Delay Ripening Changes and Extending the Khalal Stage of Barhee and Zaghloul Date Fruits by Putrescine and 1-MCP Applications

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ABSTRACT

The present investigation was carried out during 2009 and 2010 seasons to study the effect of different concentrations of 1-methylcyclopropene (1-MCP) and putrescine (PUT) on the postharvest fruit quality and storagability of Barhee and Zaghloul dates as well as the fruit physicochemical properties during cold storage. The fruits were treated with 0.5 or 1 ppm 1-MCP for 20 hours; dipped for 5 min in 1 or 2 μM PUT or untreated as control fruits then, all fruits were stored at 0±1°C and 85-90±5 % R.H. The above treatments prolonged the storage period of Barhee dates by 1, 2 and 3 weeks for 0.5 ppm 1-MCP, 1 ppm 1-MCP and both PUT treatments, respectively. However, the corresponding periods of Zaghloul dates were 1 and 2 weeks for 1-MCP and PUT treatments, respectively. All treatments effectively delayed ripening and senescence of the fruits and significantly improved their storagability and the best quality was for PUT treated fruits. All treatments increased the hue° of fruit skin and maintained it higher (colorful) than that of control fruits during the storage period. Both 1-MCP and PUT decreased the fruit weight loss, the percent of rutab incidence, whole fruit and flesh texture loss, pectin solubilization, soluble solids loss, malic acid loss, polyphynol oxidase (PPO) and peroxidase (POD) enzymes activity. The previous best results were obtained with PUT treatments.

Key words: Putrescine, 1-MCP, postharvest, storage and dates.

INTRODUCTION

Date is a high energy and nutritious fruit. It is the only fruit in which flavonoid sulfates (highly beneficial anti-oxidant compounds) have been reported and the antioxidant activity varies among cultivars from moderate to high relative to other fruits (Kader and Hussein, 2009). Date fruit can be consumed at three stages of its growth and development, including Khalal, Rutab and Tamar. Barhee and Zaghloul are two of the most popular cultivars marketed and consumed at the Khalal stage where fruits are physiologically mature, hard and crisp, bright yellow (Barhee) or red (Zaghloul) in color, have a low amount of tannin and low astringency. But, due to the high moisture content, fruits are very perishable with short storage life and its economical value decreases sharply when they ripen as surplus production has to be sold at lower prices. Thus, it would be beneficial to reduce loss of fruit quality to prolong the Khalal stage of these cultivars and expand their shelf life and marketability as well. (Mortazavi *et al.*, 2007; Kader and Hussein, 2009 and Kassem *et al.*, 2010).

Ethylene is a plant hormone that regulates many processes of growth and development, including ripening, and is also an important mediator of plant responses to biotic and abiotic stresses (Wang *et al.*, 2002). The rise in ethylene production accompanying the climacteric is a major regulatory event in the ripening of many fruit species (Klee and Clark, 2002). Serrano *et al.*, (2001) reported that in early ripening stages of 'Negros' date palm fruits growing in Spain, a small peak in ethylene production was detected followed by a peak in respiration rate, suggesting dates are climacteric fruits, with ethylene being responsible for the ripening processes.

Polyamines are natural compounds involved in many growth and developmental processes with ubiquitous presence in all cells (Valero *et al.*, 2002). Polyamines such as putrescine have been reported as anti-senescence agents may be by the antagonism with ethylene, possible by competing for S-adenosylmethionine, a common precursor of both plant bioregulators (Galston and Kaur-Sawhney, 1995). Putrescine reported to delay ethylene production, decrease respiration rate, induce mechanical resistance, decrease firmness loss and fruit weight loss, retard color change, reduce chilling symptoms and extend fruit shelf life (Kramer *et al.*, 1991; Valero *et al.*, 1999; Al-Obeed, 2010 and Kassem *et al.*, 2010).

1-Methylcyclopropene (1-MCP) is another ethylene action inhibitor that has been used after harvest to retard ripening and it has been reported to decrease softening, color development, respiration rates, and ethylene production (Khan and Singh, 2007 and Villalobos-Acuña *et al.*, 2011). Ethylene may not be the only factor that explains the beneficial effects of 1-MCP on fruit ripening where the changes in antioxidant potential seem to constitute an important factor and are probably also involved in this process (Larrigudière *et al.*, 2004), where an increase in antioxidant potential is

generally associated with slowing the senescence processes (Lacan and Baccou, 1998).

The aim of the current work was to study the effect of different 1-MCP and putrescine concentrations on the postharvest fruit quality and storagability of Barhee and Zaghloul dates as well as the fruit physicochemical properties during cold storage at 0°C.

MATERIALS AND METHODS

The present study was carried out during 2009 and 2010 seasons on Barhee and Zaghloul date fruits harvested at full colored stage (end of Khalal stage) from El-Magraby (MAFA) orchard (Barhee) and from El-Maamoura Botanical Garden (Zaghloul), Alex. Governorate. As an average of two seasons, Barhee had 21.69 gm fruit weight, 4.13 cm fruit length and 3.09 cm fruit breadth, however, Zaghloul had 28.7 gm fruit weight, 6.22 cm fruit length and 2.82 cm fruit breadth. The fruits were transported to the Postharvest Center of Horticulture Crops, Faculty of Agriculture, Alexandria University. The fruits of both cvs. were sorted carefully to eliminate any fruits with obvious mechanical damage, browning or defect. Sound selected fruits of each cv. (attached to the spikelet) were divided into five lots of 15 Kg of each. The first two lots were treated with 1 and 2 μM putrescine (PUT), respectively by dipping fruits for 5 min at room temperature. The second two lots were treated with 0.5 and 1 ppm 1-MCP, respectively for 20 hours at 20°C. The last lot was untreated fruits to serve as control. Fruits of each lot were packed into 3 open plastic boxes (5 Kg of each) and then were stored at 0 ±1°C and 85-90±5 % relative humidity (RH). The physicochemical properties of the stored date fruits were determined initially and were followed up in 7 day intervals throughout the storage period as follow.

Five plastic nets (each contained 15-20 fruits) from each lot were labeled then weighed to determine the fruit weight loss percents during the storage period in relation to its original weight. Another 5 nets were labeled to calculate the percentage of fruits rutab incidence (changing from khalal or full colored to rutab or full brown in Barhee and full black in Zaghloul) and to record any obvious shriveling symptoms.

External color of each fruit in the weekly sample (25 fruits from each treatment) was estimated visually and measured with Minolta Chromameter CR-200-Japan on four points of each fruit in the sample. a* and b* values were used to calculate the hue angle (hue°) of each fruit in the sample of each treatment according to Sancho *et al.*, (2010) where hue° = Arctan (b*/a*). Hue° is a quantitative expression of color and represents the changes in fruit color (0 = red, 90 = yellow, 180 = green, and 270 = blue).

Fruit texture of two sides of each fruit in the sample with and without peeling was determined as gm by Stevens-Lefra Texture Analyzer with a penetrating cylinder of 1 mm diameter, constant distance of 3 mm and constant speed of 2 mm/sec.

Three replicates of five fruits were squeezed and the obtained juice was used to determine the percentage of the soluble solids content (SSC) by the use of a hand refractometer (Chen and Mellenthin, 1981). The titratable acidity was determined in three samples of the same above juice as g malic acid /100 ml of fruit juice (Chen and Mellenthin, 1981).

Three samples of 50 g were taken to determine water soluble pectin content (WSP) as Ca pectate according to Care and Haynes (1922).Polyphynol oxidase (PPO) and peroxidase (POD) enzyme activities were determined in the crude extracts (Brenneman and Black, 1979) of three fruit samples in each treatment. The activity of PPO was measured using the method of Matta and Dimond (1963) and the activity of POD was determined by the method of Chance and Maehly (1955).

All obtained data were statistically analyzed according to Snedecor and Cochran (1980). The individual comparisons were carried out by using the Least Significant Difference (LSD) and simple regression coefficient r^2 between storage period and studied properties was calculated according SAS Institute (1997).

RESULTS AND DISSCUSSION

Fruit Quality and Storagability:

A great deal of extension occurred in the storage period of full mature 'Barhee and Zaghloul date fruits stored at 0°C by 1-MCP and PUT applications. Evidently in both seasons, the resulted extensions in the storage period of Barhee date fruits were 1, 2 and 3 weeks for 0.5 ppm 1-MCP, 1 ppm 1-MCP and both PUT treatments, respectively. However, the corresponding periods in Zaghloul dates were 1 and 2 weeks for 1-MCP and PUT treatments, respectively. All treatments effectively retarded ripening and senescence of the fruits and significantly improved their storagability. In Barhee, the untreated fruits began to change into rutab stage after 2 weeks of cold storage (Fig. 3) and with the progress of weeks the fruits loss thier quality with the appearance of shriveling symptoms (Fig. 4), however, the treated fruits had better appearance and the best quality was for PUT treated fruits. The same results were observed on Zaghloul dates after 4 weeks (Fig. 5) and also PUT treatments gave the best fruit quality. With the advancing of cold storage period, PUT treatments maintained the fruit quality of both Barhee (Fig. 6) and Zaghloul (Fig. 7) dates.

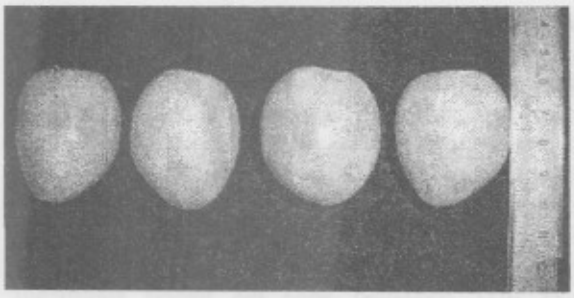


Fig. 1: The initial quality (external appearance) of Barhee date fruits.

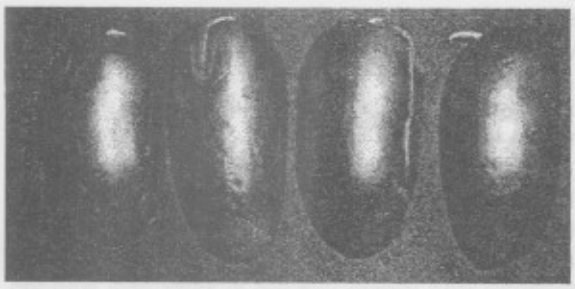


Fig. 2: The initial quality (external appearance) of Zaghloul date fruits.

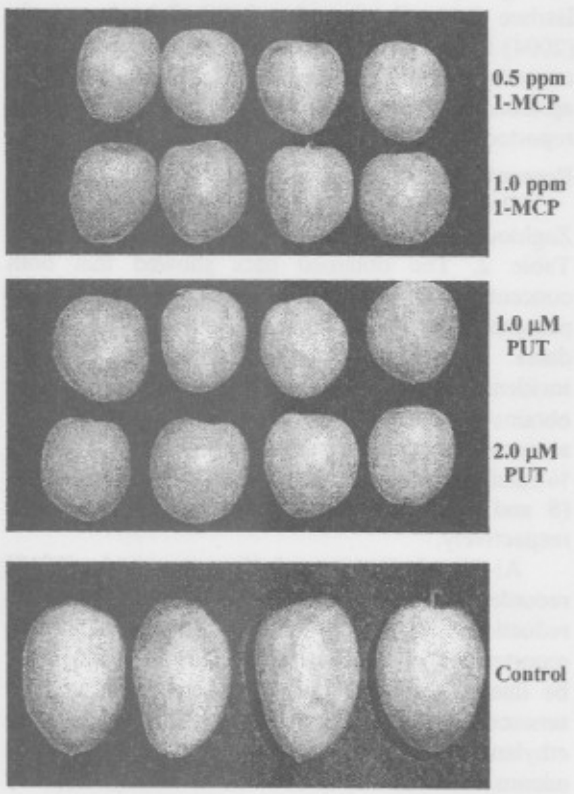


Fig. 3: Quality of Barhee date Fruits after 2 weeks of cold storage at 0°C.

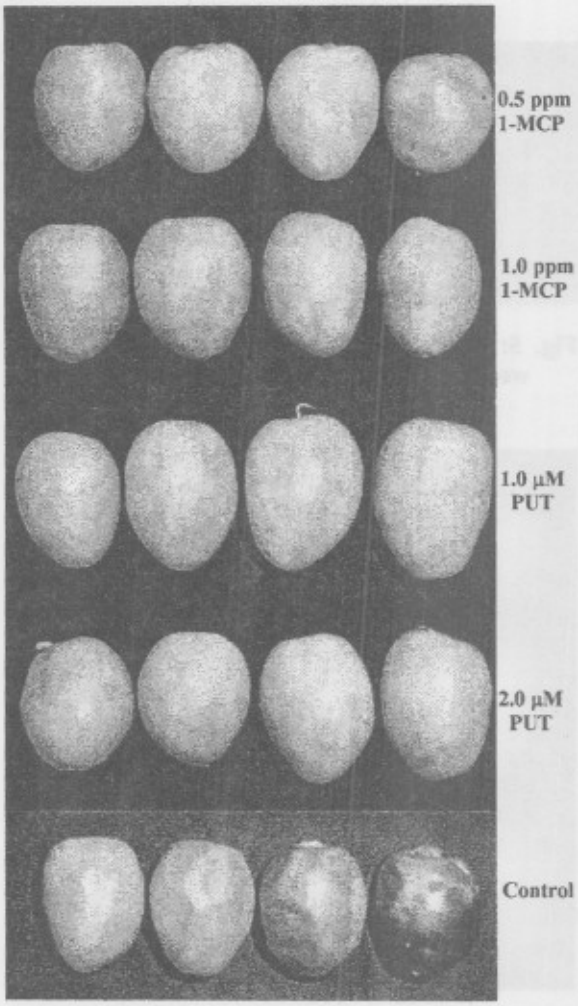
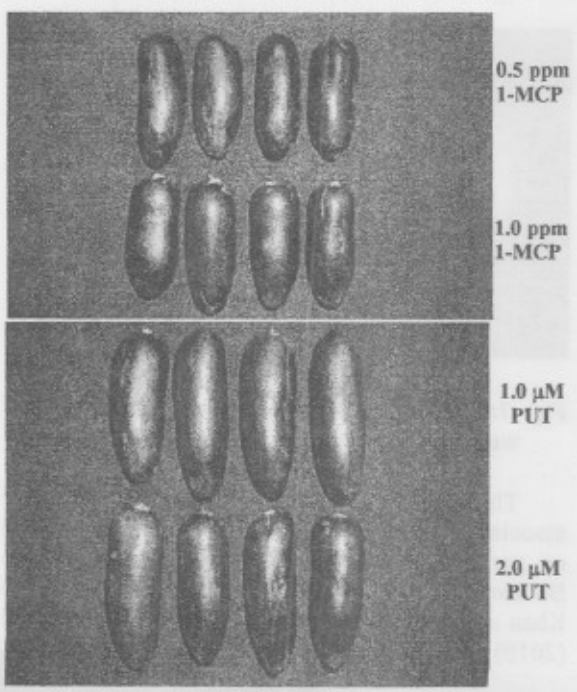


Fig. 4: Quality of Barhee date Fruits after 5 weeks of cold storage at 0°C.



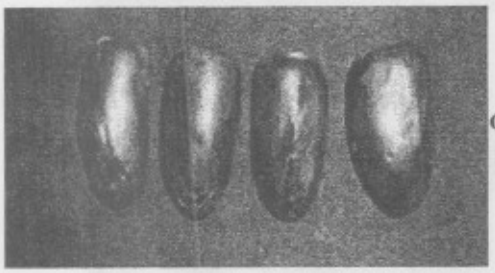


Fig. 5: Quality of Zaghloul date Fruits after 4 weeks of cold storage at 0°C.

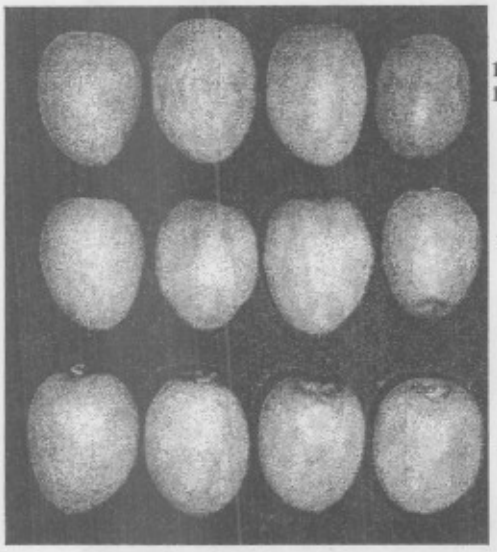


Fig. 6: Quality of Barhee date Fruits after 7 weeks of cold storage at 0°C.

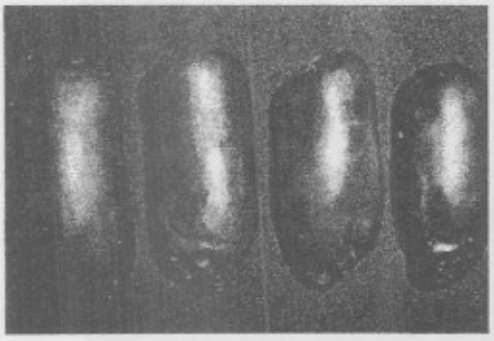


Fig. 7: Quality of Zaghloul date Fruits after 6 weeks of cold storage at 0°C.

The above obtained data of 1-MCP are associated with the results of Salvador *et al.*, (2004) on persimmons and Mortazavi *et al.*, (2010) on Barhee dates. Also, the data of PUT agree with Khan *et al.*, (2008) on plums and both of Al-Obeed (2010) and Kassem *et al.*, (2010) on Barhee dates.

Weight loss (%):

Regarding the effect of 1-MCP and PUT on fruit weight loss during cold storage, the obtained data in Table (1) revealed that all treatments decreased the fruit weight loss of both Barhee and Zaghloul in both seasons. In Barhee samples, there were unsignificant differences between 1-MCP and PUT treatments during the first 5 weeks and with the progress of cold storage period (6^{th} week) the 2 µM PUT treatment gave the lowest significant weight loss. In Zaghloul samples, the same finding was obtained during the first season (no significant differences during the first 3 weeks) and in the second one 2 µM PUT treatment gave the lowest significant weight loss during all intervals. All the obtained weight loss percentages significantly increased with the increase of the storage period (r^2 values were highly significant).

From the above results, the reduction in weight loss may be due to the effect of 1-MCP and PUT on regulating ethylene production or action and thus slowing down fruit senescence. The PUT results on reducing fruit weight loss are in agreement with the results of Serrano *et al.*, (2003) on plums, both of Al-Obeed (2010) and Kassem *et al.*, (2010) on Barhee dates. The results of 1-MCP on fruit weight loss agree with those of Mortazavi *et al.*, (2010) on Barhee dates. On the other hand, Salvador *et al.*, (2004) found slightly higher weight loss for 1-MCP treated persimmon fruits while Fan *et al.*, (2000) on apricots and Salvador *et al.*, (2003) on plums reported that 1-MCP did not affect fruit weight loss.

Percent of rutab incidence:

The percents of rutab incidence of Barhee and Zaghloul fruits in both seasons are presented in Table 2. The obtained data showed that both concentrations of 1-MCP and PUT reduced the percents of rutab incidence of Barhee and Zaghloul dates. The highest reduction effect on rutab incidence of Barhee and Zaghloul fruits was obtained by the 2 µM PUT treatment in both seasons. This treatment showed less than 50 and 30 % rutab incidence by the end of the storage period (8 and 6 weeks) of Barhee and Zaghloul fruits, respectively.

Al-Obeed (2010) and Kassem *et al.*, (2010) recorded same results of PUT on rutab incidence reduction of Barhee dates. Al-Obeed (2010) reported that the reduction of rutab incidence may be due to the effect of PUT on regulating fruit senescence as a result of its competing directly with ethylene for their common precursor S-adenosylmethionine, thus reduce or even nullify ethylene emission.

Table 1: Effects of 1-MCP and PUT treatments on weight loss (%) of cold stored Barhee and Zaghloul date fruits in 2009 and 2010 seasons.

	CV.	Treatment	Storage Period (weeks)									r^2
			0	1	2	3	4	5	6	7	8	
2009	Barhee	0.5 ppm 1-MCP	0.00a	0.88d	1.98d	3.42d	5.16e	7.51de	8.30c			0.980**
		1 ppm 1-MCP	0.00a	0.83d	1.89d	3.27d	4.98e	6.75ef	8.46c	9.94a		0.989**
		1 μ M PUT	0.00a	0.70d	1.98d	3.44d	4.98e	6.35f	6.35d	9.93a	13.22a	0.949**
		2 μ M PUT	0.00a	0.85d	1.94d	3.69cd	5.44de	6.79ef	7.51c	9.94a	11.65a	0.990**
		Control	0.00a	1.59c	3.05c	4.50c	6.23d	8.06d				0.998**
	Zaghloul	0.5 ppm 1-MCP	0.00a	2.64ab	5.50ab	7.89b	11.10bc	13.73a				0.999**
		1 ppm 1-MCP	0.00a	2.35b	5.00b	7.62b	10.77bc	12.07bc				0.993**
		1 μ M PUT	0.00a	2.56ab	5.41ab	8.34ab	11.70b	12.80ab	13.87a			0.975**
		2 μ M PUT	0.00a	2.35b	4.91b	7.57b	10.28c	11.53c	12.70b			0.982**
		Control	0.00a	2.92a	5.73a	8.93a	13.53a					0.989**
2010	Barhee	0.5 ppm 1-MCP	0.00a	0.95c	1.90e	3.40f	5.28f	6.95e	8.53c			0.986**
		1 ppm 1-MCP	0.00a	0.77c	1.79e	3.31f	4.93f	6.68e	8.36c	9.76a		0.989**
		1 μ M PUT	0.00a	0.72c	1.65e	3.20f	4.80f	6.11e	6.61d	9.29a	12.76a	0.954**
		2 μ M PUT	0.00a	0.83c	2.01e	3.33f	5.17f	6.61e	7.21d	9.10a	11.08b	0.991**
		Control	0.00a	1.70b	3.06d	4.68e	6.54e	8.56d				0.997**
	Zaghloul	0.5 ppm 1-MCP	0.00a	2.55a	5.01b	7.49c	10.31d	12.00bc				0.997**
		1 ppm 1-MCP	0.00a	2.70a	5.27ab	8.03c	11.33c	12.77b				0.994**
		1 μ M PUT	0.00a	2.78a	5.23ab	8.95b	12.27b	14.07a	14.83a			0.976**
		2 μ M PUT	0.00a	2.02b	4.43c	6.60d	10.04d	11.33c	12.73b			0.988**
		Control	0.00a	2.99a	5.67a	9.94a	14.07a					0.990**

Means within a column (in same season) having a common letter are not significantly different.
r^2=Determination coefficient.

Table 2: Effects of 1-MCP and PUT treatments on rutab incidence (%) of cold stored Barhee and Zaghloul date fruits in 2009 and 2010 seasons.

	CV.	Treatment	Storage Period (weeks)						r^2
			3	4	5	6	7	8	
2009	Barhee	0.5 ppm 1-MCP	25.00abc	38.33a	43.33b	47.67a			0.873*
		1 ppm 1-MCP	13.33cd	17.67b	23.33c	30.00bc	53.67a		0.914**
		1 μ M PUT	20.00bcd	16.67b	21.67c	25.00c	38.33b	60.00a	0.850**
		2 μ M PUT	6.67d	12.33b	19.33c	23.33c	35.00b	44.33b	0.982**
		Control	40.00a	46.67a	55.00a				0.825**
	Zaghloul	0.5 ppm 1-MCP	20.00bcd	40.00a	43.33b				0.931*
		1 ppm 1-MCP	20.00bcd	43.33a	50.00ab				0.959*
		1 μ M PUT	13.33cd	19.33b	25.00c	34.33b			0.974**
		2 μ M PUT	11.67cd	16.67b	23.33c	26.67c			0.955**
		Control	33.33ab	46.67a					0.942
2010	Barhee	0.5 ppm 1-MCP	27.67bc	48.33a	53.33ab	59.00a			0.885*
		1 ppm 1-MCP	16.67cde	23.33b	28.33c	33.33b	64.67a		0.886**
		1 μ M PUT	11.67e	14.00b	19.00cd	23.33cd	41.67b	70.67a	0.851**
		2 μ M PUT	6.67e	10.00b	15.00d	19.00d	31.00b	49.00b	0.905**
		Control	33.33ab	50.00a	65.00a				0.959*
	Zaghloul	0.5 ppm 1-MCP	33.33ab	46.67a	53.33ab				0.889*
		1 ppm 1-MCP	23.33bcd	40.00a	45.00b				0.931*
		1 μ M PUT	15.00de	20.67b	28.33c	36.67b			0.972**
		2 μ M PUT	11.67e	15.67b	23.33cd	29.33bc			0.977**
		Control	40.00a	51.67a					0.909

Means within a column (in same season) having a common letter are not significantly different.
r^2=Determination coefficient.

Skin color (hue°):

There were significant effects of 1-MCP and PUT on date fruits skin color (Table 3). Both treatments increased the hue° of Barhee and Zaghloul fruits and maintained it higher than control during the storage period. At the first two weeks, 1-MCP treated fruits had the highest hue° values then with the progress of cold storage period PUT treated fruits were the most colorful and had the highest significant hue° values with the lowest r^2 values that reflected the delaying in fruit color changes..

The investigations of Salvador *et al.*, (2004) on persimmon, Win *et al.*, (2006) on lime and Mortazavi *et al.*, (2010) on Barhee dates recorded same results of 1-MCP on the increase of hue° values and reducing the fruit color changes during cold storage. Serrano *et al.*, (2003) reported same PUT results on reducing color changes of plum fruits. That effect of PUT is an indicator of reduced fruit senescence rate (Martinez-Romero *et al.*, 2002 on apricots and Valero *et al.*, 1998 on lemon).

With the duration of cold storage hue° values decreased reflecting the presence of browning (Barhee) or blacking (Zaghloul) due to rutab stage development. Ismail *et al.*, (2008) reported that Barhee and Khalas dates color changed with prolonged storage. Polyphenols reported to be involved in the darkening of date fruits under storage (Maier and Metzler, 1965).

Fruit texture (gm):

Both 1-MCP and PUT treated fruits of Barhee and Zaghloul (unpeeled whole fruit) had significantly higher texture values than control ones in both seasons (Table 4). The highest r^2 values of untreated fruits reflected the high texture loss rate of those fruits and the delaying effect of the above treatments on fruit texture loss. There were not significant differences among treatments during the first 4 weeks except the highest significant values of 2 µM PUT treated Zaghloul fruits in the 2nd week in 2009 season and the 4th week in 2010 season. After 4 weeks, PUT treated fruits gave the highest significant texture values and by the end of the storage period the treatment of 2 µM PUT had the highest significant fruit texture. The same above results were recorded for the peeled Barhee and Zaghloul fruits Table 5) where the 2 µM PUT treatment gave the best results in both seasons.

The results of 1-MCP agree with those of Larrigaudière *et al.*, (2004) on pears and Mortazavi *et al.*, (2010) on Barhee dates.

Table 3: Effects of 1-MCP and PUT treatments on peel color (hue°) of cold stored Barhee and Zaghloul date fruits in 2009 and 2010 seasons.

	CV.	Treatment	Storage Period (weeks)									r^2
			0	1	2	3	4	5	6	7	8	
2009	Barhee	0.5 ppm 1-MCP	76.92a	76.91a	76.57a	76.08a	75.77b	75.52a	74.81c			0.959**
		1 ppm 1-MCP	76.92a	75.97ab	76.60a	76.27a	76.19b	76.34a	75.16bc	73.42b		0.596*
		1 µ M PUT	76.92a	74.13b	75.32a	76.65a	77.73ab	76.08a	75.84ab	75.89a	75.23a	0.002
		2 µ M PUT	76.92a	75.61ab	75.28a	77.14a	79.60a	76.37a	76.12a	75.86a	75.39a	0.023
		Control	76.92a	73.96b	72.79b	71.41b	65.82c	60.32b				0.918**
	Zaghloul	0.5 ppm 1-MCP	28.94a	32.80a	27.42a	25.82a	24.60a	23.73a				0.707*
		1 ppm 1-MCP	28.94a	26.19ab	26.95a	22.63ab	25.42a	20.66a				0.728*
		1 µ M PUT	28.94a	22.47bc	23.53ab	23.06ab	24.39a	21.60a	22.35a			0.422
		2 µ M PUT	28.94a	26.10ab	24.95ab	20.62b	25.92a	22.79a	21.70a			0.532
		Control	28.94a	17.92c	18.10b	12.20c	11.88b					0.833*
2010	Barhee	0.5 ppm 1-MCP	73.32a	77.19a	77.84a	76.18a	75.77ab	76.09a	73.72b			0.020
		1 ppm 1-MCP	73.32a	76.27a	76.56a	76.18a	76.50a	76.68a	73.25b	73.07b		0.079
		1 µ M PUT	73.32a	75.06a	75.58a	77.14a	77.20a	77.15a	76.27a	75.56a	74.91a	0.106
		2 µ M PUT	73.32a	75.56a	77.73a	77.97a	77.49a	76.70a	75.45ab	75.80a	75.42a	0.010
		Control	73.32a	73.53a	71.06b	70.23b	64.35b	58.06b				.0.849*
	Zaghloul	0.5 ppm 1-MCP	25.47a	28.04a	25.45a	26.46a	22.61ab	22.69a				0.534
		1 ppm 1-MCP	25.47a	27.12ab	24.25a	21.82ab	20.20ab	21.07a				0.789*
		1 µ M PUT	25.47a	27.44ab	22.53ab	23.92a	23.10ab	20.32a	19.59a			0.771*
		2 µ M PUT	25.47a	26.97ab	23.72ab	22.19ab	23.68a	21.62a	20.43a			0.779*
		Control	25.47a	22.99b	18.70b	18.48b	16.77b					0.914**

Means within a column (in same season inside same cv.) having a common letter are not significantly different.
r^2=Determination coefficient.

Table 4: Effects of 1-MCP and PUT treatments on unpeeled fruit texture (gm) of cold stored Barhee and Zaghloul dates in 2009 and 2010 seasons.

	CV.	Treatment	Storage Period (weeks)									r^2
			0	1	2	3	4	5	6	7	8	
2009	Barhee	0.5 ppm 1-MCP	180.17a	166.83ab	164.33abc	147.83b	161.50a	158.67b	142.67c			0.670*
		1 ppm 1-MCP	180.17a	171.50ab	168.33ab	152.50b	156.33a	161.0ab	156.33b	132.67b		0.752**
		1 µ M PUT	180.17a	166.67ab	162.50abc	163.33ab	164.83a	163.17ab	160.50ab	146.33a	127.83b	0.730**
		2 µ M PUT	180.17a	178.83ab	180.83a	165.17ab	167.00a	168.67a	165.17a	150.00a	138.67a	0.820**
		Control	180.17a	159.33b	112.83e	122.33c	84.50b	54.17e				0.944**
	Zaghloul	0.5 ppm 1-MCP	175.67b	172.67ab	144.67cd	158.33ab	146.83a	135.67d				0.768*
		1 ppm 1-MCP	175.67b	175.17ab	152.83bcd	157.33ab	158.83a	154.67bc				0.604
		1 µ M PUT	175.67b	170.17ab	147.17bcd	164.17ab	149.50a	148.83c	136.33d			0.738*
		2 µ M PUT	175.67b	186.67a	177.33a	174.83a	159.17a	159.67b	148.00c			0.793**
		Control	175.67b	170.83ab	136.00d	120.17c	47.17c					0.881*
2010	Barhee	0.5 ppm 1-MCP	182.67a	164.33bcd	148.33ab	146.67a	164.17abc	151.67cd	137.83d			0.553
		1 ppm 1-MCP	182.67a	166.67cd	170.50a	164.83a	169.33ab	157.50bc	146.17c	126.67c		0.799**
		1 µ M PUT	182.67a	181.67ab	163.83ab	161.83a	163.67abcd	160.33b	151.67b	137.83b	124.67b	0.900**
		2 µ M PUT	182.67a	186.83a	167.00a	160.50a	158.83abcd	168.67a	161.00a	152.33a	136.00a	0.771**
		Control	182.67a	151.33d	141.83bc	119.17b	100.50e	60.67f				0.971**
	Zaghloul	0.5 ppm 1-MCP	175.83a	172.17abc	163.00ab	153.50a	140.83cd	138.17e				0.974**
		1 ppm 1-MCP	175.83a	170.67abcd	155.17ab	169.50a	153.67bcd	150.00d				0.676*
		1 µ M PUT	175.83a	166.83abcd	151.50ab	162.67a	137.00d	149.67d	127.00e			0.778**
		2 µ M PUT	175.83a	184.00ab	165.00a	167.83a	183.33a	170.00a	150.00bc			0.326
		Control	175.83a	167.0 abcd	124.50c	113.33b	41.50d					0.907

Means within a column (in same season) having a common letter are not significantly different.
r^2=Determination coefficient.

Table 5: Effects of 1-MCP and PUT treatments on peeled fruit texture (gm) of cold stored Barhee and Zaghloul dates in 2009 and 2010 seasons.

	CV.	Treatment	Storage Period (weeks)									r^2
			0	1	2	3	4	5	6	7	8	
2009	Barhee	0.5 ppm 1-MCP	119.33a	109.50abc	100.17cd	106.50cd	94.33c	85.67c	67.33d			0.886**
		1 ppm 1-MCP	119.33a	108.50abc	105.17abcd	119.00bc	113.33abc	99.17b	83.17b	67.33b		0.674*
		1 μ M PUT	119.33a	106.17abc	103.17bcd	128.33ab	111.0abc	94.17b	76.33c	68.33b	52.50b	0.730**
		2 μ M PUT	119.33a	112.50a	121.67a	135.67a	136.83a	119.50a	94.17a	79.67a	63.33a	0.512*
		Control	119.33a	100.50abc	89.00de	105.00d	61.17de	38.00e				0.802*
	Zaghloul	0.5 ppm 1-MCP	118.50a	95.33bc	92.67d	108.17cd	91.83cd	71.33d				0.590
		1 ppm 1-MCP	118.50a	110.17ab	114.83abc	119.50bc	98.00bc	73.83d				0.607
		1 μ M PUT	118.50a	109.17abc	103.33bcd	117.50bcd	114.50abc	100.83b	85.67b			0.477
		2 μ M PUT	118.50a	112.00a	117.00ab	128.00ab	126.83ab	113.17a	92.50a			0.184
		Control	118.50a	94.50c	74.67e	107.67cd	47.83e					0.522
2010	Barhee	0.5 ppm 1-MCP	115.83a	103.17abc	87.00b	109.33a	97.83b	84.17e	75.00d			0.622*
		1 ppm 1-MCP	115.83a	109.67ab	77.33bc	111.33a	102.50b	91.33d	80.33c	62.67b		0.347
		1 μ M PUT	115.83a	105.00abc	112.00a	114.67a	127.17ab	102.67c	90.83b	72.83a	54.50b	0.613*
		2 μ M PUT	115.83a	116.33a	126.33a	117.67a	141.00a	126.33a	97.83a	78.67a	64.00a	0.465*
		Control	115.83a	93.50c	66.33c	114.67a	58.33c	31.00f				0.578
	Zaghloul	0.5 ppm 1-MCP	112.00a	109.67ab	91.67b	120.83a	107.17ab	83.17e				0.220
		1 ppm 1-MCP	112.00a	102.33abc	80.50bc	123.00a	110.67ab	93.17d	91.67b			0.068
		1 μ M PUT	112.00a	99.33bc	114.00a	114.83a	106.83ab	110.83b	92.00b			0.160
		2 μ M PUT	112.00a	107.33abc	121.33a	116.83a	110.83ab	108.17bc				0.017
		Control	112.00a	96.83bc	85.83bc	114.33a	42.67e					0.434

Means within a column (in same season) having a common letter are not significantly different.
r^2=Determination coefficient.

The effect of PUT on retarding fruit softening was reported by Serrano *et al.*, (2003) and Khan *et al.*, (2007) on plums. Postharvest application of PUT retarded fruit softening during cold storage due to suppressed ethylene production, reduced activities of ethylene biosynthesis enzymes [1-aminocyclopropane-1-carboxylic acid synthase (ACS) and 1-aminocyclopropane-1-carboxylic acid oxidase (ACO)] and 1-aminocyclopropane-1-carboxylic acid (ACC) contents, and as well as fruit softening enzymes [*exo*-polygalacturonase (*exo*-PG), *endo*-polygalacturonase (*endo*-PG), pectin esterase (PE) and *endo*-1,4-β-d-glucanase] in skin as well as pulp tissues (Khan *et al.*, 2007).

Water soluble pectin (WSP %):

The obtained data of Barhee and Zaghloul in both seasons (Table 6) showed that 1-MCP and PUT significantly affected the WSP except the insignificant differences of 0.5 ppm 1-MCP treatment in some intervals. The highest reduction was obtained by PUT application and there was not significant deference between its two concentrations except the last two weeks for Barhee fruits where the 2 μM PUT treated fruits had the lowest WSP percent. WSP contents of all treated and untreated Barhee and Zaghloul fruits increased with the duration of cold storage and the highest r^2 values were recorded for untreated fruits in both seasons.

The cell walls of fruit are generally composed of cellular microfibrils tethered with xylogycans embedded in pectin mesh and glycoproteins (Carpita and Gibeaut, 1993). Softening appears to be mainly associated with changes in the pectin fraction of the cell wall (Huber, 1983). Thus, a large increase in pectin solubilization has been correlated with softening (Brummell and Harpster, 2001). These ultra structural and chemical changes may result from de novo synthesis of the cell wall hydrolases such as polygalacturonase (PG), pectin methyl esterase (PME), pectate lyase (PL) and cellulase. The effect of PUT on decreasing fruit firmness loss and WSP content can be attributed to its cross-linking to the –COO- group of the pectic substances in the cell wall, resulting in blocking the access of degrading enzymes (Valero *et al.*, 1999 and Valero *et al.*, 2002). Same effects of 1-MCP were reported by Lohani *et al.*, (2004).

Soluble solids content (SSC %):

The initial values of SSC were 35.73 & 34.13 % for Barhee and 29.13 & 27.80 % for Zaghloul, respectively in 2009 and 2010 seasons (table 7). Both 1-MCP and PUT applications reduced the SSC loss in Barhee and Zaghloul dates compared to untreated fruits during cold storage in both seasons. Generally in both cvs., the highest significant values of SSC were obtained by the higher concentrations of 1-MCP and PUT in both seasons. Also, the previous both treatments had the lowest r^2 values that reflect the lowest SSC changes during cold storage period. The above results of 1-MCP and PUT may be due to their effect on regulating ethylene production or action and thus slowing

down fruit senescence. 1-MCP and PUT results respectively agree with the work of Singh and Pal (2008) on guava fruits and the studies of Al-Obbed (2010) and Kassem *et al.*, (2010) on Barhee dates. However, Salvador *et al.*, (2004) found no effect of 1-MCP on SSC of persimmon fruits. Also, Khan *et al.*, (2008) found no effect of PUT on SSC of plum fruits.

Table 6: Effects of 1-MCP and PUT treatments on water soluble pectin (%) of cold stored Barhee and Zaghloul date fruits in 2009 and 2010 seasons.

	CV.	Treatment	Storage Period (weeks)									r^2
			0	1	2	3	4	5	6	7	8	
2009	Barhee	0.5 ppm 1-MCP	0.49a	0.96a	1.14a	1.20b	1.28b	1.34b	1.41a			0.815**
		1 ppm 1-MCP	0.49a	0.78bc	0.81bc	0.86cd	0.89cd	0.93c	1.03b	1.47a		0.804**
		1 µ M PUT	0.49a	0.69d	0.71de	0.73f	0.75efg	0.78def	0.81c	1.09b	1.53a	0.723**
		2 µ M PUT	0.49a	0.67d	0.70e	0.72fg	0.75efg	0.75def	0.77c	0.83c	1.16b	0. 735**
		Control	0.49a	0.99a	1.17a	1.33a	1.46a	1.52a				0.888**
	Zaghloul	0.5 ppm 1-MCP	0.46a	0.76bc	0.78c	0.81de	0.84de	0.85cd				0.659*
		1 ppm 1-MCP	0.46a	0.74c	0.76cd	0.77ef	0.79ef	0.82cde				0.631
		1 µ M PUT	0.46a	0.67d	0.69e	0.71fg	0.71fg	0.72ef	0.78c			0.673*
		2 µ M PUT	0.46a	0.65d	0.67e	0.65g	0.67g	0.68f	0.72c			0.660*
		Control	0.46a	0.80b	0.87b	0.89c	0.96c					0.771*
2010	Barhee	0.5 ppm 1-MCP	0.50a	0.98b	1.15a	1.27a	1.32a	1.35b	1.43a			0.800**
		1 ppm 1-MCP	0.50a	0.84cd	0.85bc	0.89c	0.94c	0.99c	1.02b	1.50a		0.777**
		1 µ M PUT	0.50a	0.74fg	0.75de	0.77de	0.80de	0.82de	0.85c	1.09b	1.55a	0.789**
		2 µ M PUT	0.50a	0.69gh	0.71ef	0.73ef	0.76ef	0.78ef	0.82c	0.88c	1.19b	0.789**
		Control	0.50a	1.04a	1.20a	1.33a	1.40a	1.52a				0.852**
	Zaghloul	0.5 ppm 1-MCP	0.47b	0.79de	0.81cd	0.86c	0.88cd	0.91cd				0.697*
		1 ppm 1-MCP	0.47b	0.76ef	0.81cd	0.84cd	0.86cd	0.88cde				0.693*
		1 µ M PUT	0.47b	0.66hi	0.68f	0.70ef	0.75ef	0.77ef	0.80c			0.817**
		2 µ M PUT	0.47b	0.63i	0.65f	0.66f	0.68f	0.70f	0.74c			0.774**
		Control	0.47b	0.85c	0.93b	1.07b	1.16b					0.899*

Means within a column (in same season) having a common letter are not significantly different. r^2=Determination coefficient.

Table 7: Effects of 1-MCP and PUT treatments on soluble solids content (%) of cold stored Barhee and Zaghloul date fruits in 2009 and 2010 seasons.

	CV.	Treatment	Storage Period (weeks)									r^2
			0	1	2	3	4	5	6	7	8	
2009	Barhee	0.5 ppm 1-MCP	35.73a	31.67a	33.27a	31.00b	29.20c	29.80b	28.67b			0.805**
		1 ppm 1-MCP	35.73a	32.20a	31.80b	32.07ab	30.60b	29.20bc	30.53a	39.33a		0.005
		1 µ M PUT	35.73a	30.28b	32.20ab	30.00bc	29.20c	28.80cd	29.73a	33.00c	30.73b	0.138
		2 µ M PUT	35.73a	32.07a	31.93b	33.13a	33.87a	32.93a	29.87a	37.00b	31.87a	0.011
		Control	35.73a	27.87c	30.00c	28.47cd	28.93c	28.07d				0.432
	Zaghloul	0.5 ppm 1-MCP	29.13b	27.60c	27.00e	24.67e	26.20d	26.93.e				0.402
		1 ppm 1-MCP	29.13b	25.67d	29.00cd	27.00d	26.07d	26.53e				0.246
		1 µ M PUT	29.13b	25.60d	27.93de	27.27d	26.73d	25.27f	24.80c			0.540
		2 µ M PUT	29.13b	27.40c	28.67d	31.67ab	31.40b	26.87e	24.27c			0.146
		Control	29.13b	25.00d	25.87f	23.00e	24.73e					0.572
2010	Barhee	0.5 ppm 1-MCP	34.13a	31.80a	33.73a	31.33b	29.00d	30.87b	28.53c			0.716*
		1 ppm 1-MCP	34.13a	31.60a	31.47bc	31.67b	31.87b	31.07b	31.40a	35.47ab		0.019
		1 µ M PUT	34.13a	31.00a	32.40ab	30.67b	29.93c	28.67c	29.40b	32.13b	31.27a	0.192
		2 µ M PUT	34.13a	31.40a	32.07b	33.47a	33.93a	33.67a	31.80a	37.33a	32.00a	0.050
		Control	34.13a	28.40b	30.47cd	27.40c	28.67d	27.80d				0.520
	Zaghloul	0.5 ppm 1-MCP	27.80b	25.20c	28.47ef	25.67d	25.53e	26.07e				0.172
		1 ppm 1-MCP	27.80b	27.60b	29.80de	27.47c	28.40d	26.00e				0.147
		1 µ M PUT	27.80b	26.47bc	27.80fg	27.73c	25.53e	25.20f	23.80d			0.690*
		2 µ M PUT	27.80b	28.07b	28.53ef	31.33b	25.80e	26.20e	23.20d			0.378
		Control	27.80b	25.13c	26.80g	23.47e	24.40f					0.575

Means within a column (in same season) having a common letter are not significantly different. r^2=Determination coefficient.

Titratable acidity (TA %) :

Barhee and Zaghloul malic acid contents significantly were affected by 1-MCP and PUT treatments (Table 8) where the treated fruits had higher significant TA values than untreated ones. Both treatments by their two concentrations maintained the TA higher than control during the first storage weeks but with the progress of cold storage period the highest effect was obtained by PUT treatments. All TA contents of Barhee and Zaghloul fruits decreased by the progress of cold storage period and the highest changes were obtained with untreated fruits where they had the highest r^2 values in both seasons.

The effect of 1-MCP and PUT on TA may be due to their effect on regulating ethylene production and then delaying fruit senescence. Same results of 1-MCP were obtained by Serrano *et al.*, (2003) on plums and Singh and Pal (2008) on guava. The results of PUT agree with Al-Obeed (2010) on Barhee dates.

POD and PPO enzymes activity (O.D.):

The highest significant enzyme activities of POD (Table 9) and PPO (Table 10) in untreated fruits reflect the significant effects of 1-MCP and PUT on reducing those activities in Barhee and Zaghloul dates in both seasons. For POD activity in Barhee fruits, 1 ppm 1-MCP and 2 µM PUT treatments gave the highest reduction in the first 3 and 2 weeks in 2009 and 2010 seasons, respectively. Then, there were not significant differences among 1 ppm 1-MCP and both PUT treatments. However, 1 ppm 1-MCP treatment had the lowest POD activity values in the first 2 weeks of Zaghloul storage and by the advancing of storage period the 2 µM PUT treatment gave the highest reduction in POD activity.

Regarding to PPO activity, in Barhee samples there were not significant differences among treatments during the first 5 weeks in the first season then PUT treatments gave the lowest significant activities. The same results were obtained in the second season except the significant high PPO activity of 0.5 ppm 1-MCP treated fruits compared with other treatments. The results of Zaghloul samples were similar to those of Barhee in the second season. With the advancing of cold storage period, all PPO activities increased with highly significant r^2 values.

The results of 1-MCP on suppression POD activity were showed by Blankenship and Dole (2003) on apples and Win *et al.*, (2006) on limes. However, Cai *et al.*, (2006) found that 1-MCP significantly reduced the postharvest PPO activity of loquat fruits.

Table 8: Effects of 1-MCP and PUT treatments on titratable acidity (g malic acid /100 ml of fruit juice) of cold stored Barhee and Zaghloul date fruits in 2009 and 2010 seasons.

	CV.	Treatment	Storage Period (weeks)									r^2
			0	1	2	3	4	5	6	7	8	
2009	Barhee	0.5 ppm 1-MCP	0.23b	0.20cd	0.18e	0.17ef	0.17d	0.16de	0.16b			0.827**
		1 ppm 1-MCP	0.23b	0.23bc	0.21cd	0.18def	0.17d	0.15e	0.15b	0.15b		0.917**
		1 µ M PUT	0.23b	0.20de	0.18e	0.17f	0.17d	0.17de	0.16b	0.15b	0.15b	0.830**
		2 µ M PUT	0.23b	0.21bcd	0.19de	0.19cde	0.18d	0.18d	0.17b	0.16a	0.17a	0.837**
		Control	0.23b	0.19de	0.18de	0.15g	0.12e	0.10f				0.985**
	Zaghloul	0.5 ppm 1-MCP	0.32a	0.19de	0.26b	0.23b	0.28b	0.27b				0.001
		1 ppm 1-MCP	0.32a	0.19de	0.28ab	0.24b	0.28b	0.28b				0.001
		1 µ M PUT	0.32a	0.24b	0.26b	0.19cd	0.25c	0.25c	0.24a			0.215
		2 µ M PUT	0.32a	0.30a	0.30a	0.29a	0.31a	0.30a	0.26a			0.482
		Control	0.32a	0.17e	0.22c	0.20c	0.17d					0.476
2010	Barhee	0.5 ppm 1-MCP	0.22b	0.21bcd	0.18d	0.15e	0.15d	0.15e	0.14c			0.864**
		1 ppm 1-MCP	0.22b	0.22bc	0.21c	0.18d	0.16d	0.15e	0.15c	0.14b		0.930**
		1 µ M PUT	0.22b	0.20cd	0.18d	0.18d	0.17d	0.16e	0.16c	0.15b	0.15b	0.905**
		2 µ M PUT	0.22b	0.21bcd	0.22c	0.18d	0.20c	0.19d	0.18b	0.17a	0.16a	0.821**
		Control	0.22b	0.20cd	0.17d	0.14e	0.12e	0.11f				0.980**
	Zaghloul	0.5 ppm 1-MCP	0.35a	0.19d	0.26b	0.28a	0.29b	0.28b				0.001
		1 ppm 1-MCP	0.35a	0.25a	0.28b	0.26b	0.29b	0.27b				0.203
		1 µ M PUT	0.35a	0.23ab	0.27b	0.21c	0.21c	0.23c	0.25a			0.321
		2 µ M PUT	0.35a	0.25a	0.31a	0.29a	0.33a	0.31a	0.25a			0.105
		Control	0.35a	0.19d	0.23c	0.19d	0.16d					0.647

Means within a column (in same season) having a common letter are not significantly different.
r^2=Determination coefficient.

Table 9: Effects of 1-MCP and PUT treatments on POD activity (O.D.) of cold stored Barhee and Zaghloul date fruits in 2009 and 2010 seasons.

	CV.	Treatment	Storage Period (weeks)									r^2
			0	1	2	3	4	5	6	7	8	
2009	Barhee	0.5 ppm 1-MCP	0.019a	0.019bcd	0.020cde	0.021de	0.025d	0.014bc	0.012ab			0.212
		1 ppm 1-MCP	0.019a	0.015ef	0.016fg	0.017fg	0.020f	0.011d	0.010c	0.013ab		0.409
		1 µ M PUT	0.019a	0.018cd	0.019de	0.019ef	0.021ef	0.012cd	0.011bc	0.014a	0.014a	0.485
		2 µ M PUT	0.019a	0.014f	0.015g	0.016g	0.019f	0.011d	0.009c	0.011b	0.012a	0.476
		Control	0.019a	0.022ab	0.023ab	0.024bc	0.033b	0.020a				0.173
	Zaghloul	0.5 ppm 1-MCP	0.017a	0.019bcd	0.021cd	0.026b	0.033b	0.019a				0.259
		1 ppm 1-MCP	0.017a	0.017de	0.018ef	0.022cd	0.026cd	0.015b				0.076
		1 µ M PUT	0.017a	0.021abc	0.021bc	0.023cd	0.029c	0.012cd	0.013a			0.082
		2 µ M PUT	0.017a	0.019bcd	0.020cde	0.022cd	0.023de	0.011d	0.011bc			0.239
		Control	0.017a	0.023a	0.024a	0.029a	0.040a					0.910*
2010	Barhee	0.5 ppm 1-MCP	0.017a	0.019bc	0.020bc	0.021cd	0.026bc	0.016c	0.015ab			0.016
		1 ppm 1-MCP	0.017a	0.016de	0.017de	0.018d	0.021d	0.013de	0.012c	0.014a		0.248
		1 µ M PUT	0.017a	0.018bcd	0.019bcd	0.018d	0.025cd	0.013de	0.011c	0.013a	0.016a	0.193
		2 µ M PUT	0.017a	0.014e	0.016e	0.018d	0.021d	0.012e	0.012c	0.012a	0.013b	0.263
		Control	0.017a	0.023a	0.025a	0.028b	0.038a	0.022a				0.300
	Zaghloul	0.5 ppm 1-MCP	0.016a	0.020b	0.021b	0.027b	0.031b	0.019b				0.268
		1 ppm 1-MCP	0.016a	0.017d	0.018cde	0.024bc	0.027bc	0.017bc				0.234
		1 µ M PUT	0.016a	0.019bc	0.020bcd	0.024bc	0.026bc	0.015cd	0.015a			0.008
		2 µ M PUT	0.016a	0.018bcd	0.019bcd	0.024bc	0.026bc	0.013de	0.013bc			0.033
		Control	0.016a	0.023a	0.024a	0.023bc	0.041a					0.724*

Means within a column (in same season) having a common letter are not significantly different.
r^2=Determination coefficient.

Table 10: Effects of 1-MCP and PUT treatments on PPO activity (O.D.) of cold stored Barhee and Zaghloul date fruits in 2009 and 2010 seasons.

	CV.	Treatment	Storage Period (weeks)									r^2
			0	1	2	3	4	5	6	7	8	
2009	Barhee	0.5 ppm 1-MCP	0.001b	0.003de	0.010cd	0.010cd	0.012c	0.013cd	0.014abc			0.874**
		1- ppm 1-MCP	0.001b	0.003def	0.008d	0.008d	0.010c	0.011d	0.014ab	0.015a		0.956**
		1 µ M PUT	0.001b	0.002ef	0.009cd	0.010cd	0.011c	0.012cd	0.012c	0.013b	0.010a	0.646**
		2 µ M PUT	0.001b	0.001f	0.009cd	0.009d	0.010c	0.012cd	0.012bc	0.012b	0.009a	0.600*
		Control	0.001b	0.008b	0.013b	0.014b	0.019b	0.022a				0.962**
	Zaghloul	0.5 ppm 1-MCP	0.004a	0.005c	0.013b	0.014b	0.016b	0.019b				0.928**
		1 ppm 1-MCP	0.004a	0.005cd	0.010c	0.011c	0.012c	0.014c				0.933**
		1 µ M PUT	0.004a	0.004cd	0.009cd	0.009d	0.011c	0.012cd	0.016a			0.934**
		2 µ M PUT	0.004a	0.003de	0.008d	0.009d	0.010c	0.011cd	0.013bc			0.911**
		Control	0.004a	0.012a	0.019a	0.021a	0.024a					0.931**
2010	Barhee	0.5 ppm 1-MCP	0.002a	0.002e	0.011cd	0.013cd	0.015c	0.016bc	0.017a			0.872**
		1 ppm 1-MCP	0.002a	0.002e	0.009ef	0.010ef	0.012de	0.013cd	0.013b	0.014a		0.850**
		1 µ M PUT	0.002a	0.003de	0.008ef	0.009f	0.011e	0.012d	0.012b	0.014a	0.011a	0.779**
		2 µ M PUT	0.002a	0.002e	0.007f	0.009f	0.011e	0.012d	0.013b	0.013a	0.009b	0.659**
		Control	0.002a	0.007b	0.015b	0.016b	0.020b	0.022a				0.942**
	Zaghloul	0.5 ppm 1-MCP	0.003a	0.006bc	0.013b	0.014c	0.018b	0.018b				0.924**
		1 ppm 1-MCP	0.003a	0.005c	0.011c	0.012de	0.014cd	0.014cd				0.888**
		1 µ M PUT	0.003a	0.005c	0.009de	0.010ef	0.012de	0.013cd	0.019a			0.949**
		2 µ M PUT	0.003a	0.004cd	0.008ef	0.009f	0.011e	0.012d	0.014b			0.971**
		Control	0.003a	0.012a	0.018a	0.022a	0.026a					0.966**

Means within a column (in same season) having a common letter are not significantly different.
r^2=Determination coefficient.

CONCLUSION

1-MCP and PUT applications effectively delayed ripening and senescence of Barhee and Zaghloul date fruits and significantly improved their storagability which reflected on the increase of fruit skin hue° and maintaining it higher (colorful) than that of control during the storage period and also decrease fruit weight loss, percent of rutab incidence, texture loss, pectin solubilization, soluble solids loss, malic acid loss, PPO and POD enzymes activity. The best above significant results were obtained by PUT treatments.

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الملخص العربي

تأخير تغّيرات النضج وإطالة مرحلة الخلال لثمار البلح البارحي والزغلول بعد الجمع بمعاملات ١- ميثيل سيكلوبروبين والبيوتريسين

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أجريت هذه الدراسة خلال موسمي ٢٠٠٩ ، ٢٠١٠ لدراسة تأثير التركيزات المختلفة من كل من ١- ميثيل سيكلوبروبين والبيوتريسين على جودة وقابلية التخزين بعد الجمع لثمار البلح صنفي البارحي والزغلول بالإضافة إلى التأثير على الخواص الفسيوكيمائية خلال التخزين المبرد. تم معاملة الثمار بتركيزين ٠,٥ ، ١ جزء في المليون من ١- ميثيل سيكلوبروبين لمدة ٢٠ ساعة وتركيزين ١ ، ٢ ميكرومول بيوتريسين بالغمر لمدة ٥ دقائق بالمقارنة بالثمار غير المعاملة (كنترول) ثم تم تخزين الثمار علي درجة صفر ± ١°م ورطوبة نسبية ٨٥-٩٠ ±٥ %. المعاملات السابقة أطالت فترة تخزين ثمار البارحي ١، ٢ ،٣ أسابيع للمعاملات ٠,٥ جزء في المليون ١- ميثيل سيكلوبروبين و١ جزء في المليون ١- ميثيل سيكلوبروبين وكلا معاملتي البيوتريسين ، على التوالي. وفي صنف الزغلول هذه الفترات كانت ١ ،٢ أسبوع لكلا تركيزي ١- ميثيل سيكلوبروبين وكلا تركيزي البيوتريسين على التوالي. جميع المعاملات أخرت من نضج وتدهور الثمار وحسنت معنويا من قابليتها للتخزين وقد أعطت المعاملة بالبيوتريسين بكلا التركيزين أفضل جودة للثمار. جميع المعاملات قللت من فقد لون قشرة الثمار ومحتواها من الأنثوسيانين، فقد الوزن، نسبة الترطيب، فقد صلابة الثمار الكاملة واللحم، ذوبان البكتين، فقد المواد الصلبة الذائبة، فقد حامض الستريك، نشاط إنزيمي البيروكسديز والبولي فينول أوكسيديز. وقد أعطت المعاملة بالبيوتريسين أفضل النتائج ويمكن التوصية باستخدامها لتأخير نضج وتدهور ثمار البلح البارحي والزغلول بعد الجمع.