EVALUATING THE EFFECT OF PRE-STORAGE APPLICATION WITH 1-METHYLE CYCLOPROPENE AND SALICYLIC ACID FOR ENHANCING ANTIOXIDANT ENZYME ACTIVITY AND QUALITY OF DATE PALM FRUITS DURING COLD STORAGE. (1) PHYSICAL CHARACTERISTICS

Department of Horticulture, Faculty of Agriculture, Menoufia University

Received: Jun. 26, 2022 Accepted: Jul. 3, 2022

ABSTRACT: Barhi fruits is one of a climacteric fruit that ripens very quickly after harvest resulting in very short storage life. (1-MCP) and (SA) are widely used because it inhibits the action of ethylene receptors. The objective of this experiment was to evaluate the effect of pre-storage application with either 1-MCP or SA immediately after harvest on quality, storability and shelf life of Barhi during the two seasons 2020 and 2021. Barhi fruits divided into three equal groups and exposed to 1-MCP at 0, 0.5 or 1 ppm for 24 hours at room temperature. After the duration of 1-MCP treatments, the fruits divided into three equal subgroups and the Barhi fruits in each subgroup were dipped into aqueous solutions of SA at 0, 0.5 or 1 mM concentration for five minutes. All treatments of Barhi fruits stored at 0±1°C and 90±5% relative humidity for 8 weeks followed by 5 days shelf life at ~25 as a simulation marketing period. The changes in physical properties of fruits were determined at weekly intervals throughout the cold storage period at 0°C as well as after end of cold storage plus 5 days shelf life at room temperature. All pre-storage studied treatments of Barhi fruits significantly improved fruit quality characteristics than control treatment during cold storage and shelf life. Combinations treatments of 1-MCP at 0.5 or 1 ppm plus SA at 0.5 or 1 mM were superior to 1-MCP or SA alone. Barhi fruits treated with the combinations of exposure to 0.5 ppm of 1-MCP plus 0.5 or 1 mM SA dipping had less weight loss and decay percentage with higher marketable percentage and fruit firmness.

Key words: Date palm, Barhi, 1-Methylcyclopropene, Salicylic acid, Fruit quality.

INTRODUCTION

Date palm (Phoenix dactylifera L.) is one of the important fruit grown in Egypt. Dates are rich in many minerals such as potassium (K) and calcium (Ca) and contain a moderate amounts of copper (Cu), magnesium (Mg), phosphorus (P) and sulphur (S) (Nixom and Carpenter,1978) as well as some vitamins (Yousif et al.,1982). Barhi is the best soft type date palm cultivar. Date palm can grow well under drastic environmental conditions which may be not suitable for many fruit species. In Egypt, the total date palm planted reached 113220 feddans, while the date plan planted fruiting area reached 15.5 million palm trees produced nearly 112.656 tons. A date palm is a climacteric fruit that produces large amount of ethylene at the ripening (Mita et al., 1999). It starts to loss its physical characteristics directly after harvest and through the storage period (Ezzat et al., 2012). Fruit temperature reduction used to Control bruising injury and also delay ripening process in dates (De Martino et al. 2002). And on the contrary, the use of low temperature on date palms very often inhibits aroma development especially in early harvested fruits and show some physiological disorders such as mealiness development, losses of juiciness and gel breakdown (Ezzat et al., 2012). 1-Methylcyclopropene (1- MCP) (C₄H₆ ) It is used as an ethylene blocker that blocks ethylene receptors (Sisler and Serek, 1997). It is a cyclic olefin that inhibition ripening process by occupying irreversibly ethylene binding sites (Blankenship and Dole, 2003). Application of 1-Methylcyclopropene at low concentrations prior to the climacteric increase delayed the onset of the climacteric peaks of (CO₂) and ethylene production by reducing the activities of ethylene fragmentation.
biosynthesis enzymes (Blankenship and Dole, 2003). 1-MCP applications used for delaying ripening process, improving postharvest quality and extending fruit storage life for many fruits including date palm (Fan et al., 2000 and Egea et al., 2010).

Salicylic acid (SA) is a natural, safe simple compound and plant growth regulator that regulates many processes in plants. And an important component in the signal transduction pathway (Raskin, 1992). SA treatment has reported to delay ripening on different climacteric fruits by inhibiting ethylene biosynthesis and maintain postharvest quality of fruits (Asghari and Aghdam, 2010). Postharvest application of SA prolonged the storage life and preserved the valuable marketing characteristics of apricots (Hajilou and Fakhimrezaei, 2013). And also, dipping apricots in 2 mM Salicylic acid for 15 minutes significantly reduced the decay with maintaining fruit quality during cold storage at 1°C for 28 days (Ezzat, 2014). In addition to, dipping apricots in 0.5 mM SA for 3 min plus covered with cellophane film significantly improved fruit quality and extended fruit shelf life after 3 weeks of cold storage at 0.5°C (Moradinezhad and Jahani, 2016). Dipping of SA at 1 mM doses delayed decay and maintained peach fruit quality during cold storage at 1°C for 28 days and subsequently 3 days shelf life at room temperature (Wang et al., 2006). likewise, dipping peach fruits in 2 mM concentration of SA delaying fruit surface decay and keeping fruit quality intact along during storage at 1°C up to 5 weeks (Tareen et al., 2012a, b). Subsequently this study was designed to investigate the effect of pre-storage applications of exposure to 1-MCP, SA dipping and co-applications on postharvest quality of date palm fruits cv. “Barhi” during cold storage at 0±1°C and 90±5% relative humidity (RH).

MATERIALS AND METHODS

The present investigation was conducted during two successive seasons 2020 and 2021 at Horticulture Department, Faculty of Agriculture, menoufia University, Egypt. Date palm fruits cv. ‘Barhi’ were picked at commercial maturity stage (bright yellow) kader (1992) during the 2nd week of August. Trees were similar apparently uniform in size and free of visible symptoms of infection grown in a private orchard in Sadat City, Menoufia Governorate, Egypt. Barhi date palm trees were 7 years old and planted at a spacing of 8 x 8 meters apart in a sandy soil under drip irrigation system and subjected to all ideal agriculture practices. In both seasons, fruits were brought to the postharvest laboratory in plastic boxes through 2 hours. Fruits were cleaned and the detective fruits including wounded. The sound fruits at the same maturity stage were washed with 0.01% sodium hypochlorite water solution for 2 min and completely air dried at room temperature 25°C. A 2430 clean sound ‘Barhi’ date palm fruits were randomly selected and divided into three equal groups. All groups were exposed to 0, 0.5 or 1 ppm of 1-methylcyclopropene (1-MCP) concentrations for 24 hours at room temperature (25±1°C and 65±5% RH). A powder containing 0.14% of 1-MCP as active ingredient was released from a commercial powdered formulation by adding distilled water.

After the duration of 1-methylcyclopropene treatments, the fruits in each group were removed and divided into three subgroups. The fruits in each subgroup were dipped into aqueous solutions of salicylic acid at 0, 0.5 or 1 mM concentration for 5 min in five liter of an aqueous solution containing Tween 0.05%. After immersing treatments, fruits were air dried for half hour at room temperature and placed into unsealed netted plastic bags 30x20 cm. Each treatment consisted of 9 bags with three replicates and each replicate contained of 30 fruits for each storage period. All treatments packed in corrugated cartons and experimental boxes were stored at 0±1°C and 90±5% RH. Data was recorded on physical characteristics at the picking date at 2weeks intervals during cold storage period ,in addition to zero time of cold storage. After end of cold storage period (8weeks at 0°C) three bags of each treatment were moved to room conditions (25±1°C and 65±5% RH) for five days as a simulation-marketing period for determining different quality attributes.
Evaluating the effect of pre-storage application with 1-methyle cyclopropene and salicylic acid for ………

Measurements of fruit:

Weight loss percentage: Calculate as follows [(fruit weight before storage - fruit weight after each period of storage) / (fruit weight before storage)] × 100.

Decay: It is calculated weekly by counting the damaged fruits and calculated as a percentage of the initial number of stored fruits using the following equation: (number of decayed fruits after special storage period / initial number of stored fruits) × 100.

 Marketable percentage: using the following equation: (weight of sound fruits after special storage period / initial weight of fruits) × 100.

Fruit firmness (g/cm²): in flesh was measured in three date palm fruits per replication at two equatorial sites to determine the penetration force by using a hand-held fruit firmness tester (Model FT-327 Italy) (Watkins and Harman, 1981). The firmness value was expressed in terms of kilogram force (kgf) and data was calculated as Newton (N) by using the following equation (1 N = 0.1 kgf).

Experimental design and statistical data analysis:

The experimental in cold storage consisting of two factors (pre-storage treatments and storage periods) and analysis as factorial, while in shelf life consisting of one factor that is pre-storage treatments. Data calculated as percentage were transformed to arcsine of square root before statistical analysis and non-transformed means are shown. The effects of treatments and cold storage periods on different attributes were analyzed statistically by (ANOVA) using the MSTAT-C statistical package. Comparisons between means in cold storage or shelf life were done by Duncan’s at probability ≤ 0.05.

RESULTS AND DISCUSSION

Effect of pre-storage application with exposure to 1-methyle cyclopropene (1-MCP), salicylic acid (SA) dipping and their combinations on physical characteristics of Barhi fruits during cold storage and shelf life:

Fruit weight loss, decay incidence, marketable percentage and firmness:

Data in Tables (1, 2, 3 and 4) reveal that, exposure of Barhi fruits to 0.5 or 1 ppm of 1-methycyclopropene (1-MCP) or dipping in salicylic acid (SA) at 0.5 or 1 mM concentration significantly decreased fruit weight loss and decay especially their combination treatments. On the contrary, these treatments significantly increased marketable percentage and flesh firmness in comparison with control fruits during the two seasons (2020 and 2021) in this study. Data also cleared that, combined treatment with 1-MCP and SA delayed the decay incidence of Barhi date fruits up to 6 weeks of cold storage at 0°C in both seasons under this study. Barhi date fruits treated with the combination of exposure to 0.5 ppm of 1-MCP and 1 mM SA dipping had the lowest weight loss (5.34 & 5.10 %) and decay percentage (0.69 & 0.77 %) as compared to the other treatments in the first and second seasons, respectively. Moreover, these fruits had the highest marketable fruit percentage (94.04 & 94.21 %) and flesh firmness (22.69 & 21.71 N) in 2020 and 2021 seasons, respectively as compared to all the other treatments. On the other hand, untreated fruits (control) had the highest weight loss (15.22 & 14.25 %) and decay incidence (16.71 & 18.72 %) as well as had the lowest marketable fruit percentage (71.81 & 70.82 %) and flesh firmness (13.28 & 12.75 N) in the first and second seasons, respectively.

With respect to the effect of storage period, data in Tables 1, 2, 3 and 4 demonstrate that, weight loss and decay percentage of Barhi date fruits generally significantly increased with prolonging of storage period in both seasons. In contrary, Barhi date fruits showed gradual and significant reduction in marketable percentage and flesh firmness with the advancement of storage period in both seasons. The results indicated that, maximum weight loss (13.02 & 12.94 %), decay percentage (14.81 & 16.04 %) and the minimum marketable fruits percentage (74.57 & 73.58 %) and flesh firmness (15.92 & 14.82 N) were observed at the end of cold storage period at 0°C in the first and second seasons, respectively. The interaction effect
between pre-storage treatments and storage periods were showed significant differences at p≤0.05 for weight loss, decay and marketable percentages and firmness of Barhi date fruits in both seasons under this experiment.

Table (1): Changes in weight loss percentage of ‘Barhi’ palms treated with exposure to 1-methylcyclopropene (1-MCP) application, salicylic acid (SA) dipping and their combined treatments during cold storage at 0 °C for 8 weeks.

<table>
<thead>
<tr>
<th>Pre-storage Treatments</th>
<th>Storage period ( weeks)</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td><strong>Season 2020</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control (Distilled water)</td>
<td>0.00 s</td>
<td>11.86 def</td>
</tr>
<tr>
<td>0.5 ppm 1-MCP</td>
<td>0.00 s</td>
<td>6.40 mno</td>
</tr>
<tr>
<td>1 ppm 1-MCP</td>
<td>0.00 s</td>
<td>6.60 mno</td>
</tr>
<tr>
<td>0.5 mM SA</td>
<td>0.00 s</td>
<td>5.24 o-r</td>
</tr>
<tr>
<td>1 mM SA</td>
<td>0.00 s</td>
<td>5.60 opq</td>
</tr>
<tr>
<td>0.5 ppm 1-MCP+0.5 mM SA</td>
<td>0.00 s</td>
<td>4.47 qr</td>
</tr>
<tr>
<td>0.5 ppm 1-MCP+1 mM SA</td>
<td>0.00 s</td>
<td>4.04 r</td>
</tr>
<tr>
<td>1 ppm 1-MCP+0.5 mM SA</td>
<td>0.00 s</td>
<td>4.76 pqr</td>
</tr>
<tr>
<td>1ppm 1-MCP+1mM SA</td>
<td>0.00 s</td>
<td>4.69 pqr</td>
</tr>
<tr>
<td><strong>Means</strong></td>
<td>0.00 E</td>
<td>5.96 D</td>
</tr>
<tr>
<td><strong>Season 2021</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control (Distilled water)</td>
<td>0.00 n</td>
<td>11.75 e</td>
</tr>
<tr>
<td>0.5 ppm 1-MCP</td>
<td>0.00 n</td>
<td>6.56 j</td>
</tr>
<tr>
<td>1 ppm 1-MCP</td>
<td>0.00 n</td>
<td>6.21 jk</td>
</tr>
<tr>
<td>0.5 mM SA</td>
<td>0.00 n</td>
<td>6.51 j</td>
</tr>
<tr>
<td>1 mM SA</td>
<td>0.00 n</td>
<td>6.33 jk</td>
</tr>
<tr>
<td>0.5 ppm 1-MCP+0.5 mM SA</td>
<td>0.00 n</td>
<td>4.10 m</td>
</tr>
<tr>
<td>0.5 ppm 1-MCP+1 mM SA</td>
<td>0.00 n</td>
<td>3.67 m</td>
</tr>
<tr>
<td>1ppm 1-MCP+0.5 mM SA</td>
<td>0.00 n</td>
<td>4.59 lm</td>
</tr>
<tr>
<td>1ppm 1-MCP+1mM SA</td>
<td>0.00 n</td>
<td>4.52 lm</td>
</tr>
<tr>
<td><strong>Means</strong></td>
<td>0.00 E</td>
<td>6.03 D</td>
</tr>
</tbody>
</table>

Means followed by the same letters within pre-storage treatments, storage periods and their interactions in each season are not significantly different at level P< 0.05 according to DMRT. The duration of the exposure to 1-MCP and SA dipping were 24 hours and 5 minutes, respectively.
Evaluating the effect of pre-storage application with 1-methyle cyclopropene and salicylic acid for ……..

Table (2): Changes in decay percentage of "Barhi" palms treated with exposure to 1-methyle cyclopropene (1-MCP) application, salicylic acid (SA) dipping and their combined treatments during cold storage at 0°C for 8 weeks.

<table>
<thead>
<tr>
<th>Pre-storage treatments</th>
<th>Storage period (weeks)</th>
<th>0</th>
<th>2</th>
<th>4</th>
<th>6</th>
<th>8</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Season 2020</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control (Distilled water)</td>
<td>0.00 g</td>
<td>7.69 efg</td>
<td>10.35 c-f</td>
<td>25.34 b</td>
<td>40.15 a</td>
<td>16.71 A</td>
<td></td>
</tr>
<tr>
<td>0.5 ppm 1-MCP</td>
<td>0.00 g</td>
<td>0.00 g</td>
<td>0.00 g</td>
<td>10.75 c-f</td>
<td>18.72 bc</td>
<td>5.89 B</td>
<td></td>
</tr>
<tr>
<td>1 ppm 1-MCP</td>
<td>0.00 g</td>
<td>0.00 g</td>
<td>0.00 g</td>
<td>8.99 d-g</td>
<td>16.83 b-e</td>
<td>5.17 B</td>
<td></td>
</tr>
<tr>
<td>0.5 mM SA</td>
<td>0.00 g</td>
<td>0.00 g</td>
<td>0.00 g</td>
<td>11.13 c-f</td>
<td>20.94 b</td>
<td>6.42 B</td>
<td></td>
</tr>
<tr>
<td>1 mM SA</td>
<td>0.00 g</td>
<td>0.00 g</td>
<td>0.00 g</td>
<td>10.23 c-f</td>
<td>17.07 bcd</td>
<td>5.46 B</td>
<td></td>
</tr>
<tr>
<td>0.5 ppm 1-MCP+0.5 mM SA</td>
<td>0.00 g</td>
<td>0.00 g</td>
<td>0.00 g</td>
<td>0.00 g</td>
<td>4.71 fg</td>
<td>0.94 C</td>
<td></td>
</tr>
<tr>
<td>0.5 ppm 1-MCP+1 mM SA</td>
<td>0.00 g</td>
<td>0.00 g</td>
<td>0.00 g</td>
<td>0.00 g</td>
<td>3.43 fg</td>
<td>0.69 C</td>
<td></td>
</tr>
<tr>
<td>1ppm 1-MCP+ 0.5 mM SA</td>
<td>0.00 g</td>
<td>0.00 g</td>
<td>0.00 g</td>
<td>0.00 g</td>
<td>6.21 fg</td>
<td>1.24 C</td>
<td></td>
</tr>
<tr>
<td>1ppm 1-MCP+ 1mM SA</td>
<td>0.00 g</td>
<td>0.00 g</td>
<td>0.00 g</td>
<td>0.00 g</td>
<td>5.25 fg</td>
<td>1.05 C</td>
<td></td>
</tr>
<tr>
<td>Means</td>
<td>0.00 C</td>
<td>0.85 C</td>
<td>1.15 C</td>
<td>7.38 B</td>
<td>14.81 A</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Season 2021</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control (Distilled water)</td>
<td>0.00 f</td>
<td>8.94 def</td>
<td>14.58 cde</td>
<td>26.98 b</td>
<td>43.11 a</td>
<td>18.72 A</td>
<td></td>
</tr>
<tr>
<td>0.5 ppm 1-MCP</td>
<td>0.00 f</td>
<td>0.00 f</td>
<td>0.00 f</td>
<td>0.00 cde</td>
<td>19.48 bcd</td>
<td>6.34 B</td>
<td></td>
</tr>
<tr>
<td>1 ppm 1-MCP</td>
<td>0.00 f</td>
<td>0.00 f</td>
<td>0.00 f</td>
<td>0.00 de</td>
<td>18.61 bcd</td>
<td>5.97 B</td>
<td></td>
</tr>
<tr>
<td>0.5 mM SA</td>
<td>0.00 f</td>
<td>0.00 f</td>
<td>0.00 f</td>
<td>0.00 cde</td>
<td>22.68 bc</td>
<td>7.45 B</td>
<td></td>
</tr>
<tr>
<td>1 mM SA</td>
<td>0.00 f</td>
<td>0.00 f</td>
<td>0.00 f</td>
<td>0.00 de</td>
<td>18.75 bcd</td>
<td>6.14 B</td>
<td></td>
</tr>
<tr>
<td>0.5 ppm 1-MCP+0.5 mM SA</td>
<td>0.00 f</td>
<td>0.00 f</td>
<td>0.00 f</td>
<td>0.00 f</td>
<td>0.00 ef</td>
<td>1.10 C</td>
<td></td>
</tr>
<tr>
<td>0.5 ppm 1-MCP+1 mM SA</td>
<td>0.00 f</td>
<td>0.00 f</td>
<td>0.00 f</td>
<td>0.00 f</td>
<td>0.00 ef</td>
<td>0.77 C</td>
<td></td>
</tr>
<tr>
<td>1ppm 1-MCP+0.5 mM SA</td>
<td>0.00 f</td>
<td>0.00 f</td>
<td>0.00 f</td>
<td>0.00 f</td>
<td>0.00 ef</td>
<td>1.35 C</td>
<td></td>
</tr>
<tr>
<td>1ppm 1-MCP+1mM SA</td>
<td>0.00 f</td>
<td>0.00 f</td>
<td>0.00 f</td>
<td>0.00 f</td>
<td>0.00 ef</td>
<td>1.13 C</td>
<td></td>
</tr>
<tr>
<td>Means</td>
<td>0.00 C</td>
<td>0.99 C</td>
<td>1.62 C</td>
<td>8.55 B</td>
<td>16.04 A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Means followed by the same letters within pre-storage treatments, storage periods and their interactions in each season are not significantly different at level P< 0.05 according to DMRT. The duration of the exposure to 1-MCP and SA dipping were 24 hours and 5 minutes, respectively.
Table (3): Changes in marketable percentage of ‘ Barhi ’ palms treated with exposure to 1-methylcyclopropene (1-MCP) application, salicylic acid (SA) dipping and their combined treatments during cold storage at 0 °C for 8 weeks.

<table>
<thead>
<tr>
<th>Pre-storage treatments</th>
<th>Storage period (weeks)</th>
<th>0</th>
<th>2</th>
<th>4</th>
<th>6</th>
<th>8</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Season 2020</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control (Distilled water)</td>
<td>100.00 a</td>
<td>81.38 fgh</td>
<td>75.02 hij</td>
<td>58.57 k</td>
<td>44.06 l</td>
<td>71.81 C</td>
<td></td>
</tr>
<tr>
<td>0.5 ppm 1-MCP</td>
<td>100.00 a</td>
<td>93.60 ab</td>
<td>90.41 b-e</td>
<td>78.92 ghi</td>
<td>70.95 j</td>
<td>86.77 B</td>
<td></td>
</tr>
<tr>
<td>1 ppm 1-MCP</td>
<td>100.00 a</td>
<td>93.40 abc</td>
<td>90.37 b-e</td>
<td>80.70 f-i</td>
<td>72.67 ij</td>
<td>87.43 B</td>
<td></td>
</tr>
<tr>
<td>0.5 mM SA</td>
<td>100.00 a</td>
<td>94.76 ab</td>
<td>91.10 b-e</td>
<td>79.43 ghi</td>
<td>69.59 j</td>
<td>86.98 B</td>
<td></td>
</tr>
<tr>
<td>1 mM SA</td>
<td>100.00 a</td>
<td>94.40 ab</td>
<td>91.43 a-e</td>
<td>80.40 f-i</td>
<td>73.26 ij</td>
<td>87.90 B</td>
<td></td>
</tr>
<tr>
<td>0.5 ppm 1-MCP+0.5 mM SA</td>
<td>100.00 a</td>
<td>95.53 ab</td>
<td>92.84 a-d</td>
<td>90.87 b-e</td>
<td>85.00 c-g</td>
<td>92.85 A</td>
<td></td>
</tr>
<tr>
<td>0.5 ppm 1-MCP+1 mM SA</td>
<td>100.00 a</td>
<td>95.96 ab</td>
<td>93.95 ab</td>
<td>92.40 a-d</td>
<td>87.91 b-f</td>
<td>94.04 A</td>
<td></td>
</tr>
<tr>
<td>1 ppm 1-MCP+0.5 mM SA</td>
<td>100.00 a</td>
<td>95.24 ab</td>
<td>92.38 a-d</td>
<td>90.76 b-e</td>
<td>83.32 efg</td>
<td>92.34 A</td>
<td></td>
</tr>
<tr>
<td>1 ppm 1-MCP+1 mM SA</td>
<td>100.00 a</td>
<td>95.31 ab</td>
<td>92.64 a-d</td>
<td>90.85 b-e</td>
<td>84.40 d-g</td>
<td>92.64 A</td>
<td></td>
</tr>
<tr>
<td>Means</td>
<td>100.00 A</td>
<td>93.29 B</td>
<td>90.02 C</td>
<td>82.55 D</td>
<td>74.57 E</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Season 2021</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control (Distilled water)</td>
<td>100.00 a</td>
<td>80.38 fgh</td>
<td>71.74 hij</td>
<td>58.70 k</td>
<td>43.29 l</td>
<td>70.82 C</td>
<td></td>
</tr>
<tr>
<td>0.5 ppm 1-MCP</td>
<td>100.00 a</td>
<td>93.44 a-d</td>
<td>91.43 a-e</td>
<td>77.66 ghi</td>
<td>69.78 ij</td>
<td>86.46 B</td>
<td></td>
</tr>
<tr>
<td>1 ppm 1-MCP</td>
<td>100.00 a</td>
<td>93.79 a-d</td>
<td>91.80 a-e</td>
<td>78.72 f-i</td>
<td>70.90 ij</td>
<td>87.04 B</td>
<td></td>
</tr>
<tr>
<td>0.5 mM SA</td>
<td>100.00 a</td>
<td>93.49 a-d</td>
<td>91.72 a-e</td>
<td>75.85 g-j</td>
<td>67.11 j</td>
<td>85.63 B</td>
<td></td>
</tr>
<tr>
<td>1 mM SA</td>
<td>100.00 a</td>
<td>93.67 a-d</td>
<td>91.82 a-e</td>
<td>78.39 ghi</td>
<td>70.84 ij</td>
<td>86.94 B</td>
<td></td>
</tr>
<tr>
<td>0.5 ppm 1-MCP+0.5 mM SA</td>
<td>100.00 a</td>
<td>95.90 ab</td>
<td>93.76 a-d</td>
<td>91.50 a-e</td>
<td>85.11 c-g</td>
<td>93.25 A</td>
<td></td>
</tr>
<tr>
<td>0.5 ppm 1-MCP+1 mM SA</td>
<td>100.00 a</td>
<td>96.33 ab</td>
<td>94.70 abc</td>
<td>92.07 a-e</td>
<td>87.93 b-f</td>
<td>94.21 A</td>
<td></td>
</tr>
<tr>
<td>1 ppm 1-MCP+0.5 mM SA</td>
<td>100.00 a</td>
<td>95.41 ab</td>
<td>93.06 a-d</td>
<td>90.95 a-e</td>
<td>82.93 efg</td>
<td>92.47 A</td>
<td></td>
</tr>
<tr>
<td>1 ppm 1-MCP+1 mM SA</td>
<td>100.00 a</td>
<td>95.48 ab</td>
<td>93.47 a-d</td>
<td>91.22 a-e</td>
<td>84.31 d-g</td>
<td>92.90 A</td>
<td></td>
</tr>
<tr>
<td>Means</td>
<td>100.00 A</td>
<td>93.10 B</td>
<td>90.39 B</td>
<td>81.67 C</td>
<td>73.58 D</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Means followed by the same letters within pre-storage treatments, storage periods and their interactions in each season are not significantly different at level P < 0.05 according to DMRT. The duration of the exposure to 1-MCP and SA dipping were 24 hours and 5 minutes, respectively.
### Table (4): Changes in firmness (N) of ‘Barhi’ palms treated with exposure to 1-methylcyclopropene (1-MCP) application, salicylic acid (SA) dipping and their combined treatments during cold storage at 0 °C for 8 weeks.

<table>
<thead>
<tr>
<th>Pre-storage treatments</th>
<th>Storage period (weeks)</th>
<th>Season 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td><strong>Control</strong> (Distilled water)</td>
<td>24.53 a</td>
<td>17.99 k</td>
</tr>
<tr>
<td>0.5 ppm 1-MCP</td>
<td>24.53 a</td>
<td>21.58 b-h</td>
</tr>
<tr>
<td>1 ppm 1-MCP</td>
<td>24.53 a</td>
<td>22.24 a-f</td>
</tr>
<tr>
<td>0.5 mM SA</td>
<td>24.53 a</td>
<td>20.60 e-j</td>
</tr>
<tr>
<td>1 mM SA</td>
<td>24.53 a</td>
<td>21.91 b-g</td>
</tr>
<tr>
<td>0.5 ppm 1-MCP+0.5 mM SA</td>
<td>24.53 a</td>
<td>23.54 abc</td>
</tr>
<tr>
<td>0.5 ppm 1-MCP+1 mM SA</td>
<td>24.53 a</td>
<td>23.87 ab</td>
</tr>
<tr>
<td>1 ppm 1-MCP + 0.5 mM SA</td>
<td>24.53 a</td>
<td>22.89 a-e</td>
</tr>
<tr>
<td>1 ppm 1-MCP + 1 mM SA</td>
<td>24.53 a</td>
<td>22.32 a-d</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pre-storage treatments</th>
<th>Storage period (weeks)</th>
<th>Season 2021</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td><strong>Control</strong> (Distilled water)</td>
<td>23.87 a</td>
<td>17.66 j-n</td>
</tr>
<tr>
<td>0.5 ppm 1-MCP</td>
<td>23.87 a</td>
<td>20.93 c-g</td>
</tr>
<tr>
<td>1 ppm 1-MCP</td>
<td>23.87 a</td>
<td>21.58 b-e</td>
</tr>
<tr>
<td>0.5 mM SA</td>
<td>23.87 a</td>
<td>20.60 c-h</td>
</tr>
<tr>
<td>1 mM SA</td>
<td>23.87 a</td>
<td>21.26 b-f</td>
</tr>
<tr>
<td>0.5 ppm 1-MCP + 0.5 mM SA</td>
<td>23.87 a</td>
<td>22.56 abc</td>
</tr>
<tr>
<td>0.5 ppm 1-MCP + 1 mM SA</td>
<td>23.87 a</td>
<td>23.22 ab</td>
</tr>
<tr>
<td>1 ppm 1-MCP + 0.5 mM SA</td>
<td>23.87 a</td>
<td>21.91 a-d</td>
</tr>
<tr>
<td>1 ppm 1-MCP + 1 mM SA</td>
<td>23.87 a</td>
<td>22.24 a-d</td>
</tr>
<tr>
<td>Means</td>
<td>23.87 A</td>
<td>21.33 B</td>
</tr>
</tbody>
</table>

Means followed by the same letters within pre-storage treatments, storage periods and their interactions in each season are not significantly different at level P< 0.05 according to DMRT. The duration of the exposure to 1-MCP and SA dipping were 24 hours and 5 minutes, respectively.

The overall results in Table (5) reveal that, all pre-storage treatments especially combined treatments showed significantly retarded the deterioration in physical attributes as compared to untreated fruits (control) at the end of cold storage (8 weeks) plus 5 days shelf life at ambient temperature. Data also showed that, pre-storage treatment of Barhi date fruits with 0.5 ppm of 1-MCP and 1 mM of SA had the lowest weight loss and decay percentage and the highest marketable percentage and firmness in the two seasons.
The loss in fruit weight during storage could be attributed to the loss in moisture that occurs through physiological processes such as transpiration and respiration (Wang et al., 2006). The reducing decay appearance may be associated with changes in natural antifungal compounds (Prusky and Keen, 1993) and increase in activities of antioxidant enzyme (Tareen et al., 2012b; Shi et al., 2013 and Ezzat, 2014). 1-MCP and SA are highly effective antibrowning agent for fruits (Tareen et al., 2012b and Ezzat, 2014) and enhancement the disease resistance in apricots. The rate of fruit firmness losses affects on fruit quality and the storage life. Fruit softening starts with the conversion of insoluble protopectin into water soluble pectin and associated with dissolution of the middle lamellae that lead to an increase of pectin solubility and depolymerization of matrix polysaccharides (Vicente et al., 2007). The increasing of hydrolytic enzymes activity such as PME, polygalacturonase and betagalactosidase are contributors in reduced rigidity of cell walls and lead to fruit softening (Payasi et al., 2009). Thus, the reduction in flesh firmness of apricots during storage might be due to regradation in cellular structures because of respiration and other metabolic activities (Femenia et al., 1998).

The results in the current study suggested that, treated Barhi dates with exposure to either 0.5 or 1 ppm of 1-MCP, dipping fruits in either 0.5 or 1 mM of SA and especially their combined treatments probably reduced respiration, transpiration, maintaining cellular integrity and delaying the activities of cell wall degrading enzymes (Ezzat 2014 and Özkaya et al., 2016). Therefore, treated Barhi date fruits with exposure to 1-MCP and SA dipping especially their combined treatments reduced weight loss and decay percentages with a significant increase in marketable fruit percentage as well as maintained fruit firmness, thus delayed ripening and senescence processes of Barhi dates.

Table (5): Changes in fruit physical attributes of ‘Barhi’ palms treated with exposure to 1-methylocyclopene (1-MCP) application, salicylic acid (SA) dipping and their combined treatments during cold storage at 0 °C for 8 weeks and then transferred to about 25 °C for 5 days shelf life.

<table>
<thead>
<tr>
<th>Pre-storage treatments</th>
<th>Weight loss (%)</th>
<th>Decay (%)</th>
<th>Marketable %</th>
<th>Firmness (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Season 2020</td>
<td>Season 2021</td>
<td>Season 2020</td>
<td>Season 2021</td>
</tr>
<tr>
<td>Control (Distilled ater)</td>
<td>30.95 a</td>
<td>28.78 a</td>
<td>67.40 a</td>
<td>66.05 a</td>
</tr>
<tr>
<td>0.5 ppm 1-MCP</td>
<td>14.43 b</td>
<td>14.50 b</td>
<td>27.67 b</td>
<td>28.83 b</td>
</tr>
<tr>
<td>1 ppm 1-MCP</td>
<td>14.32 b</td>
<td>14.35 b</td>
<td>25.27 b</td>
<td>26.17 b</td>
</tr>
<tr>
<td>0.5 mM SA</td>
<td>13.99 b</td>
<td>14.44 b</td>
<td>29.41 b</td>
<td>29.25 b</td>
</tr>
<tr>
<td>1 mM SA</td>
<td>13.49 bc</td>
<td>14.02 b</td>
<td>25.98 b</td>
<td>27.04 b</td>
</tr>
<tr>
<td>0.5ppm 1-MCP+0.5m SA</td>
<td>12.36 bc</td>
<td>12.18 c</td>
<td>10.54 c</td>
<td>11.87 c</td>
</tr>
<tr>
<td>0.5ppm 1-MCP+1mM SA</td>
<td>10.84 c</td>
<td>10.95 d</td>
<td>7.58 c</td>
<td>7.38 c</td>
</tr>
<tr>
<td>1ppm 1-MCP+0.5m SA</td>
<td>12.79 bc</td>
<td>12.89 c</td>
<td>12.43 c</td>
<td>12.82 c</td>
</tr>
<tr>
<td>1ppm 1-MCP+ 1mM SA</td>
<td>12.78 bc</td>
<td>12.55 c</td>
<td>11.98 c</td>
<td>12.03 c</td>
</tr>
</tbody>
</table>

Means followed by the same letters within pre-storage treatments, storage periods and their interactions in each season are not significantly different at level P< 0.05 according to DMRT. The duration of the exposure to 1-MCP and SA dipping were 24 hours and 5 minutes, respectively.
Evaluating the effect of pre-storage application with 1-methyle cyclopropene and salicylic acid for ……

Our findings in the present study are in agreement with the previous studies by Erkan and Eski (2012) on ‘Black Beauty’ and ‘Autumn Giant’ plums, Shi et al. (2013) on apricots and Mohamed et al. (2016) on ‘Zibda’ mangoes. They reported that, 1-MCP treatment reduced fruit weight loss and decay percentages, increased marketable fruits percentage and maintained fruit firmness during cold storage period and shelf life. Also, the obtained results are in harmony with reports that 1-MCP application delayed fruit softening in a number of crops including, apricots and plums (Fan et al., 2000), and nectarines (Özkaya et al., 2016). Furthermore, the current investigation findings agree with those mentioned by Ali et al., (2013), Hajilou and Fakhimrezaei (2013), Ezzat (2014) and Moradinezhad and Jahani (2016) on apricots. Moreover, these results in accordance with those reported by Wang et al. (2006) and Tareen et al. (2012a, b) on peaches and on ‘Valencia’ oranges. They reported that, SA treatment reduced weight loss percentage, decay incidence, increased marketable fruit percentage and maintained fruit firmness as compared with control during cold storage.

CONCLUSION

In general, this experiment showed the effectiveness of pre-storage treatments of ‘Barhi’ dates with exposure to either 0.5 or 1 ppm of 1-MCP for 24 hours at room temperature, SA dipping in either 0.5 or 1 mM concentration for 5 min and their combined treatments on keeping qualities. Pre-storage application of ‘Barhi’ fruits with exposure to either 0.5 or 1 ppm of 1-MCP then its dipping in either 0.5 or 1 mM concentration of SA was more effective in maintaining physical characteristics. Therefore, pre-storage application of ‘Barhi’ dates with exposure to 1-MCP at 0.5 ppm for hours then its dipping in either 0.5 or 1 mM concentration of SA consider that is a reliable treatments and promising methods to delaying ripening process and fruit senescence during cold storage and shelf life.

REFERENCES


تقييم تأثير استخدام معاملات
1 - ميثيل سيلكلوروبين وحامض السالسيليك بعد الحصاد لتحسين نشاط مضادات الأكاسدة
الإنزيمية والمحافظة على جودة ثمار البلح أثناء التخزين المبرد

مُجري رابح محمد - عاطف محمد حجازي - أحمد محمد فتح الله - علاء جمال عيسى
قسم اليسانيين - كلية الزراعة - جامعة المنوفية

المختص العربي

تعتبر ثمار البريحي أحد الفضائل الأطعمة التي تتضح بسرعة كبيرة بعد الحصاد والتي تودي بالتألي لذوبها وقصر حياتها التخزينية. 1- ميثيل سيلكلوروبين وحامض السالسيليك يستخدمتا على نطاق واسع لأنهما يعملان على اعاقة عمل مستقبلات الإنزيم. كان الهدف من هذه التجربة هو تقييم تأثير المعاملة التطبيقية قبل التخزين بالعرض إلى 1-ميثيل سيلكلوروبين وحامض السالسيليك بعد الحصاد مباشرة على الجودة والقدرة التخزينية والنمو التنظيمي لثمار البلح صنف (البريحي) خلال موسمي 2020 و 2021. قسم ثمار إلى ثلاث مجموعات متساوية ثم تم معالجتها باستخدام 1-ميثيل سيلكلوروبين بتركيز صفر، 0.5 جزء في المليون لمدة 24 ساعة في درجة حرارة الغرفة (حوالي 25°C). بعد فترة المعاملة ب 1-ميثيل سيلكلوروبين تمثل كل مجموعة من المجموعات الثلاثة السابقة قسم إلى ثلاث مجموعات فرعية متساوية حيث تم قرب كل مجموعة فرعية في محاور من حامض السالسيليك بتركيز صفر، 0.5، 1 مللي مولار لمدة خمس دقائق، كل معاملات ثمار البلح صنف البريحي تم تخزينها عند درجة حرارة الصفر المئوي ± 1 درجة مئوية ورطوبة نسبة 90 ± 5% لمدة 8 أسابيع تبادل فترة صلاحية 5 أيام عند درجة حرارة الغرفة كفترة عمر تنظيمي وذالك لمحاكاة العملية التشريعية. التغيرات في الخواص الطبيعية قد قدرت على قطع أسبوعاً طوال فترة التخزين المبرد على درجة الصفر المئوي وايضا بعد نهاية فترة التخزين المبرد بالإضافة إلى 5 أيام فترة عمر تنظيمي (حوالي 65°C). كل المعاملات تحت الدراسة التي أجريت قبل التخزين على ثمار حسبنن بشكل منهجيخارص جودة التماز مقاومة ثمار الكتلة أثناء التخزين المبرد والعمر التنظيمي. معالمة تعريض الثمار الي 0.5 جزء في المليون من 1-ميثيل سيلكلوروبين لمدة 24 ساعة ثم البقاء في حامض السالسيليك بتركيز 0.5، او 1 مللي مولار لمدة 5 دقائق كانت أكثر فائدة لحفظ التماز أثناء التخزين وكذلك الفترة التنظيمية مقارنة بالمعالمة بدون معامل مثل 1-ميثيل سيلكلوروبين وحامض السالسيليك بصورة مفردة.معالمة الثمار بالعرض الي 0.5 جزء في المليون من 1-ميثيل سيلكلوروبين وحامض السالسيليك بتركيز 0.5، او 1 مللي مولار أظهرت أقل نسبة مئوية لفقد الثمار في الوزن والتفش مع اعطاء أعلى نسبة مئوية للثمار القابلة للتصويق وكذلك اعلى قيمة لصلاحية الثمار.