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Effects of 1-Methylcyclopropane on Quality of Tomato and Sweet Pepper Fruits during Mixed Loads.

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Different concentrations of 1-Methylcyclopropene were applied (0% as control, 1.5% and 5%) as sheets, in separate cold storage. The sheets putted on tomato fruits (*Lycopersicon esculentum*) (which harvested in ripening stages green yellow) stored with sweet pepper fruits (*Capsicum annuum* L.) in the different carton at 10°C+90 % RH. Samples were evaluated for the changes in the quality parameters during storage as follows: 1-Methylcyclopropene at concentration of 5% reduced the weight loss percentage and decay. Also maintained external surface color, fruit firmness, general appearance, total soluble solids (TSS), titreatable acidity content, total sugars and ascorbic acid content followed by 1-Methylcyclopropene at concentration of 1.5% compared with untreated as control.

Keywords: Mixed loads - 1-Methylcyclopropene - Tomato - Sweet pepper – General appearance.

INTRODUCTION

Tomato (*Lycopersicon esculentum* L.) is one of most important crops in the world. The fruit is classified climacteric fruit during physical and chemical changes in the process of ripening by ethylene production Sabir et al., (2012). Tomato fruit are highly producer ethylene (Alexander and Grierson, 2002 and Hoeberichts et al., 2002). Ethylene is a cause color change of tomato fruit (Hertog et al., 2004). Also softening in tomatoes depends on the rate of ethylene production (Jeong et al., 2004, Sabir et al., 2012).

Pepper (*Capsicum annuum*, L.) also, is one of important crops in the world and a main component of the traditional human diet. It is one of the most crops have a nutritive value, higher content of ascorbic acid (vitamin c), which important for human nutrient, and until now strong evidence to link dietary ascorbic acid with protective effects against various oxidative stress-related diseases (Davey et al., 2000). Nevertheless, shelf life for pepper about 28 days at 7.5°C and 14 days during storage at 5°C and high sensitive to diseases (Cantwell, 2013)**.**Several chemical postharvest treatments were used to increase the storage period of pepper fruit such as chlorine gas and hypochlorite salts. The residues of these chemical treatments showed a harmful effect on human health.

1-methylcyclopropene point out to potential benefits of crops during storage. Its important play in delaying ripening or senescence processes is a gaseous substance which averts ethylene binding to active sites causing delay in formation of color, firmness and ethylene production in tomato fruit (Jeang et al., 2004, Amodio et al., 2005, Ilic et al., 2009, Sabir et al., 2012 and Ilic et al., 2014).

1-methylcyclopropene can be used as ethylene binding inhibitors in order to extend storage of tomato and pepper fruit (Ilic et al., 2009 and Tigist et al., 2012).

(Opiyo and Ying, 2005), reported that on tomatoes

fruit there is 1-methylcyclopropene of 0.07 and 0.11 µL L-1 were to produce less ethylene followed by (0.035 µL L-1) of 1-MCP produced even higher ethylene compared to non-treated one and attained their climacteric peaks seven days after treatment while the climacteric fruit treated higher concentration (0.07 and 0.11 µL L-1) delayed the ripening.

The present investigation aims to extend the storage period of tomato mixed load with sweet pepper fruit by environmentally safe different concentrations of 1-Methylcyclopropene. Also, the effect of these treatments on the tomato and sweet pepper fruit quality during different storage period was studied and compared to control fruit.

MATERIALS AND METHODS

Tomato (*Lycopersicon esculentum* L.)and sweet pepper fruit (*Capsicum annuum* L. cv. 58 F1 hybrid) used in this experiment were grown under greenhouse conditions of De Bruin Farm, Wadi Natrun, Elbehira Governorate, Egypt. During the two successive seasons of 2015 and 2016. Fruit were harvested at the commercial maturity stage and transferred to the laboratory of the Vegetable Handling Department, Horticulture Research Center. In the same day, uniform fruit, in size, appearance, with no physical defects or fungal infection, were selected and placed in carton boxes. Different concentrations of 1-Methylcyclopropene were applied (1.5% and 5%) as sheets compared with untreated as control, in separate cold storage. The sheets putted on tomato fruit (*Lycopersicon esculentum*) (which harvested in ripening stages green yellow) stored with sweet pepper fruit (*Capsicum annuum* L.) in the different carton at 10°C+90 % RH. Each concentration from 1-Methylcyclopropene which putted on tomato fruit and control transferred afterwards immediately to storage at 10 °C, different cold room. Samples were taken at random from the three replicates and examined every 0, 7, 14 and 21 days at 10°C. Samples were evaluated for the changes in the quality parameters during storage as follows:

2.1 Weight loss percentage:

Tomato and sweet pepper fruit were estimated according to the following equation: Weight loss% = [(Initial weight - weight of fruit at sampling date)/Initial weight of fruit] x 100.

2.2 Decay:

it was determined as score system of 1= none, 2= slight, 3= moderate, 4= moderately severe, 5= severe. This depends on decay percentage on fruit.

2.3 General appearance:

it was determined as score system of excellent> 9, good> 7 to 8.9, fair> 5 to 6.9, poor> 3 to 4.9, and unassailable> 2.9. The scale depends on morphological defects such as shriveling, fresh appearance, color change of fruit and decay. Fruit rating (5) or below considered unmarketable.

2.4 Firmness:

the average firmness of the fruit was measured in kg/cm^2 by digital force Gauge model FGV 50 A, Shimpo Instrument Co, Japan, with total capacity of $20kg/cm^2$ and resolution of $0.01kg/cm^2$ using cone pointed head.

2.5 Titratable acidity:

This is content was determined by titration of blended flesh against NHOH 0.01 N using phenolphthalein indicator (A.O.A.C., 2000). The results were calculated as mg. citric acid per 100 g fresh weight.

2.6 Total sugars:

Using Nelson (1974)-Somogyi (1952**)** Method, were determined colormetrically using spectrophotometer model 6305 UV/visible range with 520 nm wavelength (Sadasivam and Manickam, 2004).

2.7 Total soluble solids percentage (TSS):

was determined as a composite juice sample by digital refractometer of model Abbe Leica according to (A.O.A.C., 2000).

2.8 Ascorbic acid content

was determined using the dye 2, 6-dichloro-phenol indophenols method (A.O.A.C., 2000).

2.9 External surface color:

was evaluated by a color difference meter (Minolta CR200)to measure the *L** describes lightness (*L**=0 for black, *L**=100 for white) and *a** describes intensity inred-green (*a**>0 for red, *a**<0 for green).

Statistical analysis:

Data of the two seasons were arranged and statistically analyzed using Mstatic. The comparison among means of the different treatments was determined by using Duncan's test. The data were tabulated and statistically analyzed according to a factorial complete

randomized design (Snedecor and Cochran 1982).

RESULTS

1 Weight loss:

Data in Table (1) show that weight loss percentage of tomato and sweet pepper fruit was significantly affected by different concentrations of 1-Methylcyclopropene compared with untreated as control during storage period.

Fruit exposed to high concentrations of 1-Methylcyclopropene (5%) gave the lowest value of weight loss percentand the highest value of weight loss percent was observed in untreated as control for tomato and sweet pepper fruit in both seasons.

For, storage period, data indicate that increasing storage period from 0, 7, 14 and 21 days were significantly increase weight loss percent of tomato and sweet pepper. This trend was true under all using concentrations of 1-Methylcyclopropene as shown in both seasons. In support to this result, stated by Guillen et al., (2006) who found significantly affected by 1-MCP on weight loss of tomatoes during storage. Also, data agree with Smith et al., (2006), Fernandez-Trujillo et al., (2009) and Ilic et al., (2009) they found that water loss in sweet pepper fruit is subject to the effects of genotype and pre- and postharvest environments and that can also interact with 1-MCP.

Decay:

Results in Table (1) indicate clearly that examined both concentrations of 1-Methylcyclopropene used had lower decay score in comparison to control. Concentrations of 1-Methylcyclopropene (5%) was the most effective for reducing decay score, concentrations of 1-Methylcyclopropene (1.5%) was less effective than concentrations of 1-Methylcyclopropene (5%) in reducing fruit decay as shown in both seasons.

Data also clear that the decay started slowly and increased at the end of storage. This finding may be due to the continuous chemical and biochemical changes happened in the fruit such as transformation of complex compounds to simple forms of a more liability to fungal infection. These results are similar to those found by Sabir et al., (2012) on tomatoes and Ilic et al., (2014) on pepper.

1-MCP has important effects of delaying, slowing maturation and ripening fruit also maintaining postharvest quality when used during the storage period. These results are in agreement with Fernandez- Trujillo et al., (2009), Ilic et al., (2009) and Ilic et al., (2012) on peppers and Sabir et al. (2012**)** on tomato fruit.

General appearance:

Data in Table (1) indicate that general appearance of tomato and sweet pepper fruit treated for 1-Methylcyclopropene 5% or treated to 1-methylcyclopropene1.5% gave the best appearance compared with untreated in both seasons. However, fruit 1-methylcyclopropene 5% gave the best appearance followed by 1-methylcyclopropene 1.5% compared with control during the first season in tomato fruit. The keeping quality of general appearance was improved by using 1-Methylcyclopropene attributed to the effect of 1-Methylcyclopropene on the reduction of weight loss and rot rate of tomato and pepper fruit. 1-Methylcyclopropene treatments have beneficial effects on fruit physiology such as delaying ripening of peppers by the Ilic et al., (2012).

General appearance of tomato and sweet pepper fruit decreased with the prolongation of storage period in both seasons. Similar results were reported by Sabir et al., (2012) on tomatoes and Ilic et al., (2014) on pepper.

Fruit firmness (kg/cm^2):

Results in Table (2) show that firmness of tomato and sweet pepper fruit was significantly affected by different concentrations of 1-methylcyclopropene during storage period. The effect of treatments of fruit firmness during storage in both seasons, data indicated that various applied concentrations of 1-methylcyclopropene had significantly greater fruit firmness as compared with untreated. however, the highest values of fruit firmness were obtained from fruit exposed to 1-methylcyclopropene 5% .followed by fruit exposed to 1-methylcyclopropene 1.5% with significant differences between then, while the lowest values were found in untreated. Fernandez-Trujillo et al., (2009) and Ilic et al., (2009) found that 1-methylcyclopropene have increased pepper fruit susceptibility to shriveling, weight loss, and finger texture.

Storage of fruit is accompanied by loss of cell wall integrity due to breakdown of peptic substances, which led to an increase in soluble pectin and decrease in fruit firmness Ilic et al., (2014) on pepper fruit.

Table (1):Effects of 1-methylcyclopropane on weight loss %, decay and general appearance of tomato and sweet pepper fruits during mixed loads at 10ºC in 2015 and 2016 seasons.

Treatments	Days After storage	First season (2015)						Second season (2016)					
		Weight loss %		Decay		General appearance		Weight loss %		Decay		General appearance	
		Tomato fruits											
MCP 1.5 %	0			1.00	c	9.00	a			1.00	d	9.00	a
	7	1.93	h	1.00	c	9.00	a	2.15	h	1.00	d	9.00	a
	14	3.43	e	2.00	bc	7.00	ab	3.66	e	1.67	cd	7.67	ab
	21	6.74	b	2.67	ab	5.67	bc	7.01	b	2.33	bc	6.33	bc
MCP 5 %	0			1.00	c	9.00	a			1.00	d	9.00	a
	7	1.75	h	1.00	c	9.00	a	1.84	i	1.00	d	9.00	a
	14	3.16	f	1.33	c	8.33	a	3.33	f	1.33	cd	8.33	ab
	21	6.15	c	1.67	bc	7.67	ab	6.33	c	1.67	cd	7.67	ab
Control	0			1.00	c	9.00	a			1.00	d	9.00	a
	7	2.11	g	1.00	c	9.00	a	2.36	g	1.33	cd	8.33	ab
	14	4.04	d	2.67	ab	5.67	bc	4.35	d	3.00	ab	5.00	cd
	21	8.06	a	3.67	a	3.67	c	8.23	a	3.67	a	3.67	d
MCP 1.5 %		4.03	B	1.67	B	7.67	B	4.27	B	1.50	B	8.00	A
MCP 5 %		3.69	C	1.25	C	8.50	A	3.83	C	1.25	B	8.50	A
Control		4.74	A	2.08	A	6.83	C	4.98	A	2.25	A	6.50	B
	0			1.00	C	9.00	A			1.00	C	9.00	A
	7	1.93	C	1.00	C	9.00	A	2.11	C	1.11	C	8.78	A
	14	3.54	B	2.00	B	7.00	B	3.78	B	2.00	B	7.00	B
	21	6.98	A	2.67	A	5.67	C	7.19	A	2.56	A	5.89	C
		Sweet pepper fruits											
MCP 1.5 %	0			1.00	c	9.00	a			1.00	c	9.00	a
	7	1.54	h	1.00	c	9.00	a	1.74	h	1.33	c	8.33	ab
	14	2.95	e	1.67	bc	7.67	ab	3.62	e	1.67	bc	7.67	ab
	21	6.25	b	2.67	ab	7.00	bc	7.12	b	3.00	a	6.33	bc
MCP 5 %	0			1.00	c	9.00	a			1.00	c	9.00	a
	7	1.35	i	1.00	c	9.00	a	1.54	h	1.00	c	9.00	a
	14	2.55	f	1.33	c	8.33	ab	3.06	f	1.33	c	8.33	ab
	21	5.65	c	1.67	bc	5.67	cd	6.04	c	1.67	bc	5.00	cd
Control	0			1.00	c	9.00	a			1.00	c	9.00	a
	7	1.73	g	1.33	c	7.00	bc	2.12	g	1.67	bc	7.00	abc
	14	3.33	d	2.00	bc	5.00	d	4.67	d	2.67	ab	3.67	de
	21	7.95	a	3.33	a	3.00	e	8.63	a	3.67	a	2.33	e
MCP 1.5 %		3.58	B	1.58	AB	8.17	A	4.16	B	1.75	B	7.83	A
MCP 5 %		3.18	C	1.25	B	8.00	A	3.55	C	1.25	C	7.83	A
Control		4.33	A	1.92	A	6.00	B	5.14	A	2.25	A	5.50	B
	0			1.00	C	9.00	A			1.00	C	9.00	A
	7	1.54	C	1.11	C	8.33	A	1.80	C	1.33	BC	8.11	A
	14	2.94	B	1.67	B	7.00	B	3.78	B	1.89	B	6.56	B
	21	6.61	A	2.56	A	5.22	C	7.27	A	2.78	A	4.56	C
Values followed by the same letter (s) are not significantly different at 5%													

Table (2): Effects of 1-methylcyclopropane on firmness (kg/cm^2), titratable acidity and total sugars of tomato and sweet pepper fruits during mixed loads at 10ºC in 2015 and 2016 seasons.

Treatments	Days after storage	First season (2015)						Second season (2016)					
		irmness (kg/cm^2)		Titratable acidity		Total sugars		irmness (kg/cm^2)		Titratable acidity		Total sugars	
		Tomato fruits											
MCP 1.5 %	0	5.22	a	0.42	e	4.22	j	5.03	a	0.40	f	4.03	j
	7	4.12	c	0.43	de	4.81	h	3.88	c	0.41	ef	4.61	h
	14	3.33	e	0.44	bc	5.84	e	3.11	f	0.43	cd	5.63	e
	21	2.64	h	0.45	ab	7.19	b	2.44	i	0.45	ab	6.93	b
MCP 5 %	0	5.22	a	0.42	e	4.22	j	5.03	a	0.40	f	4.03	j
	7	4.54	b	0.42	e	4.53	i	4.31	b	0.40	f	4.33	i
	14	3.76	d	0.43	de	5.05	g	3.53	e	0.42	de	4.86	g
	21	3.02	f	0.44	cd	6.21	d	2.81	g	0.43	cd	5.96	d
Control	0	5.22	a	0.42	e	4.22	j	5.03	a	0.40	f	4.03	j
	7	3.82	d	0.44	cd	5.22	f	3.63	d	0.42	de	5.06	f
	14	2.92	g	0.45	ab	6.92	c	2.71	h	0.43	bc	6.73	c
	21	2.03	i	0.46	a	7.74	a	1.88	j	0.46	a	7.53	a
MCP 1.5 %		3.83	B	0.44	B	5.51	B	3.62	B	0.42	B	5.30	B
MCP 5 %		4.13	A	0.43	C	5.00	C	3.92	A	0.41	C	4.79	C
Control		3.50	C	0.44	A	6.02	A	3.31	C	0.43	A	5.84	A
	0	5.22	A	0.42	D	4.22	D	5.03	A	0.40	D	4.03	D
	7	4.16	B	0.43	C	4.86	C	3.94	B	0.41	C	4.67	C
	14	3.34	C	0.44	B	5.93	B	3.11	C	0.43	B	5.74	B
	21	2.57	D	0.45	A	7.05	A	2.38	D	0.45	A	6.81	A
		Sweet pepper fruits											
MCP 1.5 %	0	7.15	a	0.23	d	7.92	g	6.83	a	0.22	f	7.62	g
	7	5.91	c	0.24	cd	8.44	e	5.54	c	0.23	ef	8.12	e
	14	5.03	e	0.24	c	8.90	b	4.64	e	0.24	cd	8.63	b
	21	3.54	h	0.26	b	8.62	d	3.15	h	0.25	ab	8.33	d
MCP 5 %	0	7.15	a	0.23	d	7.92	g	6.83	a	0.22	f	7.62	g
	7	6.24	b	0.23	d	8.63	d	5.86	b	0.22	f	8.32	d
	14	5.44	d	0.23	d	9.13	a	5.02	d	0.22	f	8.84	a
	21	4.03	g	0.24	cd	8.91	b	3.64	g	0.23	de	8.63	b
Control	0	7.15	a	0.23	d	7.92	g	6.83	a	0.22	f	7.62	g
	7	5.04	e	0.24	c	8.31	f	4.64	e	0.23	de	8.02	f
	14	4.33	f	0.25	b	8.78	c	3.90	f	0.24	bc	8.41	c
	21	2.51	i	0.27	a	8.33	f	2.12	i	0.25	a	8.03	f
MCP 1.5 %		5.41	B	0.24	B	8.47	B	5.04	B	0.23	B	8.18	B
MCP 5 %		5.71	A	0.23	C	8.65	A	5.34	A	0.22	C	8.36	A
Control		4.76	C	0.25	A	8.33	C	4.37	C	0.24	A	8.02	C
	0	7.15	A	0.23	D	7.92	D	6.83	A	0.22	D	7.62	D
	7	5.73	B	0.24	C	8.46	C	5.34	B	0.23	C	8.15	C
	14	4.93	C	0.24	B	8.94	A	4.52	C	0.23	B	8.63	A
	21	3.36	D	0.25	A	8.62	B	2.97	D	0.24	A	8.33	B
Values followed by the same letter (s) are not significantly different at 5%													

Titratable acidity (mg. citric acid /100g FW):

As presented in Table (2), tomato fruit exposed to 1-methylcyclopropene 5% and mixed loaded with sweet pepper fruit recorded decrease in acidity values during the remaining period at 10°C followed by tomato fruit exposed to 1-methylcyclopropene 1.5% and mixed loaded with sweet pepper fruit compared with untreated as control for tomato and sweet pepper fruit in both seasons. Maybe this demonstrates that the maturity in control tomatoes progresses faster than the treated tomatoes. Similar results were reported by Sabir et al., (2012) on tomatoes and Ilic et al., (2014) on pepper.

Data presented indicated titratable acidity content in tomato and sweet pepper fruit were gradually and continuously increased till 21 days in both seasons**.** This data agree with Ilic et al., (2012).

Total sugars (mg /100g FW):

Data in Table (2) indicated that total sugars content of tomato and sweet pepper fruit were significantly affected by different concentrations of 1-methylcyclopropene and storage period in both seasons.

Concerning the treatments data indicated that untreated fruit had significantly higher total sugars than tomato fruit exposed to 1-methylcyclopropene 5% and mixed loaded with sweet pepper fruit or tomato fruit exposed to 1-methylcyclopropene 1.5% and mixed loaded with sweet pepper fruit. However, tomato fruit exposed to 1-methylcyclopropene 5% and mixed loaded with sweet pepper fruit was less effective than tomato fruit exposed to 1-methylcyclopropene 1.5% and mixed loaded with sweet pepper fruit with significant differences between them. This depend on the maturity in tomatoes are faster than the treated tomatoes. This result agrees with Sabir et al., (2012) on tomatoes and Ilic et al., (2014) on pepper.

Data presented indicated total sugars contents in tomato and sweet pepper fruit were gradually and continuously increased till end of the storage period in both seasons.

The increase in total sugars in the first period of storage might owe much to the higher rate moisture loss through transpiration than the rate of dry matter loss through respiration. Also, the reduction in total sugars during storage might owe much to the higher rate of sugar loss through respiration than water loss through transpiration (Wills et al., 1981).

Total soluble solids (TSS) contents:

The normal trend of increase in TSS content in tomato and sweet pepper fruit during cold storage at 10°C is clearly displayed in Table (3). Data showed that, fruit exposed to 1-methylcyclopropene 5% or exposed to 1-methylcyclopropene1.5% had the highest content of TSS as compared with untreated fruit in both seasons. However, 1-methylcyclopropene1.5% was less effective than 1-methylcyclopropene 5% during the second season in sweet pepper fruit. Similar results were also stated by Guillen et al., (2005), Guillen et al., (2007) and Sabir and Agar (2011) who indicated that obvious influence of 1-MCP on S.S.C value.

Ascorbic acid content (mg /100g FW):

As shown in Table (3), there were significant differences between the different concentrations of 1-methylcyclopropene during storage period in both seasons. Tomato and sweet pepper fruit exposed to 1-methylcyclopropene 5% or 1.5% for, exhibited highest ascorbic acid content compared with untreated fruit. However, all over storage period fruit treated with 1-methylcyclopropene 5% were the most effective treatment these results were agreement with those obtained by Madhavi and Salunke (1998), Lee and Kader (2000) and Sabir et al., (2012).

It was also obvious that there were significant reduction in ascorbic acid content with the increase of storage period for some all treatments.

Wills et al., (1981) attributed the reduction of vit. C during storage to great metabolic activity during storage as it is respired.

Color (L* and a* value):

Data in Table (4) the color of tomato and sweet pepper fruit were significant differences between the different concentrations of 1-methylcyclopropene during storage period in both seasons. Fruit treated with 1-methylcyclopropene 5% and mixed loaded with sweet pepper or fruit treated with 1-methylcyclopropene 1.5% and mixed loaded with sweet pepper had lighter color (high *L** value) than fruit untreated control darker color (low *L** value). However, Fruit treated with 1-methylcyclopropene 5% and mixed loaded with sweet pepper was lighter color (high *L** value) than fruit treated with 1-methylcyclopropene 1.5% and mixed loaded with sweet pepper with significant differences between them.

Table (3): Effects of 1-methylcyclopropane on total soluble solids% and ascorbic acid of tomato and sweet pepper fruits during mixed loads at 10ºC in 2015 and 2016 seasons.

Treatments	Days after storage	First season (2015)				Second season (2016)			
		Total soluble solids%		Ascorbic acid		Total soluble solids%		Ascorbic acid	
		Tomato fruits							
MCP 1.5 %	0	5.00	a	39.20	a	5.00	a	38.80	a
	7	4.67	a	35.04	c	4.67	a	34.63	abc
	14	4.00	ab	31.32	f	4.00	abc	30.92	cd
	21	3.33	b	27.24	i	4.00	abc	26.82	de
MCP 5 %	0	5.00	a	39.20	a	5.00	a	38.80	a
	7	5.00	a	37.15	b	5.00	a	36.74	ab
	14	4.33	ab	34.06	d	4.33	ab	33.64	bc
	21	4.00	ab	30.56	g	4.33	ab	30.41	cd
Control	0	5.00	a	39.20	a	5.00	a	38.80	a
	7	4.00	ab	32.24	e	4.33	ab	31.83	bc
	14	3.33	b	28.16	h	3.33	bc	31.08	cd
	21	3.33	b	24.11	j	3.00	c	23.73	e
MCP 1.5 %		4.25	AB	33.20	B	4.42	A	32.79	B
MCP 5 %		4.58	A	35.24	A	4.67	A	34.90	A
Control		3.92	B	30.93	C	3.92	B	31.36	B
	0	5.00	A	39.20	A	5.00	A	38.80	A
	7	4.56	A	34.81	B	4.67	A	34.40	B
	14	3.89	B	31.18	C	3.89	B	31.88	C
	21	3.56	B	27.31	D	3.78	B	26.99	D
		Sweet pepper fruits							
MCP 1.5 %	0	10.00	a	135.80	a	10.00	a	130.20	a
	7	9.33	abc	130.40	c	9.00	ab	125.53	c
	14	8.67	bcde	127.27	e	8.33	bcd	120.50	f
	21	7.67	ef	120.33	h	7.33	de	114.73	i
MCP 5 %	0	10.00	a	135.80	a	10.00	a	130.20	a
	7	9.67	ab	132.23	b	10.00	a	127.50	b
	14	9.00	abcd	129.30	d	9.00	ab	123.87	d
	21	8.33	cde	125.60	f	8.33	bcd	119.73	g
Control	0	10.00	a	135.80	a	10.00	a	130.20	a
	7	9.00	abcd	127.63	e	8.67	bc	122.60	e
	14	8.00	def	123.40	g	7.67	cde	116.23	h
	21	7.00	f	114.50	i	6.67	e	108.47	j
MCP 1.5 %		8.92	A	128.45	B	8.67	B	122.74	B
MCP 5 %		9.25	A	130.73	A	9.33	A	125.33	A
Control		8.50	B	125.33	C	8.25	C	119.37	C
	0	10.00	A	135.80	A	10.00	A	130.20	A
	7	9.33	B	130.09	B	9.22	B	125.21	B
	14	8.56	C	126.66	C	8.33	C	120.20	C
	21	7.67	D	120.14	D	7.44	D	114.31	D
Values followed by the same letter (s) are not significantly different at 5 %									

Table (4): Effects of 1-methylcyclopropane on *aand *L** Value of tomato and sweet pepper fruits during mixed loads at 10ºC in 2015 and 2016 seasons.**

Treatments	Days after storage	First season (2015)				Second season (2016)			
		*a** Value		*L** Value		*a** Value		*L** Value	
		Tomato fruits							
MCP 1.5 %	**0**	20.81	j	48.32	a	21.52	i	47.24	a
	7	25.33	h	43.71	c	26.03	g	41.04	c
	14	28.05	e	39.03	f	29.35	e	36.14	f
	21	31.16	b	35.36	i	32.33	b	32.29	i
MCP 5 %	**0**	20.81	j	48.32	a	21.52	i	47.24	a
	7	24.26	i	44.34	b	24.13	h	42.24	b
	14	26.73	f	40.32	e	27.54	f	38.03	e
	21	29.32	d	37.32	g	30.24	d	35.31	g
Control	**0**	20.81	j	48.32	a	21.52	i	47.24	a
	7	26.26	g	42.11	d	27.48	f	40.12	d
	14	30.13	c	37.22	h	31.53	c	34.14	h
	21	33.72	a	31.11	j	34.16	a	28.18	j
MCP 1.5 %		26.34	B	41.60	B	27.31	B	39.18	B
MCP 5 %		25.28	C	42.58	A	25.86	C	40.70	A
Control		27.73	A	39.69	C	28.67	A	37.42	C
	0	20.81	D	48.32	A	21.52	D	47.24	A
	7	25.28	C	43.39	B	25.88	C	41.13	B
	14	28.30	B	38.86	C	29.47	B	36.11	C
	21	31.40	A	34.60	D	32.24	A	31.92	D
		Sweet pepper fruits							
MCP 1.5 %	**0**	22.15	j	44.03	a	23.28	j	43.12	a
	7	27.94	h	40.03	c	29.07	h	38.95	c
	14	30.84	e	36.22	f	31.97	e	35.10	f
	21	34.54	b	31.64	i	35.71	b	30.44	i
MCP 5 %	**0**	22.15	j	44.03	a	23.28	j	43.12	a
	7	26.36	i	41.24	b	27.51	i	40.05	b
	14	29.24	f	37.32	e	30.13	g	36.11	e
	21	32.05	d	33.54	h	33.24	d	32.65	h
Control	**0**	22.15	j	44.03	a	23.28	j	43.12	a
	7	29.15	g	38.92	d	30.25	f	37.74	d
	14	32.65	c	34.32	g	33.74	c	33.01	g
	21	36.95	a	28.54	j	38.03	a	27.45	j
MCP 1.5 %		28.87	B	37.98	B	30.01	B	36.90	B
MCP 5 %		27.45	C	39.03	A	28.54	C	37.98	A
Control		30.23	A	36.45	C	31.33	A	35.33	C
	0	22.15	D	44.03	A	23.28	D	43.12	A
	7	27.82	C	40.06	B	28.94	C	38.91	B
	14	30.91	B	35.95	C	31.95	B	34.74	C
	21	34.52	A	31.24	D	35.66	A	30.18	D
Values followed by the same letter (s) are not significantly different at 5%									

In general, value for a increased during

storage for all treatment in both seasons. Concerning the treatments data indicated that fruit treated with 1-methylcyclopropene 5% and mixed loaded with sweet pepper had lower *a** value (low *a** value) followed by Fruit treated with 1-methylcyclopropene 1.5% and mixed loaded with sweet pepper compared to untreated fruit higher *a**value (high *a**value). Indeed, with this treatment the color of tomato and sweet pepper fruit was maintained, these results agreement with Sabir et al., (2012) on tomatoes and Ilic et al., (2009) on pepper

CONCLUSION

From the previous results, it could be concluded that exposed tomato with sweet pepper fruits to 1-Methylcyclopropene at concentration of 5% was the most effective treatments in maintaining quality till 21 days of storage at 10˚C and 90-95% relative humidity.

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CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

AUTHOR CONTRIBUTIONS

Huda A. Ibrahim and M. A. A**.** Abdullah designed and performed the experiments and also wrote the manuscript, data analysis, designed experiments and reviewed the manuscript. All authors read and approved the final version.

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