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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

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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 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 sulpher (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 envronnmental 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 fruits that products 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) (C_4 H_6) 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 (Co_2) and ethylene production by reducing the activities of ethylene

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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.

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/cm^2): 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-methylcyclopropene (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-methylcyclopropene (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 ^{0}C for 8 weeks .

Pre-storage Treatments	Storage period (weeks)					
	0	2	4	6	8	Means
	Season 2020					
Control (Distilled water)	0.00 s	11.86 def	16.34 c	21.54 b	26.37 a	15.22 A
0.5 ppm 1-MCP	0.00 s	6.40 mno	9.59 g-j	11.50 def	12.73 d	8.05 B
1 ppm 1-MCP	0.00 s	6.60 mno	9.63 g-j	11.32 def	12.61 de	8.03 B
0.5 mM SA	0.00 s	5.24 o-r	8.90 jk	10.58 fgh	11.94 def	7.33 C
1 mM SA	0.00 s	5.60 opq	8.57 jkl	10.43 f-i	11.66 def	7.25 C
0.5 ppm 1-MCP+0.5 mM SA	0.00 s	4.47 qr	7.16 lmn	9.13 hij	10.83 fg	6.32 D
0.5 ppm 1-MCP+1 mM SA	0.00 s	4.04 r	6.05 nop	7.60 klm	8.98 ijk	5.34 E
1ppm 1-MCP+0.5 mM SA	0.00 s	4.76 pqr	7.62 klm	9.24 hij	11.20 ef	6.56 D
1ppm 1-MCP+1mM SA	0.00 s	4.69 pqr	7.36 lmn	9.15 hij	10.90 fg	6.42 D
Means	0.00 E	5.96 D	9.02 C	11.17 B	13.02 A	
Season 2021						
Control (Distilled water)	0.00 n	11.75 e	15.98 c	19.63 b	23.92 a	14.25 A
0.5 ppm 1-MCP	0.00 n	6.56 j	8.57 h	11.53 e	13.34 d	8.00 B
1 ppm 1-MCP	0.00 n	6.21 jk	8.20 h	11.31 e	12.87 d	7.72 B
0.5 mM SA	0.00 n	6.51 j	8.28 h	11.21 e	13.20 d	7.84 B
1 mM SA	0.00 n	6.33 jk	8.18 h	10.97 ef	12.81 d	7.66 B
0.5 ppm 1-MCP+0.5 mM SA	0.00 n	4.10 m	6.24 jk	8.50 h	9.97 fg	5.76 D
0.5 ppm 1-MCP+1 mM SA	0.00 n	3.67 m	5.30 kl	7.93 hi	8.58 h	5.10 E
1ppm 1-MCP+0.5 mM SA	0.00 n	4.59 lm	6.94 ij	9.05 gh	11.12 e	6.34 C
1ppm 1-MCP+1mM SA	0.00 n	4.52 lm	6.53 j	8.78 h	10.68 ef	6.10 CD
Means	0.00 E	6.03 D	8.25 C	10.99 B	12.94 A	

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 (2): Changes in decay 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 ^{0}C for 8 weeks.

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

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 ^{0}C for 8 weeks .

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

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 ^{0}C for 8 weeks.

Pre-storage treatments	Storage period (weeks)					
	0	2	4	6	8	Means
	Season 2020					
Control (Distilled water)	24.53 a	17.99 k	11.77 m	7.85 N	4.25 o	13.28 E
0.5 ppm 1-MCP	24.53 a	21.58 b-h	19.62 g-k	18.31 Jk	15.04 l	19.82 CD
1 ppm 1-MCP	24.53 a	22.24 a-f	20.60 e-j	19.29 h-k	15.70 l	20.47 C
0.5 mM SA	24.53 a	20.60 e-j	19.29 h-k	17.99 k	14.72 l	19.42 D
1 mM SA	24.53 a	21.91 b-g	20.27 f-k	18.97 Ijk	15.37 l	20.21 CD
0.5 ppm 1-MCP+0.5 mM SA	24.53 a	23.54 abc	22.24 a-f	21.26 c-i	18.97 ijk	22.11 AB
0.5 ppm 1-MCP+1 mM SA	24.53 a	23.87 ab	23.22 a-d	21.91 b-g	19.95 f-k	22.69 A
1ppm 1-MCP + 0.5 mM SA	24.53 a	22.89 a-e	21.91 b-g	20.27 f-k	17.99 k	21.52 B
1ppm 1-MCP + 1mM SA	24.53 a	23.22 a-d	22.24 a-f	20.93 d-i	18.31 jk	21.84 AB
Means	24.53 A	21.98 B	20.13 C	18.53 D	15.59 E	
Season 2021						
Control (Distilled water)	23.87 a	17.66 j-n	11.12 q	7.19 R	3.92 s	12.75 D
0.5 ppm 1-MCP	23.87 a	20.93 c-g	18.64 h-m	16.68 Mn	14.06 p	18.84 C
1 ppm 1-MCP	23.87 a	21.58 b-e	19.29 f-k	17.66 j-n	14.72 op	19.42 C
0.5 mM SA	23.87 a	20.60 c-h	18.31 i-n	16.35 No	13.73 p	18.57 C
1 mM SA	23.87 a	21.26 b-f	18.97 g-l	17.00 Lmn	14.39 p	19.10 C
0.5 ppm 1-MCP + 0.5 mM SA	23.87 a	22.56 abc	20.60 c-h	19.62 e-j	18.31 i-n	20.99 AB
0.5 ppm 1-MCP + 1 mM SA	23.87 a	23.22 ab	21.58 b-e	20.60 c-h	19.29 f-k	21.71 A
1ppm 1-MCP + 0.5 mM SA	23.87 a	21.91 a-d	20.27 d-i	18.64 h-m	17.33 k-n	20.40 B
1ppm 1-MCP + 1mM SA	23.87 a	22.24 a-d	20.60 c-h	19.29 f-k	17.66 j-n	20.73 B
Means	23.87 A	21.33 B	18.82 C	17.00 D	14.82 E	

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-methylcyclopropene (1-MCP) application, salicylic acid (SA) dipping and their combined treatments during cold storage at 0 ^{0}C for 8 weeks and then transferred to about 25 ^{o}C for 5 days shelf life.

Pre-storage treatments	Weight loss (%)		Decay (%)		Marketable %		Firmness (N)	
	Season 2020	Season 2021	Season 2020	Season 2021	Season 2020	Season 2021	Season 2020	Season 2021
Control (Distilled ater)	30.95 a	28.78 a	67.40 a	66.05 a	22.53 c	24.22 d	2.62 f	2.29 d
0.5 ppm 1-MCP	14.43 b	14.50 b	27.67 b	28.83 b	61.79 b	60.85 c	12.43 de	12.10 c
1 ppm 1-MCP	14.32 b	14.35 b	25.27 b	26.17 b	64.00 b	63.22 c	13.41 d	12.75 c
0,5 mM SA	13.99 b	14.44 b	29.41 b	29.25 b	60.70 b	60.53 c	11.77 e	11.77 c
1 mM SA	13.49 bc	14.02 b	25.98 b	27.04 b	64.04 b	62.73 c	12.75 de	12.43 c
0.5ppm 1-MCP+0,5m SA	12.36 bc	12.18 c	10.54 c	11.87 c	78.33 a	77.42 ab	17.00 b	16.35 ab
0.5ppm 1-MCP+1mM SA	10.84 c	10.95 d	7.58 c	7.38 c	82.39 a	82.50 a	18.31 a	17.99 a
1ppm 1-MCP+0,5mM SA	12.79 bc	12.89 c	12.43 c	12.82 c	76.36 a	75.93 b	15.37 c	15.04 b
1ppm 1-MCP+ 1mM SA	12.78 bc	12.55 c	11.98 c	12.03 c	76.65 a	76.93 b	16.02 bc	15.37 b

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.

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

Ali, S.; Masud, T.; Abbasi, K. S.; Mahmood, T. and Ali, A. (2013). Effect of different concentrations of salicylic acid on keeping quality of apricot cv. Habi at ambient storage. Journal of Biological and Food Science Research, 2 (6): 69-78.

Asghari, M. and Aghdam, M.S. (2010). Impact of salicylic acid on postharvest physiology of horticultural crops. Trends in Food Science and Technology, 21: 502-509.

Blankenship, S.M. and Dole, J.M. (2003). 1-Methylcyclopropene: a review. Postharvest. Biology and Technology, 28: 1-25.

De Martino, G.; Massantini, R.; Botondi, R. and Mencarelli, F. (2002). Temperature affects impact injury on apricot fruit. Postharvest Biology and Technology, 25 (2): 145-149.

Egea, I.; Flores, F.B.; Martinez-Madrid, M.C.; Romojaroa, F. and Sánchez-Bela, P. (2010). 1-Methylcyclopropene affects the antioxidant system of apricots (Prunus armeniaca L. cv. B´ulida) during storage at low temperature. Journal of the Science of Food and Agriculture, 90: 549-555.

Erkan, M. and Eski. H. (2012). Combined treatment of modified atmosphere packaging and 1-methylcyclopropene improves postharvestquality of Japanese plums. Turk Journal Agriculture, 36: 563-575.

Ezzat. A.; Nyéki, J.; Soltész, M.; Amriskó, L.; Balázs, G.; Mikita, T. and Szabó, Z. (2012). Storability of some apricot varieties as affected by storage period. International Journal of Horticultural Science, 18 (1): 339-342.

Ezzat, A. (2014). Pomological evaluation of apricot cultivars and the roles of postharvest application of salicylic acid and methyl jasmonate on stress resistance. Ph.D Thesis. University of Deprecen, Hungry.

Fan, X. and Mattheis, J. P. (2000). Yellowing of broccoli in storage is reduced by 1-methylcyclopropene. HortScience 35: 885-887.

Femenia, A.; Garcia-Conesab, M.; Sirnal, S. and Rossello C. (1998). Characterisation of the cell walls of loquat (*Eriobotrya japonica* L.)

fruit tissues. Carbohydrate Polymers, 35: 169-171.

Hajilou, J. and Fakhimrezaei, S. (2013). Effects of post-harvest calcium chloride orsalicylic acidon the shelf-life and quality of apricot fruit. Journal of Horticultural Science and Biotechnology, 88 (5), 600-604.

Kader, A.A. (1992). Postharvest technology of horticulture crops.univ. of calif., Division of Agriculture and Natural Reasources. Pp296.

Mita, S.; Kirita, C.; Kato, M. and Hyodo, H. (1999). Expression of ACC synthase is enhanced earlier than that of ACC oxidase during fruit ripening of mume (*Prunus mume*). Physiologia Plantarum, 107: 319-328.

Mohamed, M.A.A.; Abd El-khalek, A.F. and Abdelaziz, A.M.R.A. (2016). Increasing storability of mango cv. 'Zibda' fruits by 1-methylcyclopropene and gibberellic acid postharvest applications. Egyptian Journal of Horticulture, 43 (2): 277-298.

Moradinezhad, F. and Jahani, M. (2016). Quality improvement and shelf life extension of fresh apricot fruit (*Prunus Armeniaca* cv. Shahroudi) using postharvest chemical treatments and packaging during cold storage. International Journal of Horticultural Science and Technology, 3 (1): 9-18.

Nixon, R.W. and Carpenter, J. B. (1978). Growing dates in the united states. Dept of agric., Washington, D.C.

Özkaya, O.; Yildirimb, D.; Dündara, Ö. and Seyhan Tükel, S. (2016). Effects of 1-methylcyclopropene (1-MCP) and modified atmosphere packaging on postharvest storage quality of nectarine fruit. Scientia Horticulturae, 198: 454 - 461.

Payasi, A.; Mishra, N.N.; Chaves, A.L.S. and Singh, R. (2009). Biochemistry of fruit softening: an overview. Physiology and Molecular Biology of Plants, 15: 103-113.

Prusky, D. and Keen, N.T. (1993). Involvement of preformed antifungal compounds and the resistance of subtropical fruits to fungal decay. Plant Disease, 77: 114-119.

Raskin, I. (1992). Role of salicylic acid in plants. Ann Rev Plant Physiol Mol Biol 43: 439–463

Shi, T.; Li, Z.; Zhang, Z.; Zhang, C. and Gao, Z. (2013). Effect of 1-methylcyclopropene (1-MCP) treatment on antioxidant enzymes of postharvest Japanese apricot. African Journal of Biotechnology, 12 (7): 689-694.

Sisler, E.C. and Serek, K. (1997). Inhibitors of ethylene responses in plant at the receptor level: Recent development. Physiologia Plantarum 100: 577-582.

Tareen, M.J.; Abbasi, N.A. and Hafiz, I.A. (2012a). Effect of salicylic acid treatments of storage life of peach fruits cv. 'Flordaking'. Pakistan Journal of Botany, 44 (1): 119-124.

Tareen, M.J.; Abbasi, N.A. and Hafiz, I.A. (2012b). Postharvest application of salicylic acid enhanced antioxidant enzyme activity and maintained quality of peach cv. 'Flordaking' fruit during storage. Scientia Horticulturae, 142: 221-228.

Vicente, A.R.; Saladie, M.; Rose, J.K.C. and Labavitch, J.M. (2007). The linkage between cell wall metabolism and fruit softening: looking to the future. Journal of the Science of Food and Agriculture, 87: 1435-1448.

Wang, L.; Chen, S.; Kong, W.; Li, S. and Archbold, D.D. (2006). Salicylic acid pretreatment alleviates chilling injury and affects the antioxidant system and heat shock proteins of peaches during cold storage. Postharvest Biology and Technology, 41: 244-251.

Watkins, C. and Harman, J. (1981). Use of penetrometer to measure flesh firmness of fruit. Orchadist, N.Z.: 14-16.

Yousif, A. K.; Benjamin, N. D.; Kado, A.; Mehi-Alddin, A. S. and Ali, S. M. (1982). Chemical composition of four Iraqi date cultivars. The Date palm Journal 1(2): 285-294.

تقييم تأثير استخدام معاملات

١- ميثيل سيكلوبروبين وحامض السالسيلك بعد الحصاد لتحسين نشاط مضادات الأكسدة الإنزيمية والمحافظة على جودة ثمار البلح أثناء التخزين المبرد

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الملخص العربي

تعتبر ثمار البرحي احد الثمارالكلايمكتيرية التي تنضج بسرعة كبيرة بعد الحصاد والتي تؤدي بالتالي لتدهورها وقصر حياتها التخزينية. ١-ميثيل سيكلوبروبين وحمض السالسيليك يستخدما على نطاق واسع لأنهما يعملان علي اعاقة عمل مستقبلات الإيثيلين. كان الهدف من هذه التجربة هو تقييم تأثير المعاملة التطبيقية قبل التخزين بالتعرض الي ١-ميثيل سيكلوبروبين وحامض السالسيليك بعد الحصاد مباشرة على الجودة والقدرة التخزينية والعمر التسويقي لثمارالبلح صنف (البرحي) خلال موسمي ٢٠٢٠ و ٢٠٢١. قسمت الثمار إلى ثلاث مجموعات متساوية ثم تم معاملتها باستخدام ١-ميثيل سيكلوبروبين بتركيز صفر ، ٠.٥ ، ١ جزء في المليون لمدة ٢٤ ساعة في درجة حرارة الغرفة (حوالي ٢٥° م). بعد فترة المعامله ب ١-ميثيل سيكلوبروبين ثمار كل مجموعة من المجموعات الثلاثة السابقة قسمت الي ثلاث مجموعات فرعية متساوية حيث غمرت كل مجموعة فرعية في محاليل من حامض السلسليك بتركيز صفر ، ٠.٥ ، ١ مللي مولار لمدة خمس دقائق ، كل معاملات ثمار البلح صنف البرحي تم تخزينها عند درجة حرارة الصفر المئوي ± ١ درجة مئوية ورطوبة نسبية ٩٠ ± ٥٪ لمدة ٨ أسابيع تليها فترة صلاحية ٥ أيام عند درجة حرارة الغرفة كفترة عمر تسويقي وذلك لمحاكاة العملية التسويقية. التغيرات في الخواص الطبيعية قدرت على فترات أسبوعية طوال فترة التخزين المبرد علي درجة الصفر المئوي وايضا بعد نهاية فترة التخزين المبرد بالإضافة إلى ٥ أيام فترة عمر تسويقي (حوالي ٢٥° م). كل المعاملات تحت الدراسة التي اجريت قبل التخزين علي الثمار حسنت بشكل معنوي خصائص الجودة للثمار مقارنة بثمار الكنترول اثناء التخزين المبرد والعمر التسويقي. معاملة تعريض الثمار الي ٠,٥ او ١ جزء في المليون من ١-ميثيل سيكلوبروبين لمدة ٢٤ ساعه ثم الغمر في حامض السلسليك بتركيز٠,٥ او ١ مللي مولار لمدة ٥ دقائق كانت اكثر قدرة للحفاظ علي الثمار اثناء التخزين وكذلك الفترة التسويقية مقارنة بالمعامل باي من ١-ميثيل سيكلوبروبين وحامض السلسليك بصورة منفردة.معاملة الثمار بالتعرض الي ٠,٥ جزء في المليون من ١-ميثيل سيكلوبروبين متبوعة بغمر الثمار في حامض السلسيك بتركيز٠,٥ او ١ مللي مولار اظهرت اقل نسبة مئويه لفقد الثمارفي الوزن والتلف مع اعطاء اعلي نسبة مئوية للثمار القابلة للتسويق وكذلك اعلي قيمة لصلابة الثمار.