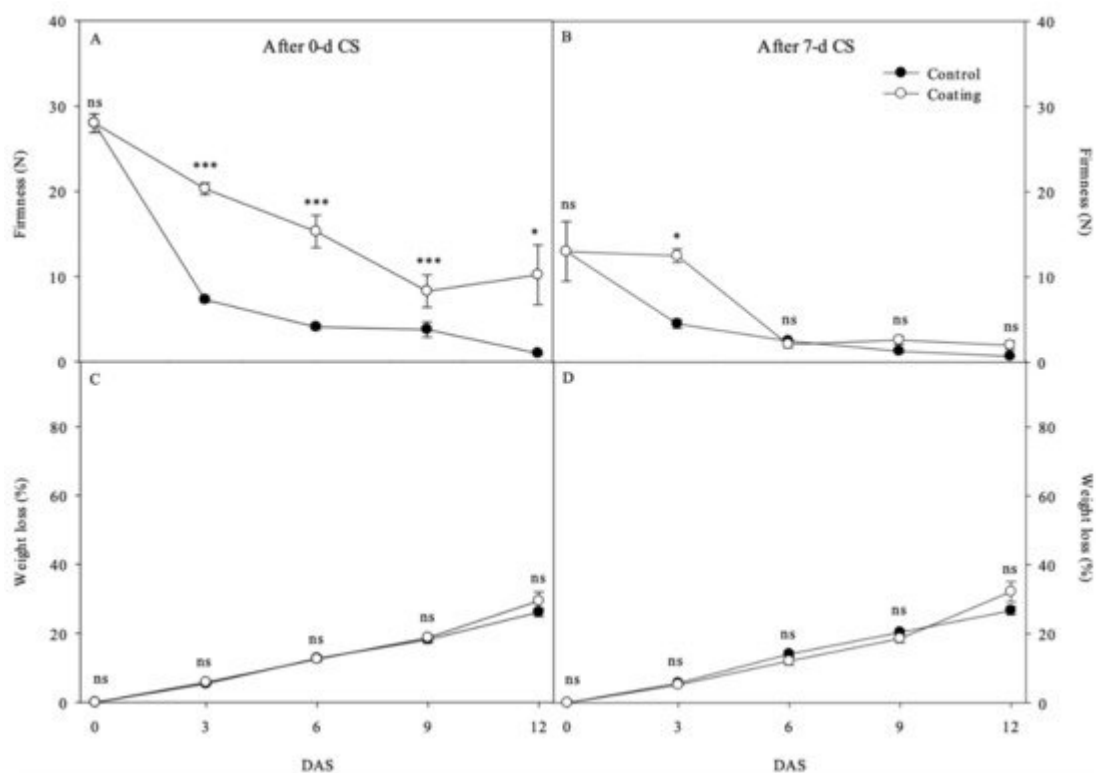


Figure 3. Fruit firmness (panels A,B) and weight loss (panels C,D) in control (uncoated) ‘Harmony’ plumcot fruits and coated fruits with coating applied either 0 days after cold storage (After 0 d CS) or 7 days after cold storage (After 7 d CS), respectively, at 0, 3, 6, 9, and 12 days of room temperature storage (DAS). Bars represent error of the means, when larger than the dimension of the symbol. ns, *, and *** indicate nonsignificant and significant differences between control and coating treatments at $p < 0.05$ and $p < 0.001$, respectively.

TSS, the components of soluble sugars and organic acids in the fruit juice, was generally higher in the control fruits at later storage periods after 0 d CS (**Figure 4 A**) and after 7 d CS (**Figure 4 B**) than in coated fruits. Low oxygen concentrations in coated fruits delayed starch degradation into TSS and inhibited Krebs cycle activity related to titratable acidity [17][18] which was observed as higher acidity in coated fruits at 3 DAS and 6 DAS after 0 d CS (**Figure 4 C**) but were not confirmed in after 7 d CS samples (**Figure 4 D**). TSS: acidity ratio increased in the control fruits at 3, 6, and 12 DAS in after 0 d CS samples (**Figure 4 E**) and at 9 DAS in after 7 d CS (**Figure 4 F**) with higher values more likely to decrease shelf-life of the different plum cultivars on the previously published research [12][15][33].

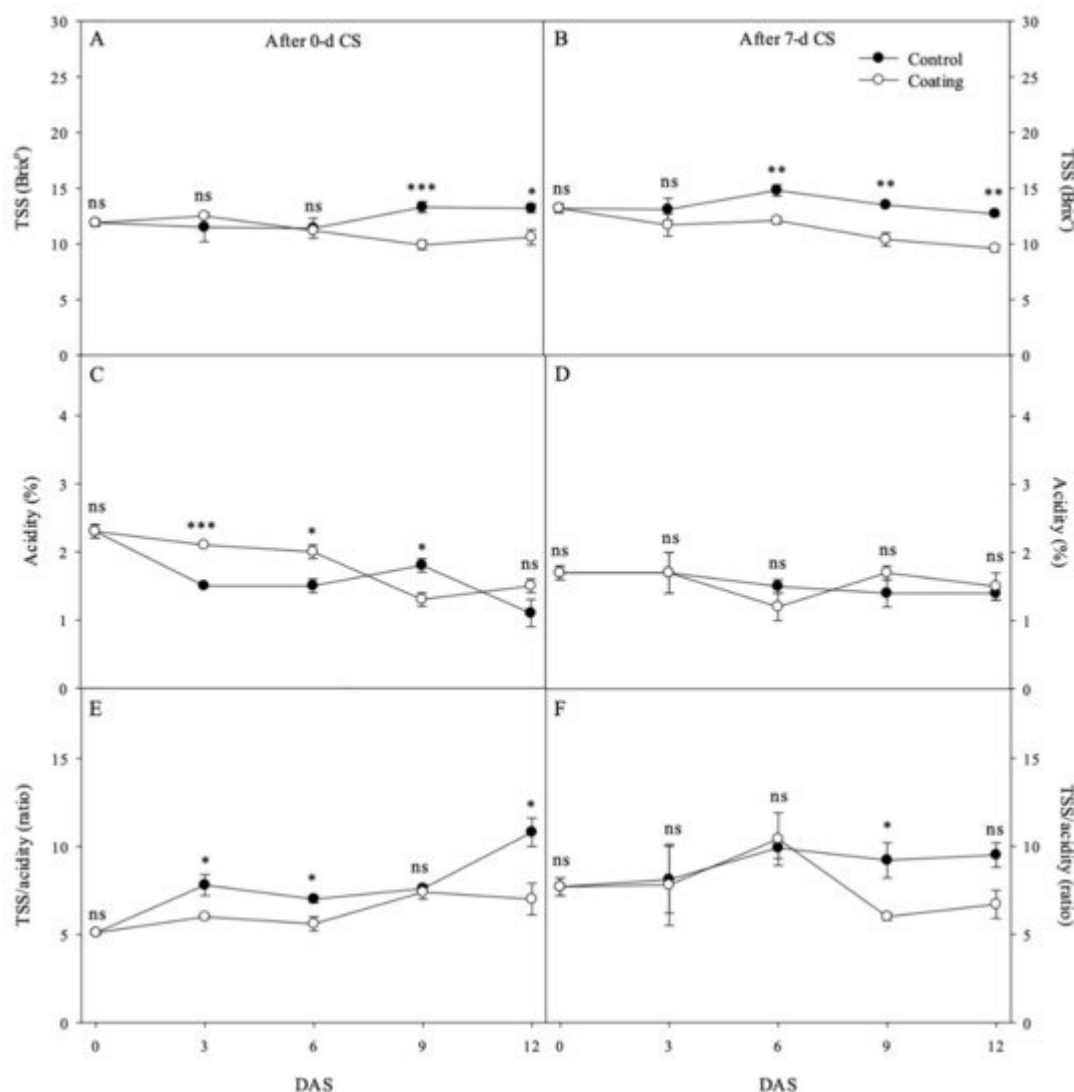


Figure 4. Total soluble solids (TSS; panels **A,B**), acidity (panels **C,D**), and TSS/acidity ratio (panels **E,F**) in control (uncoated) 'Harmony' plumcot fruits and in coated fruits with coating applied either 0 days after cold storage (After 0 d CS) or 7 days after cold storage (After 7 d CS), respectively, at 0, 3, 6, 9, and 12 days of room temperature storage (DAS). Bars represent error of the means, when larger than the dimension of the symbol. ns, *, **, and *** indicate nonsignificant and significant differences between control and coating treatments at $p < 0.05$, $p < 0.01$, and $p < 0.001$, respectively.

4. Conclusions

Immediately following harvest, plumcot fruits are susceptible to spoiling quickly during storage and distribution, significantly affecting fruit distribution to distant markets, and which is exacerbated by the lack of cold storage facilities in many developing countries [22][25][35]. Our research showed that a mixture of sucrose monoesters and volatile compounds could extend fruit shelf-life up to 9 days after 0 d CS by limiting the oxygen absorbed by the climacteric fruits compared with the control group, and could be easily used as a post-harvest treatment in plumcot fruits and other prunus fruit species during hot and humid weather. However, further research is needed to investigate the potential post-harvest effects of the coating application at different concentrations, and to acquire more detailed information on why delayed application did little to influence the post-harvest performance of fruits affected by cold stress and internal ethylene biosynthesis.

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