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Effect of post-harvest treatments on biochemical properties of Kinnow fruits during storage at room temperature

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Abstract

The present investigation was carried out in the PG Laboratory of the Department of Horticulture, CCS Haryana Agricultural University, Hisar during the years 2019 and 2020. Kinnow fruits harvested from the orchard were treated with different chemicals prior to storage at room temperature. Minimum total soluble solids, total sugars, reducing sugars and non-reducing sugars were observed in Kinnow fruits treated with 1mM salicylic acid. During storage, Total soluble solids, total sugars, reducing sugars and non-reducing sugars increased with the prolongation of storage period. TSS was minimum on zero day of storage and maximum on 28th day of storage during both the years of study.

Keywords: Kinnow, chemicals, salicylic acid, sodium nitroprusside, calcium chloride, putrescine, storage

Introduction

Mandarin orange is most common among citrus fruits grown in India. Post-harvest research is of great significance in minimizing the post-harvest losses to increase their supply without bringing additional land under cultivation ^[1]. Salicylic acid is a simple phenolic compound and has been used to control the post-harvest losses of perishable crops ^[2]. Calcium is a key plant nutrient that has a significant role in cell functions, including reducing softening and senescence of fruits ^[3], and it is also considered the most important mineral element determining the fruit quality ^[4]. Short term exposure to a low concentration of nitric oxide gas has been shown to extend the post-harvest life of various fresh fruits and vegetables ^[5 & 6]. Polyamine comes under the new class of growth regulators and they regulate the various physiological processes in plants. The major forms of polyamines including diamine putrescine, triamine spermidine and tetraamine spermine are found in every plant cell. Exogenous application of polyamines influences the post-harvest life of fruits. According to U.S. Food and Drug Administration salicylic acid, nitric oxide and calcium chloride are Generally Recognized as Safe (GRAS) compounds. Post-harvest applications of these compounds delay senescence in fruits with no detrimental effect on consumer acceptance.

Material and Methodology

The present investigation was carried out in the PG Laboratory of Department of Horticulture, CCS Haryana Agricultural University, Hisar during the years 2019 and 2020. The fresh fruits of Kinnow mandarin having uniform size were harvested with the help of secateurs at mature stage keeping small intact pedicel with each fruit from the orchards of Department of Horticulture, CCS Haryana Agricultural University, Hisar. Fruits were cleaned with muslin cloth and used for experiment. The treatments consisted of salicylic acid (1 mM), calcium chloride (1 mM), sodium nitroprusside (1 µM) and putrescine (1 mM) were applied as post-harvest dip treatment. Total soluble solids were determined by using digital refractometer by putting a drop of juice on the prism and the values were expressed in percentage. Titratable acidity was determined in terms of citric acid as per the method suggested by ^[7]. Method given by ^[8] was used for estimation of sugars.

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Results and Discussion

Total soluble solids (%)

The data recorded in Table 1 reveal that the total soluble solids of Kinnow fruits coated with different chemicals varied significantly with respect to the treatments, period of storage and their interaction. The minimum total soluble solids (10.13 and 10.05%) were recorded in fruits coated with 1mM salicylic acid and maximum (10.33 and 10.24%) in untreated Kinnow fruits. Similar results were recorded by ^[9] in litchi and ^[10] in ber. With the advancement of storage period, total soluble solids increased significantly, where the minimum TSS (9.80 and 9.60%) was observed on zero day of storage and maximum (10.82 and 10.73%) on 28th day of storage.

This might be due to enzymatic degradation of starch and pectins into simple sugars ^[11 & 12]. The interaction effect between chemicals and storage duration was significant with minimum TSS (9.80 and 9.60% during 2019 and 2020, respectively) on zero day of storage, which was at par with 1mM salicylic acid, 1mM calcium chloride, 1μM sodium nitroprusside and 1mM putrescine on 7th day of storage during 1st year of experiment and maximum (10.97 and 10.83% during 2019 and 2020, respectively) on 28th day in untreated fruits, which was at par with 1mM calcium chloride, 1μM sodium nitroprusside and 1mM putrescine on 28th day of storage during 2nd year of experiment.

Table 1: Effect of different chemicals on TSS (%) of Kinnow fruits stored at room temperature

| Treatments | Storage period (Days) | | | | | | | | | | | |
|--------------------------|-------------------------------|-------|-------|-------|-------|-------|-------------------------------|-------|-------|-------|-------|-------|
| | 2019 | | | | | | 2020 | | | | | |
| | 0 | 7 | 14 | 21 | 28 | Mean | 0 | 7 | 14 | 21 | 28 | Mean |
| S A (1 mM) | 9.80 | 9.83 | 10.07 | 10.33 | 10.60 | 10.13 | 9.60 | 9.80 | 10.03 | 10.27 | 10.53 | 10.05 |
| CaCl ₂ (1 mM) | 9.80 | 9.80 | 10.23 | 10.47 | 10.83 | 10.23 | 9.60 | 9.83 | 10.20 | 10.40 | 10.73 | 10.15 |
| SNP (1 μM) | 9.80 | 9.87 | 10.23 | 10.37 | 10.80 | 10.21 | 9.60 | 9.87 | 10.23 | 10.33 | 10.77 | 10.16 |
| Putrescine (1 mM) | 9.80 | 9.93 | 10.20 | 10.37 | 10.90 | 10.24 | 9.60 | 9.93 | 10.17 | 10.37 | 10.80 | 10.17 |
| Control (Untreated) | 9.80 | 10.00 | 10.27 | 10.60 | 10.97 | 10.33 | 9.60 | 10.07 | 10.23 | 10.47 | 10.83 | 10.24 |
| Mean | 9.80 | 9.89 | 10.20 | 10.43 | 10.82 | | 9.60 | 9.90 | 10.17 | 10.37 | 10.73 | |
| C.D. | T= 0.06, D= 0.06, T X D= 0.13 | | | | | | T= 0.05, D= 0.05, T X D= 0.11 | | | | | |

Titrateable acidity (%)

The data presented in Table 2 demonstrate that the chemicals, storage period and the interaction between chemicals and

storage period did not significantly affect the titrateable acidity under room temperature conditions during both the years of study.

Table 2: Effect of different chemicals on titrateable acidity (%) of Kinnow fruits stored at room temperature

| Treatments | Storage period (Days) | | | | | | | | | | | |
|--------------------------|-------------------------|------|------|------|------|------|-------------------------|------|------|------|------|------|
| | 2019 | | | | | | 2020 | | | | | |
| | 0 | 7 | 14 | 21 | 28 | Mean | 0 | 7 | 14 | 21 | 28 | Mean |
| S A (1 mM) | 0.87 | 0.84 | 0.82 | 0.79 | 0.75 | 0.82 | 0.86 | 0.83 | 0.81 | 0.79 | 0.74 | 0.81 |
| CaCl ₂ (1 mM) | 0.87 | 0.83 | 0.81 | 0.79 | 0.74 | 0.81 | 0.86 | 0.83 | 0.81 | 0.78 | 0.73 | 0.80 |
| SNP (1 μM) | 0.87 | 0.81 | 0.80 | 0.77 | 0.73 | 0.80 | 0.86 | 0.81 | 0.79 | 0.76 | 0.73 | 0.79 |
| Putrescine (1 mM) | 0.87 | 0.81 | 0.79 | 0.75 | 0.71 | 0.79 | 0.86 | 0.81 | 0.78 | 0.76 | 0.70 | 0.78 |
| Control (Untreated) | 0.87 | 0.80 | 0.76 | 0.72 | 0.67 | 0.77 | 0.86 | 0.81 | 0.77 | 0.73 | 0.69 | 0.77 |
| Mean | 0.87 | 0.82 | 0.80 | 0.77 | 0.72 | | 0.86 | 0.82 | 0.79 | 0.76 | 0.72 | |
| C.D. | T= NS, D= NS, T X D= NS | | | | | | T= NS, D= NS, T X D= NS | | | | | |

Total sugars (%)

The data given in Table 3 indicate that the chemicals and storage period showed significant effect on total sugars of Kinnow fruits under room temperature conditions. The fruits coated with 1mM salicylic acid had minimum total sugars (8.65 and 8.63%) and uncoated fruits had maximum total sugars (9.21 and 9.24%) during 2019 and 2020, respectively.

With the increase in storage period, the total sugars in Kinnow fruits increased gradually. The minimum total sugars (7.86 and 7.98%) were recorded on zero day of storage and maximum (9.59 and 9.44%) on 28th day of storage during 2019 and 2020, respectively. Similar results were obtained by ^[13] in apple.

Table 3: Effect of different chemicals on total sugars (%) of Kinnow fruits stored at room temperature

| Treatments | Storage period (Days) | | | | | | | | | | | |
|--------------------------|-------------------------------|------|------|------|------|------|-------------------------------|------|------|------|------|------|
| | 2019 | | | | | | 2020 | | | | | |
| | 0 | 7 | 14 | 21 | 28 | Mean | 0 | 7 | 14 | 21 | 28 | Mean |
| S A (1 mM) | 7.86 | 8.43 | 8.74 | 9.00 | 9.23 | 8.65 | 7.98 | 8.45 | 8.70 | 8.91 | 9.12 | 8.63 |
| CaCl ₂ (1 mM) | 7.86 | 8.85 | 9.28 | 9.26 | 9.71 | 8.99 | 7.98 | 8.87 | 9.22 | 9.15 | 9.40 | 8.93 |
| SNP (1 μM) | 7.86 | 8.74 | 9.05 | 9.41 | 9.49 | 8.91 | 7.98 | 8.77 | 9.03 | 9.28 | 9.37 | 8.89 |
| Putrescine (1 mM) | 7.86 | 8.99 | 9.36 | 9.27 | 9.62 | 9.02 | 7.98 | 9.03 | 9.30 | 9.12 | 9.48 | 8.98 |
| Control (Untreated) | 7.86 | 9.18 | 9.50 | 9.65 | 9.88 | 9.21 | 7.98 | 9.22 | 9.54 | 9.64 | 9.81 | 9.24 |
| Mean | 7.86 | 8.84 | 9.19 | 9.32 | 9.59 | | 7.98 | 8.87 | 9.16 | 9.22 | 9.44 | |
| C.D. | T= 0.04, D= 0.04, T X D= 0.08 | | | | | | T= 0.04, D= 0.04, T X D= 0.10 | | | | | |

The interaction between treatments and storage period was significant with minimum total sugars (7.86 and 7.98%) on zero day of storage and maximum (9.88 and 9.81%) on 28th

day of storage in untreated Kinnow fruits during 2019 and 2020, respectively. Magnitude of increase in total sugars was more in untreated fruits and it was slow with the treated fruits.

Reducing sugars (%)

The data registered in Table 4 demonstrate that the chemicals and storage period significantly affected the reducing sugars in Kinnow fruits. The minimum reducing sugars (4.21 and 4.22%) were recorded in Kinnow fruits treated with 1mM salicylic acid and maximum (4.49 and 4.51%) in untreated fruits during 2019 and 2020, respectively. The reducing sugars of fruits coated with chemicals went on increasing with the advancement of storage period. The minimum reducing sugars (3.79 and 3.84%) were noticed on zero day of storage

and maximum (4.75 and 4.64%) on 28th day of storage during 2019 and 2020, respectively. Similar results were recorded by ^[12] in apple and ^[14] in ber. Reducing sugars in Kinnow fruits were significantly affected due to interaction effect of chemicals and storage period. Minimum reducing sugars (3.79 and 3.84%) were noticed on zero day of storage and maximum (4.90 and 4.83%) on 28th day of storage in control during 2019 and 2020, respectively. Increase in reducing sugars was fast in untreated fruits as compared to the treated fruits.

Table 4: Effect of different chemicals on reducing sugars (%) of Kinnow fruits stored at room temperature

| Treatments | Storage period (Days) | | | | | | | | | | | |
|--------------------------|-------------------------------|------|------|------|------|------|-------------------------------|------|------|------|------|------|
| | 2019 | | | | | | 2020 | | | | | |
| | 0 | 7 | 14 | 21 | 28 | Mean | 0 | 7 | 14 | 21 | 28 | Mean |
| S A (1 mM) | 3.79 | 4.08 | 4.24 | 4.40 | 4.56 | 4.21 | 3.84 | 4.14 | 4.24 | 4.37 | 4.50 | 4.22 |
| CaCl ₂ (1 mM) | 3.79 | 4.28 | 4.50 | 4.53 | 4.81 | 4.38 | 3.84 | 4.33 | 4.48 | 4.48 | 4.62 | 4.35 |
| SNP (1 µM) | 3.79 | 4.23 | 4.39 | 4.60 | 4.70 | 4.34 | 3.84 | 4.29 | 4.39 | 4.54 | 4.61 | 4.33 |
| Putrescine (1 mM) | 3.79 | 4.35 | 4.54 | 4.53 | 4.76 | 4.40 | 3.84 | 4.41 | 4.52 | 4.47 | 4.66 | 4.38 |
| Control (Untreated) | 3.79 | 4.44 | 4.61 | 4.72 | 4.90 | 4.49 | 3.84 | 4.50 | 4.64 | 4.72 | 4.83 | 4.51 |
| Mean | 3.79 | 4.27 | 4.46 | 4.56 | 4.75 | | 3.84 | 4.33 | 4.45 | 4.52 | 4.64 | |
| C.D. | T= 0.02, D= 0.02, T X D= 0.04 | | | | | | T= 0.02, D= 0.02, T X D= 0.05 | | | | | |

Non-reducing sugars (%)

The experimental data pertaining to non-reducing sugars of Kinnow fruits with different chemicals in Table 5 during the study period revealed significant effect with respect to the chemicals and the storage period under room temperature conditions. Fruits coated with 1mM salicylic acid recorded minimum non-reducing sugars (4.44 and 4.42%) and maximum (4.72 and 4.73%) in uncoated control fruits during 2019 and 2020, respectively. Minimum non-reducing sugars

(4.07 and 4.14%) were recorded on zero day and maximum (4.84 and 4.80%) on 28th day of storage during 2019 and 2020, respectively. Similar results were obtained by ^[14] in ber and ^[15] in guava cv. Sardar. The interaction between chemicals and the period of storage also affected the non-reducing sugars significantly, where, minimum non-reducing sugars (4.07 and 4.14%) were observed on zero day of storage and maximum (4.99 and 4.98%) on 28th day of storage in untreated fruits during 2019 and 2020, respectively.

Table 5: Effect of different chemicals on non-reducing sugars (%) of Kinnow fruits stored at room temperature

| Treatments | Storage period (Days) | | | | | | | | | | | |
|--------------------------|-------------------------------|------|------|------|------|------|-------------------------------|------|------|------|------|------|
| | 2019 | | | | | | 2020 | | | | | |
| | 0 | 7 | 14 | 21 | 28 | Mean | 0 | 7 | 14 | 21 | 28 | Mean |
| S A (1 mM) | 4.07 | 4.35 | 4.50 | 4.60 | 4.66 | 4.44 | 4.14 | 4.32 | 4.47 | 4.55 | 4.63 | 4.42 |
| CaCl ₂ (1 mM) | 4.07 | 4.57 | 4.78 | 4.73 | 4.90 | 4.61 | 4.14 | 4.54 | 4.74 | 4.67 | 4.78 | 4.57 |
| SNP (1 µM) | 4.07 | 4.51 | 4.66 | 4.81 | 4.79 | 4.57 | 4.14 | 4.49 | 4.64 | 4.74 | 4.76 | 4.55 |
| Putrescine (1 mM) | 4.07 | 4.64 | 4.82 | 4.73 | 4.86 | 4.63 | 4.14 | 4.62 | 4.78 | 4.65 | 4.82 | 4.60 |
| Control (Untreated) | 4.07 | 4.74 | 4.89 | 4.93 | 4.99 | 4.72 | 4.14 | 4.72 | 4.91 | 4.92 | 4.98 | 4.73 |
| Mean | 4.07 | 4.56 | 4.73 | 4.76 | 4.84 | | 4.14 | 4.54 | 4.71 | 4.71 | 4.80 | |
| C.D. | T= 0.02, D= 0.02, T X D= 0.04 | | | | | | T= 0.02, D= 0.02, T X D= 0.05 | | | | | |

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