Effect of salicylic acid and acylated salicylic acid on the shelf-life of guava (Psidium guajava L.) fruit during storage

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Abstract
The objective of this study was to determine the effect of salicylic acid and acylated salicylic acid on the shelf life of guava (Psidium guajava L. ‘Allahabad Safeda’) during low temperature as well as ambient storage. Freshly-harvested, physiologically mature guava fruits were treated with salicylic acid 1mM (SA), acylated salicylic acid 1mM (ASA) and control for 5 minutes by dipping method, followed by storage at 8±2°C and 90% relative humidity for 21 days. Simultaneously, fruits were also stored under ambient conditions. There was a significant difference among the treatments, dipping in 1mM SA exhibited lower per cent cumulative physiological loss in weight (CPLW %) (8.59%) as compared to control (9.92%) fruit dipped in distilled water under ambient conditions. The results were similar for CPLW in SA treated fruits stored under low temperature. Furthermore, SA treatment maintained lower ascorbic acid content (166.63 mg/100g) and TSS (9.73°B) and higher fruit firmness (10.40 Kg/Cm²) compare to ASA and control fruits on the 14th day under low temperature storage. The antioxidant content by FRAP was 108.66 μmoles/g and DPPH 89.64 % inhibition on the 14th day of cold storage. The results indicated that SA treatment was found to effectively influence to prolong its shelf-life and maintain quality of guava fruit during low temperature storage for 14 days and 7 days under ambient conditions.

Keywords: Post-harvest treatment, fruit firmness, shelf life, antioxidants, Psidium guajava L.

Introduction
After harvest, guava (Psidium guajava L.) fruits can be kept for 3-4 days under ordinary conditions. Guava fruits loose the consumer’s appeal as they are liable to deteriorate rapidly within a short span of storage. Several work on use of irradiation, controlled atmospheric storage, modified atmosphere packaging and fungicide application for shelf life extension of guava (Singh and Pal 2008 and Antala et al., 2015) [3, 17] but there is need for generally regarded as safe (GRAS) and affordable post harvest practices to enhance shelf life and maintain quality of fruits. Salicylic acid (SA) is a natural plant growth regulator which plays an important role in many physiological processes and it has given fruitful results (Asghari and Aghdam 2010) [4]. Acylated salicylic acid (ASA) maintains the bioactive and antioxidant compounds in pomegranate during post-harvest storage (Syyari et al., 2011) [21], SA prolonged the shelf-life of banana (Srivastava and Dwivedi 2000 and Mandal et al., 2016) [13, 18] and delayed papaya ripening (Mandal et al., 2017) [14]. Salicylic acid, accepted as safe and natural chemical compound for post harvest application on fruits to delay ripening and softening, reduce lipid peroxidation and chilling injury in fruits (Zhang et al.,2003 and Barman and Asrey 2014) [6, 25], SA prolonged the shelf life of guava fruits at 10 °C as well as at ambient conditions (Madhav et al., 2016 and Amanullah et al., 2017) [2, 12]. In the present investigation, the effect of salicylic acid and acylated salicylic acid (a derivative of salicylic acid) for prolonging shelf-life by maintaining physiochemical quality attributes of guava cv ‘Allahabad Safeda’ under low temperature and ambient conditions were assessed.

Materials and methods
Guava cv ‘Allahabad Safeda’ used for this study were harvested from the orchards of ICAR-Central Institute for Subtropical Horticulture, Lucknow and transported to Post Harvest Management Lab for further treatments. The fruits were divided into three lots and each lot subjected to treatments with salicylic acid 1mM (SA), acylated salicylic acid 1mM (ASA) and
control for 5 minutes by dipping method, followed by storage at 8±2°C and 90% relative humidity for 21 days. Simultaneously, fruits were also stored under ambient conditions. The fruits were periodically sampled at 7 days intervals for cold stored fruits and at 0.3, 5.5, and 9 days for fruits stored under ambient conditions for assessing various physico-chemical quality parameters.

Fruits were weighed at different sampling intervals. Then the weight loss was calculated as the difference between initial fruit weight and the fruit weight at the time of measurement and expressed as cumulative physiological weight loss (CPLW percentage). Firmness of the fruit was measured with the help of penetrometer (8 mm probe, USA) and expressed as kg/cm². Fruits were finely cut and approximately 200g were ground to pulp using a blender and samples were weighed and analysed for biochemical parameters as follows: Total soluble solid or soluble solid content (SSC) with help of Refractometer model PAL-1 (Atago, Tokyo, Japan) and titratable acidity (TA) ascorbic acid in fruit pulp was estimated by method (Ranganna, 2000) [15]. Samples (2g) were weighed and 20ml of ethanol was added and incubated deep freezer till further analysis. Ferric reducing antioxidant power (FRAP) assay was done as per the methodology (Benzie and Strain, 1996) [7]. The reduction of a ferric–tripryidyl triazine complex to its ferrous, coloured formed in the presence of antioxidants is the principle of the assay. The FRAP agent contained 2.5ml of a 10 mmol/L TPTZ (2,4,6-tripryidyl-s-triazine, Sigma) solution in 40 mmol/L HCL plus 2.5 ml of 20mmol/L FeCl3 and 25 ml of 0.3mol/L acetate buffer, pH 3.6 and was prepared freshly and warmed at 37°C. Aliquots of 40µl sample supernatant were mixed with 0.2ml distilled water and 1.8ml FRAP reagent and the reaction mixture was incubated at 37°C for 10 min. and absorbance measured by spectrophotometer at 593nm. The standard solution used was 1mmol/L trolox and the final result was expressed as the concentration of antioxidants having milli moles trolox equivalent per g of fresh sample. The DPPH (2, 2-diphenyl-1-picrylhydrazyl) estimation was done according to the method (Brand-Williams et al., 1995) [8]. DPPH was weighed (24mg) and dissolved in 100ml methanol which served as stock solution and stored at -20°C until needed. The working solution was obtained by mixing 10ml of stock solution with 45 ml methanol to get an absorbance of 1±0.02 units at 515 nm using the spectrophotometer. Fruit extracts of 150µL were allowed to react with 2850ml of DPPH solution for 24 hours in the dark. Then the absorbance was read at 515nm. The results were expressed as per cent inhibition or scavenging activity (% = \( \frac{(A_{515} \text{of control} - A_{515} \text{of sample})}{A_{515} \text{of control}} \times 100 \)).

Results and Discussion

The effects of SA and ASA on physical aspects of guava fruits are shown in (Fig. 1.). There was a significant difference (p≤0.05) among the treatments and the period of storage. The CPLW was highest in control 9.92 followed by ASA 9.85 and SA 8.59 per cent on the 9th day of storage under ambient conditions. Similar results were also found in fruits stored under low temperature on the 21st day of storage. During storage of fruits there is loss of water from fruit surface by evapo-transpiration thereby increase in CPLW and treatment with SA decreases the rate of respiration. The increase in CPLW with increase in storage period is in agreement with the findings in banana (Srivastava and Dwivedi 2000) [18], in mandarin (Zheng and Zhang 2004) [20] and (Kazemi et al., 2011) [11] in apple. SA dipped fruits had less weight loss in strawberry cv ‘Camarosa’ (Abulfazal Lolaei et al., 2012) [1], Postharvest application of SA improved fruit quality with evidence of lowered weight loss in peach cv ‘Elberta’ (Zahra and Ahmad 2013) [24]. The firmness of the fruits decreases with increase in storage period. Significant differences (p≤0.05) were observed among the treatments and increase in shelf life of fruits (Fig. 2.). Firmness was maximum 12.47 Kg/Cm² on the day of harvest which decreased up to 3.5 Kg/Cm² in control, 4.40 Kg/Cm² in ASA and 5.27 Kg/Cm² in SA treated fruits on the 9th day of storage under ambient conditions. The fruits stored under low temperature exhibited a firmness of 6.07 Kg/Cm² in control, 7.27 Kg/Cm² in ASA and 7.80 Kg/Cm² in SA at the end of storage period of 21 days. Polygalacturonase, pectinmethyl esterase and enzymes degrading the cell-wall are inhibited by SA hence the texture of the fruits is maintained. Similar results were also reported in kiwifruits (Zhang et al., 2003; Bal and Celik 2010) [25, 26] and in apple (Kazemi et al., 2011) [11]. The effect of ASA treatment on Kiwifruit softening was relatively weak (Xue-ren Yin et al., 2013) [23]. SA treatment had positive effect on firmness and improved fruit quality in peach cv ‘Elberta’ (Zahra and Ahmad 2013) [24]. There was a significant difference (p≤0.05) among the treatment and storage period under ambient conditions and low temperature (Fig.3.). T: A ratio of fruits increases with increase in storage period. Fruits stored under ambient conditions had maximum T: A ratio (97.20) in SA on the 7th day while, lowest in ASA on the 9th day. Fruits stored under low temperature had gradual increase in T: A ratio with maximum (40.69) in ASA followed by SA (34.02) on the 14th day. The organic acids like citric acid, maleic acid and tartaric acid are neutralized concomitantly the starch in the fruits are converted to sugars during ripening and SA delays the process hence fruit quality is maintained. The findings on guava fruits have confirmed the published data of (Ashghari and Aghdam 2010) [4]. These results are in agreement with in which SA application as pre and post-harvest treatments did not affect the TSS content of sweet cherry at harvest or after storage (Chan et al., 2008) [9] and SA treated apple exhibited high TSS and lower TA (Kazemi et al., 2011) [11].

The ascorbic acid content of guava fruits varied significantly (p≤0.05) under ambient condition as well as under low temperature storage of 21 days (Fig. 4.). On the 3rd day of storage the ascorbic acid content was highest in all treatments which decreased with increase in storage. Ascorbic acid content was maximum (152.27 mg/100g) in SA treated fruits on the 3rd day of storage under ambient condition. SA treated fruits had maximum (191.33 mg/100g) ascorbic acid content on the 7th day which decreased (147.73 mg/100g) on the 21st day of storage under low temperature. SA applied to oranges (Huang et al., 2008) [10] and sour pomegranates (Syyari et al., 2009) [20] reduced the rate of the decline in ascorbic acid (vitamin-C) losses found in control fruits. SA dipped fruits had higher vitamin-C in strawberry cv ‘Camarosa’ (Abulfazal Lolaei et al., 2012) [1].

The antioxidant content of guava fruits in terms of FRAP differed significantly (p≤0.05) among the treatments and storage period (Fig. 5.). FRAP was highest 7.50 mili moles TE/g in control, while it was lowest in ASA treated fruits on the 3rd day of storage under ambient condition. FRAP was highest 7.11 mili moles TE/g in SA treated fruits on the 7th day, whereas it was lowest 6.67 mili moles TE/g in control fruits on the 14th day of storage under low temperature conditions. The antioxidant for free radical scavenging activity by use of DPPH significantly differed (p≤0.05)
throughout the storage period among the treatments (Fig. 6.). The activity of DPPH was highest 95.72% inhibition in control fruits on the 9th day of storage under ambient condition, whereas it was lowest 57.63% inhibition on the day of harvest. The DPPH was maximum 93.41% per cent inhibition fruits on the 7th day; compared to minimum 89.64% inhibition on the 14th day in SA treated fruits under cold storage. The findings confirmed the published data of (Zahra and Ahmad 2013) [24] on the antioxidant capacity of fruits without any adverse influence on fruit taste and appearances. The antioxidant potential and quality of peach fruits are enhanced by SA dippings (Razavi et al., 2014) [16]. Antioxidant enzymes (Saxena et al., 2014) [19] and (Wang et al., 2006) [22] antioxidant capacity was also maintained higher in SA treated fruits of mango (Barman and Asrey 2014) [6].

Fig 1: Effect of salicylic acid (SA) and acylated salicylic acid (ASA) treatments on the CPLW per cent of guava fruits during storage under ambient condition (A) and cold storage (B).

Fig 2: Effect of salicylic acid (SA) and acylated salicylic acid (ASA) treatments on the firmness (Kg/Cm²) of guava fruits during storage under ambient condition (C) and cold storage (D).

Fig 3: Effect of salicylic acid (SA) and acylated salicylic acid (ASA) treatments on the TSS: Acid ratio of guava fruits during storage under ambient condition (E) and cold storage (F).
Conclusions
The study revealed that post-harvest SA application enhanced the shelf-life of guava (Psidium guajava L. ‘Allahabad Safeda’) fruits for 7 days under ambient condition. SA treatment was effective and additionally prolonged the shelf life for 14 days under low temperature storage. The quality of fruits were maintained in SA treated fruits as it had reduced CPLW per cent, loss of firmness, TSS:acid ratio, antioxidants and per cent inhibition compared to control untreated fruits under ambient conditions as well as low temperature storage.

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References


