Factors Affecting the Keeping Quality of Sweet Pepper Fruits and Minimizing Post Harvest Fruit Rots For Exportation to West Europe

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Abstract: Bernal, the yellow pepper cultivar showed the higher percentage of fruit decay after harvest. However, Baramo, the orange cv. followed by Celica the red cv. recorded lower percentages of fruit rots after harvest .The weight loss of the three cultivars during storage under cold temperature at 8°C was increased by increasing storage period from one to five weeks. Total soluble solids (T.S.S,) contents in the three colored sweet pepper increased with increasing the fruit color, fruit maturity and increasing the storage period from one to four weeks. Storage of sweet pepper fruits at low temperature keeps the fruits away of fungal attack. While moderate temperature under room conditions are suitable for fungal growth and encourage the fungal to attack pepper fruits during storage. Hot water brushing treatment (55±1°C for 20 second) was more effective in reducing weight loss of pepper fruits of the red, yellow and orange cultivars till 5 weeks storage when compared with tap water. The fruit firmness decreased with increasing the storage period from one to three weeks either at cold storage or at room temperature for the three cultivars under study. Ascorbic acid contents in the fruits increased considerably with increasing degree of maturity. Maximum ascorbic acid contents were observed on colored fruits of yellow, orange, and red ones. However, green (0% color) fruits of the three cultivars showed the minimum amount of ascorbic acid contents. Peroxidase activity was relatively higher in Yellow Velez pepper fruits, one week after storage at 8°C compared with fruits stored at room temperature. Fungal species commonly associated with sweet pepper fruit rots were isolated from naturally infected fruits. Isolates were identified as *Alternaria solani, Penicillum* spp. *Cladosporium sp., Rhizopus* sp., *Botrytis cineria* and *Helminthosporium* sp. Pathogenicity tests with the isolated fungi revealed that *B.cinerea* was the highly pathogenic fungus followed by *Alternaria solani* and *Helminthosporium* sp.

Keywords: Fruit maturity, Weight loss, Hot water treatment, Ascorbic acid, Total soluble solids, Peroxidase activity, *Botrytis cinerea, Alternaria solani.*

INTRODUCTION

Pepper (*Capsicum annum, L*), is a warm-season crop. Sweet bell peppers are green at the immature stage and turn red, gold, purple, orange, and/or brown as they ripen. Because sugar content increases as they ripen, colored peppers tend to be sweeter than green peppers. Good quality sweet bell peppers should be of uniform shape, size and color typical of the cultivar. The flesh should be firm, relatively thick with a bright skin color and sweet flavor, and free from defects such as cracks, decay, and sunburn. Peppers that are shriveled and dull-looking or pitted should be avoided.

Pepper fruits are harvested and consumed at different maturity stages. During ripening some substances of important nutritional quality, particularly carbohydrates and vitamin C are accumulated. Both hot and sweet peppers contain more vitamin C than any other vegetable crop (Navarro *et al.,* 2006).

The nutritional and health value of ascorbic acid is of great importance in the human diet, in order to fight diseases, reduce stress damage, and as an antioxidant (Yahia, *et al.,* 2001). Although, sweet pepper has excellent nutritive value but it is susceptible to relatively fast quality changes after harvest time.

Therefore, sweet pepper is considered of great economic importance as a source of hard currency which is needed for our country. High percentages of fruit damage that occur annually between field, harvesting, handling and marketing might destroy the infected fruits or decrease the fruit quality . The present investigation was carried out to survey most factors decrease the pepper fruit quality as post-harvest decay. Biochemical changes associated with fruit maturity, and storage conditions at low temperature, weight loss, total soluble solids, peroxidase activity and ascorbic acid contents were taken into consideration. Hot water treatment instead of using fungicides for minimizing fruit decay and keeping fruit quality was also carried out in this study.

MATERIALS AND METHODS

Incidence of physiological and pathological disorders

Occurrence of physiological disorders which include sun scald, blossom end rot, miss shape, fruit end hall and chilling injury (pitting , water-soaked areas and skin blackening) were carried out. Beside, pathological decay (fruit rots and fungal mycelia growth) on four sweet colored pepper cultivars, after harvest and before storage were recorded. Averages of fruit decay on five boxes (5 kg each) were used as a replicate for each cultivar .Incidence of the disorders was calculated as percentage of the total number of decayed fruits according to Nyanjage *et al.,* 2005. Chilling injury measured visually as surface lesion on the fruits. Fruit was considered decayed once fungal mycelia appeared on the fruit peel or calyx.

Color change

Change in skin color of pepper fruits was rated according to Antoniali Silvia *et al.*, 2007.

Weight loss:

Five k g fruits in each replicate were weighted (g) at the beginning of the experiment using a digital balance and then weighted after every 7 days during storage at 8°C compared with room temperature (mean temperature 20 ±2 °C) . Weight loss was expressed as percentage of weight loss from the initial weight (Nyanjage *et al* 2005). Pepper fruits harvested at different maturity stages, mature green, 50% color, full red, yellow and orange stages were used for determination weight loss during storage for five weeks.

Total soluble solids:

Juices of pepper peel fruits of different colored cultivars were prepared by squeezing about 10 gm of each cv. to obtain about 2 ml pepper juice, placed on the plate of a digital refractmeter. The percentage of total soluble solids was determined in each cultivar at different stages of maturity. Five replicates were used for each treatment and all the readings were performed at 20 °C.

Development of sweet pepper fruit rots and chilling injuries:

Thirty pepper fruits of Red Ember and Yellow Velez pepper fruits differed in fruit coloration (50% ., 75% and 100% color) stored in carton boxes at 8°C for 8 weeks to determine their susceptibility to fruit rots and chilling injuries .

Hot water treatment:

Ten pepper fruits of three cultivars were treated with hot water brushing at 55±1 °C for 20 seconds and another set of each cultivar were treated with tap water for 20 seconds as control. Treated and non-treated sweet pepper with hot and tap water were stored for six weeks at 8°C. Percentages of fruit rot decay and weight loss were recorded weekly.

Fruit firmness:

Fifteen kg of each cultivar under study in carton boxes (5kg each) were stored at 8°C and under room temperature. Three fruits of each Skin color stages of each cultivar were used to determine the fruit firmness with the aid of pressure tester MO (FT 327) weekly for three weeks and the average was recorded.

Ascorbic acid contents:

Ascorbic acid was quantitatively determined by using 2,6-dichlorophenolindophenol method as described by Jones and Hughes (1983) . Results were expressed as mg ascorbic acid /100 g fresh weight of pepper fruits.

Peroxidase enzyme activities:

Preparing the homogenate and determination of peroxidase enzyme activities according to the method of Mazumadar and Majumder (2003) were conducted.

Isolations and identification of the casual organisms:

Sweet colored pepper fruits showing rot disease symptoms, sampled from plastic nets greenhouses at Ismailia Governorate during 2006 and 2007 seasons, were used for isolation of associated fungi. Infected fruits were first washed with running tap water, dried between filter papers, then surface sterilized with 2% sodium hypo chloride solution for two min. Internal diseased portions were transferred onto PDA (potatoes dextrin agar) medium and incubated at 25°C for 5-7 days .Counts of fungal colonies from tested fruit parts were recorded . Fungi were sub cultured on PDA and single spore's cultures were obtained. Fungal isolates were identified according to their morphological and microscopically characters as described by Barnette and Hunter (1987) and Mubasher (1993). Identification was further confirmed at the International Mycology Center, Faculty of Science, Assout University, Egypt.

Pathogenicity tests *in vitro*:

Healthy mature ripe pepper fruits were carefully chosen free from any mechanical injury. The selected fruits were thoroughly washed in tap water, dried then surface sterilized in 2% sodium hypochlorite solutions for two minutes. Under aseptic conditions, inoculation was carried out using mycelia and spores of each isolated fungus through wounds, 2 mm diameter and 3 mm depth, near the apex of the pepper fruits. The inoculated pepper fruits of yellow and red cultivars with *Alternaria solani, Cladosporium sp, Rhizopus nigricans* and *Helminthosporium sp* were incubated at 25 °C. However, fruits inoculated with *Botrytis cinerea* and *Penicillium sp,* were incubated at 18 °C as required for the fungus (8-10 days). Eight fruits were used for each fungus and for the control. After the elapse of the required period, the percentage of decayed fruits in each treatment was calculated. Re-isolations of the same fungal, under study, were tried from pepper fruits developing typical rot symptoms.

Table (1): Occurrence of post-harvest decay of sweet peppers.

Cultivars	No. of healthy fruits(mean15 kg)	No. of mechanical injury	Physiological disorder					Fruit rots		Total of decayed fruits	Total of all fruits	Percentage of decayed fruits
			Sun scald	Blossom end rot	Misshape Fruit	Fruit end hall	total	Internal fruit rot	External fruit rot			
Celica	52.6	0.2	0.0	0.0	0.4	0.0	0.4	0.0	0.0	0.6	53.2	1.1
7158	43.2	0.6	0.1	0.0	0.4	0.2	0.6	0.0	0.0	1.3	44.4	2.9
Bernal	48.4	0.0	0.0	0.0	2.6	0.0	2.6	0.4	0.2	3.2	51.6	6.2
Baramo	56.4	0.0	0.0	0.1	0.6	0.0	0.7	0.2	0.2	1.1	57.0	1.9

RESULTS AND DISCUSSIONS

Occurrence of post-harvest decay of four Egyptian sweet pepper cultivars grown under plastic nets for exportation:

Data presented in Table (1) indicate that Bernal the yellow color cultivar showed the higher percentage of fruit decay after harvest. On the contrary Celica the red cultivar followed by Baramo the orange cultivar recorded lower percentage of fruit rot decay after harvest. In the same time, the red cultivar 7158 showed moderate percentage of fruit decay.

These results, in general, indicate that the yellow cultivar Bernal is more susceptible than Baramo the orange one. However, the red cultivar 7158 showed moderate susceptibility to post harvest decay caused by fruit rotting fungi and physiological disorder or mechanical injury.. May be the chemical composition and textural properties are part of the quality of the fruits. These results are in agreement with those reported with Antoniali Silvia *et al.,* (2007) . Physiological disorders in peppers include blossom-end rot and pepper speck. Blossom-end rot is characterized by dark , sunken lesions at the blossom end of the fruit . Pepper speck occurs as spot-like lesions that penetrate the fruit walls . Fruit showing either of these disorders will not store and should be discarded.

Effect of storage pepper fruits at low temperature (8°C) on weight loss:

It appears from Table (2) that the weight loss was higher in the fruits which were stored at room temperature (20 ±2 °C) compared with those stored under cold temperature 8°C.

This trend was clear in the three tested cultivars under study, Red Ember, Yellow Velez and Orange Baramo. During the 5 weeks storage, weight loss of stored pepper fruits increased by increasing storage period from one to five weeks, either under cold storage or under room temperature. Concerning Yellow Velez and Orange Baramo cultivars, the fruit weight loss increased by increasing the fruit maturity under cold storage during 5 weeks. Weight loss was higher in full mature ripe fruits as compared with green fruits and 50% colored fruits of both cultivars either store under cool temperature or room conditions. The highest fruit weight loss was recorded in Yellow Velez at 100% colored fruits, 5 weeks after storage at room temperature. Storage at low temperature (8°C) decreases fruit weight loss because storage at cooling temperature generally has slow respiration rates. However , high temperature increased the rates of respiration and other metabolic processes that caused depletion of substrates like sugars and proteins resulting into further weight loss. As water evaporates from the tissue, the pressure decreases and the cells begin to shrink and collapse thus leading to loss of freshness.

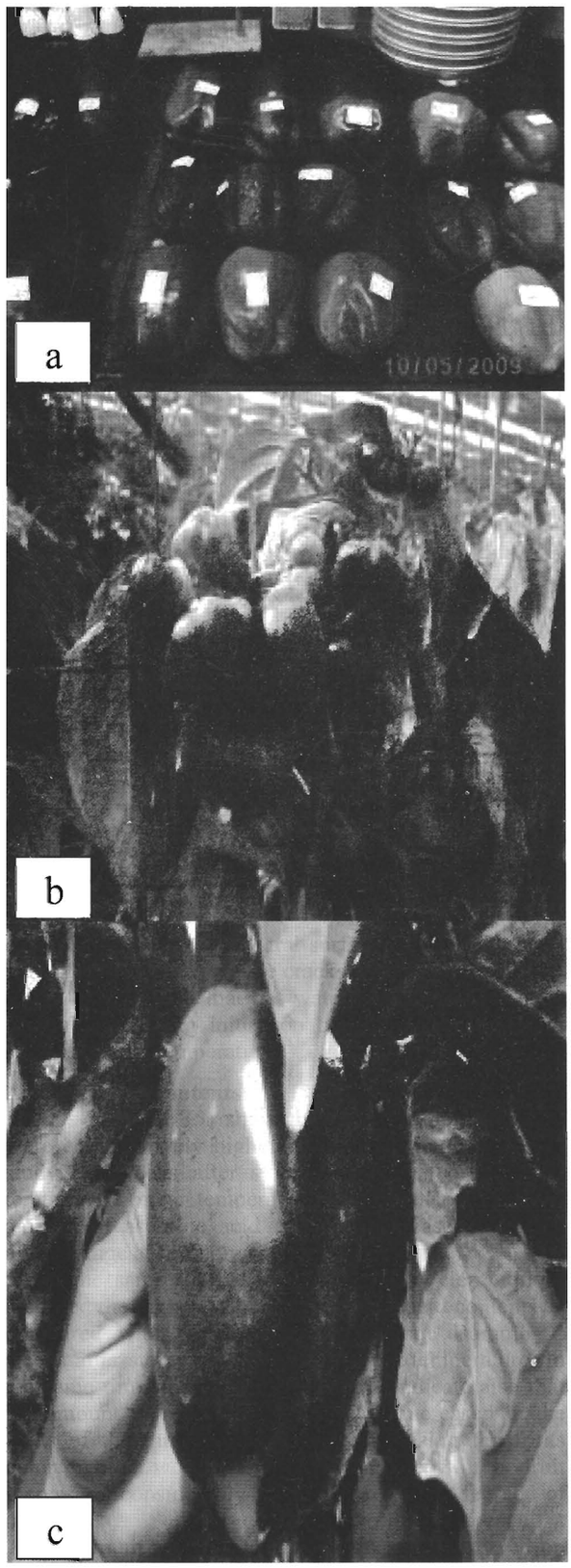

Figure (1): Shriveled pepper fruits, 5 weeks after storage at 8 °C (a), and misshape fruits (b & c) during winter season.

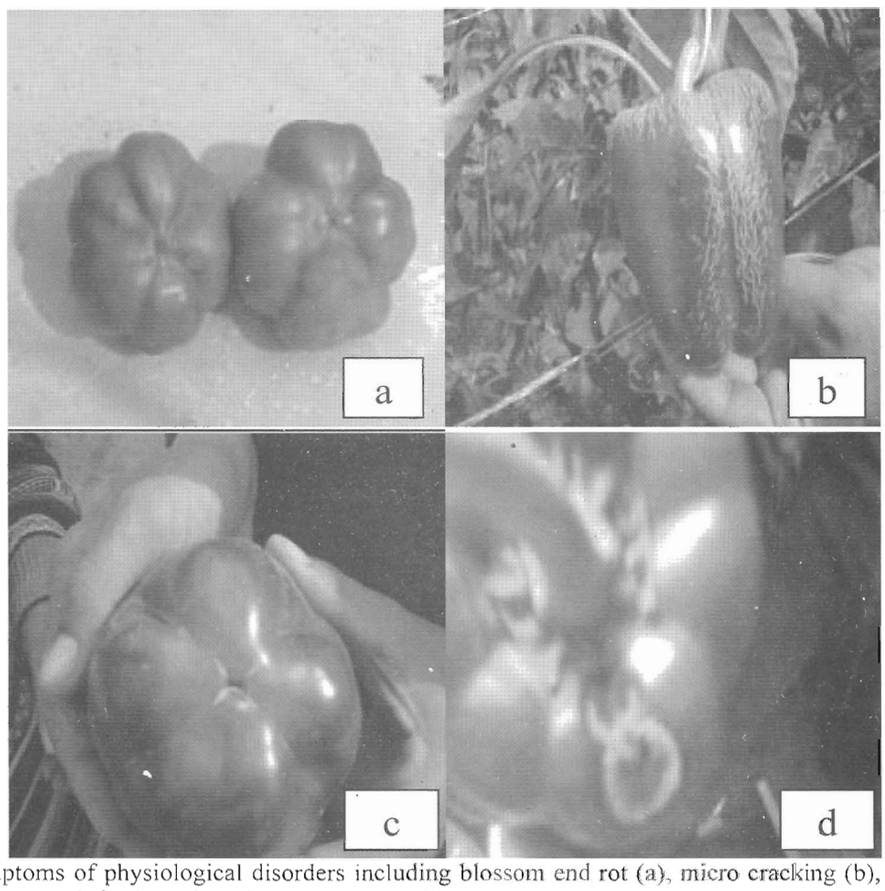

Figure (2): Symptoms of physiological disorders including blossom end rot (a), micro cracking (b), fruit end hall (c) and natural infection with *Alternaria solani* (d),

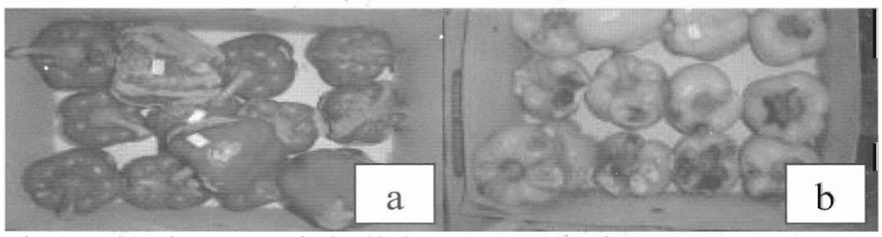

Fig. (3): Natural infection with *Alternaria. Solani* , *Cladosporium sp* (a) and *Botrytis cinerea* (b) during storage at 8°C

Total soluble solids content in three colored sweet pepper fruits including nine cultivars at different degrees of color percent and over ripe fruits:

It is clear from Table (3) that the total soluble solids (T.S.S) contents increased in most cultivars under study with increasing the fruit color and fruit maturity. No constant trend of T.S.S contents in over ripe fruits was observed.

In the meantime, Baramo the orange cultivar showed the highest amount of T.S.S percentage which reached 7.56 % followed by Bernal, Marakia and Velez, the Yellow sweet pepper cultivars. On the contrary, the orange cultivar 858 followed by Embar, 7158, Nelson and 7182, the red cultivar recorded the lowest amount of T.S.S contents.

It's also clear that, the total of the final notes of T.S.S percentages at different degrees of color percent and over ripe fruits were 37, 58.3, 67.7, 72.8 and 72.1 %for green color , 50% color , 75% color , 100% color and over ripe, respectively . May be the colored or mature fruits contained high total soluble solids content than that green one which favor and encourage the post-harvest fungi to attack the stored pepper fruits. May be also the defense mechanism is strong in immature fruits (green fruits and 50% colored fruits) and decrease in ripe fruits. During ripening the polysaccharide of the cell wall are broken up with a consequent increase in sugar levels. These results are in agreement with Lyon, *et al.*(1992) , they mentioned that the TSS increased as ripening of the fruit increased due to the greater degradation or biosynthesis of polysaccharides and the accumulation of sugar . TSS of pepper fruits was increased directly with increasing storage time.

Table (2): Effect of storage three cultivars of sweet pepper fruits at low temperature 8°C compared with room temperature (mean temperature 20 ±2 °C) on fruit weight loss % during storage for five weeks during April.

Date of determination	Temperature degree	Pepper cultivars weight loss %								
		Red(Ember)			Yellow (Velez)			Orange (Baramo)		
		Green Color	50% Color	100% Color	Green Color	50% Color	100% Color	Green Color	50% Color	100% Color
11/4/2009	8°C	0	0	0	0	0	0	0	0	0
	20 ±2 °C	0	0	0	0	0	0	0	0	0
18/4/2009	8°C	3.6	3.3	5.3	2.8	3.7	3.7	2.7	2.6	2.6
	20 ±2 °C	10.2	8.2	8.1	11.2	9.5	9.0	6.3	7.8	9.0
25/4/2009	8°C	7.3	7.5	9.4	7.5	7.5	8.1	5.6	5.9	6.3
	20 ±2 °C	24.7	16.7	19.7	20.2	22.0	21.0	14.9	19.2	17.4
2/5/2009	8°C	9.7	10.7	12.6	8.3	10.5	11.2	8.1	8.4	9.3
	20 ±2 °C	35.8	28.2	34.4	30.8	35.0	38.0	24.6	29.3	26.4
9/5/2009	8°C	11.8	13.2	16.6	10.7	13.1	13.4	10.0	10.3	11.6
	20 ±2 °C	48.1	40.2	50.0	42.5	51.0	54.0	32.7	41.4	36.6
16/5/2009	8°C	15.6	16.1	18.1	11.7	17.2	17.5	12.3	12.0	14.1
	20 ±2 °C	68.5	55.4	68.6	52.9	64.0	69.0	46.6	57.7	56.1

The increment may be due to the increasing of water loss of fruit and those led to increasing of TSS %.

Hot water treatment:

It is clear from data presented in Table (4) that hot water brushing treatment (55±1 °C for 20 seconds) was more effective in reducing weight loss of pepper fruits of the red ,yellow, and orange cultivars till 5 weeks storage when compared with treatment with tap water.

On the other hand, the relative protective effect of hot water brushing treatment against pepper fruit rots was studied on three cultivars Red Embar, Yellow Velez and Orange Baramo. Data in Table (4) show that hot water brushing treatment reduced the percentage of pepper fruit decay within 5 weeks, if compared with the control treatment (normal water).

Yellow Velez cultivar, recorded the higher percentage of fruit decay during storage followed by Red Ember cultivar and Orange Baramo one. It is also clear that hot water brushing treatment completely inhibit the disease development within the first three weeks on red and orange fruits and after two weeks on yellow cultivar. Hot water brushing treatment for food safety, minimizing fruit decay and keeping fruit quality was used as one of pesticide alternatives. Similar observation on effects of hot water treatments on firmness of bell peppers (Fallik *et al.*, 1999) has being reported. Treated fruits with hot water lost less weight due to melting of the natural surface wax, which seals natural opening or invisible cracks on the peel. LLic , *et al* .(2008) reported that hot water treatment decreases percent of chilling injury on bell pepper fruit during storage on low temperature.

Ascorbic acid contents:

Results in Table (5) show that ascorbic acid contents were comparatively higher in all cultivar fruits under study , 2 weeks after storage at (8°C) or at room temperature (mean temperature 20±2 °C) .However , the amount of ascorbic acid contents decreased 4 weeks after storage at (8°C)or at room temperature.

In the same time, fruits of Yellow Velez cultivar recorded the higher amount of ascorbic acid contents as compared with Red Embar and Orange Baramo, 2 weeks after storage at 8°C and at room temperature. In the same time, these data, in general, indicate also that the amount of ascorbic acid contents increased in the fruits of the three cultivars with increasing the fruits color. In other words, Ascorbic acid contents in the fruit increased considerably with increasing degree of maturity.

Maximum ascorbic acid contents were observed on colored fruits (yellow, orange and red). However, green or 0% colored fruits of the three cultivars showed the

Table (3): Total soluble solids percentage in fruits of different pepper cultivars at different degrees of color percent and over ripe fruits.

Fruit color	Cultivars	Total soluble solids						
		Green color	50% Color	75% Color	100% Color	Over ripe	Total	Mean
	7158	3.8*	6	7	8.8	7	32.6	6.52
	7182	4.2	7	7.2	7	9	34.4	6.88
	Nelson	5	5.5	7	7.8	8.2	33.5	6.7
Red	Embar	4.5	5.8	6.7	7.5	7.8	32.3	6.46
	Velez	4	6.5	8	8.2	8	34.7	6.94
	Marakia	3.5	7	8	8.7	8.8	36	7.2
Yellow	Bernal	3	7.5	9	8.8	7.8	36.1	7.22
	858	4	6	6	7	7.5	30.5	6.1
Orange	Baramo	5	7	8.8	9	8	37.8	7.56
Total		37	58.3	67.7	72.8	72.1	307.9	61.58
Mean		4.1	6.5	7.5	8.1	8.0	34.2	6.84

*Mean of five replicates

Table (4): Effect of treatment with hot water brushing 55±1 °C for 20 second on weight loss ,chilling injury and fruit decay on sweet pepper fruits of three cultivars stored at 8°C(10 fruits for each cultivar).

Date of determination	*Treatment with hot/tap water and tap water*	Hot water brushing treatments on %of weight loss and% of fruit decay					
		Red (Embar)		Yellow (Velez)		Orange (Baramo)	
		% Weight loss	% Decay	% Weight loss	% Decay	% Weight loss	% Decay
	Hot /Tap water	0	0	0	0	0	0
7/3/2009	Tap water	0	0	0	0	0	0
	Hot /Tap water	1.7	0	1.8	0	1.9	0
14/3/2009	Tap water	1.8	0	2	0	1.9	0
	Hot /Tap water	4.6	0	5	0	4.6	0
21/3/2009	Tap water	5	0	5	0	5.1	0
	Hot /Tap water	6.4	0	6.5	10	7	0
28/3/2009	Tap water	6.9	10	6.7	20	7.4	10
	Hot /Tap water	8.9	10	9	20	9.4	10
4/4/2009	Tap water	9.3	30	9.8	30	10.4	20
	Hot / Tap water	11.3	30	11.3	40	11.7	20
11/4/2009	Tap water	11.5	40	12.4	60	12.7	30
	Hot /Tap water	12.8	40	13.1	60	13.3	30
18/4/2009	Tap water	13.2	50	13.9	80	14.3	50

Table (5): Effect of cold storage of pepper fruits on ascorbic acid contents (mg/100g f w) on Red (Embar), Yellow (Velez) and Orange (Baramo fruits stored at 8°C comparing with room temperature (mean temperature 20±2 °C) mean of three replicates..

Period of determination	Pepper cultivars											
	Red (Embar)				Yellow (Velez)				Orange (Baramo)			
	Green Color	50% Color	100% Color	Mean	Green Color	50% Color	100% Color	Mean	Green Color	50% Color	100% Color	Mean
11/4/2009	80	86	89	85.0	122	148	173	147.7	64	74	92	76.7
2 weeks at 8°C	105	121	101	109.0	130	134	170	144.7	96	108	112	105.3
2 weeks at 20±2 °C	103	110	94	102.3	180	173	165	172.7	139	144	133	138.7
4 weeks at 8°C	95	86	88	89.7	84	95	106	95.0	88	93	87	89.3
4 weeks at 20±2 °C	88	82	85	85.0	138	142	147	142.3	104	109	107	106.7

minimum amount of Ascorbic acid contents. These are in agreement with those reported by Kidmose *et al.*,(2006). They reported that bell peppers present different nutritional compositions, depending on the cultivar and stage of maturity, but are naturally rich in ascorbic acid, specially the red ripe ones. Martenez *et al.* 2005 reported that ascorbic acid was the main form of vitamin C, and its content increases as the peppers reached maturity. The ascorbic acid content increases in pepper as they ripen. Ascorbic acid content increase with fruit ripening while , decrease during post-harvest handlings . Also, Marin *et al.* (2004) found that red ripe fruits had the highest content of vitamin C and provitamin A.

Peroxidase activity:

Data presented in Table (6) indicate that peroxidase activity was relatively higher in Yellow Velez pepper fruits one week after storage at 8°C compared with fruits stored at room temperature (19.9°C) after one week or at zero time before storage .

This trend was observed in the same cultivar of green color, 50% color and 100% color.Similar results were recorded with Orange Baramo cultivar one week after storage at 8°C compared with one week after storage at room temperature (mean temperature 19.9°C) or at zero time.

Concerning Red Embar cultivar, enzyme activity increased one week after storage at 8°C and at room temperature, than that in fruits before storage.

Two weeks after storage, peroxidase activity of pepper fruits of the three tested cultivar stored at 8°C or at room temperature fluctuated from cultivar to another and from temperature to another. No constant trend for the activity of this enzyme was observed.

In 100% colored Yellow Velez fruits, peroxidase activity was more pronounced when compared with Orange Baramo and Red Embar cultivar, 2 weeks after storage at 8°C or at room temperature. These results are in agreement with those obtained by Chang and Khao (1998). Pankotai *et al.*, (2007) reported that the changes in peroxidase activity were very similar than changes founded in ascorbic acid content. The peroxidase activity in samples picked in half-maturity level increased in the first period of storage, after that decreased. Also, Lim -Chae, *et al.*, (2007) reported that, the peroxidase activity in full-matured fruits were stable low, have changed slightly.

Isolation and identification of fungi associated with fruit decay:

Isolation trials from rotted sweet pepper fruits yielded six fungi. These common fungi associated with sweet pepper fruit rots were identified as follows:

1- The most common fungi were *Botrytis cinerea* Pres. (gray mould), *Alternaria solani*, and *Penicillium spp.*(blue *mold) which recorded the highest frequencies.*

2- *Cladosporium sp, Helminthosporium sp.* and *Rhizopus nigricans* Ehrenb. occurred in less frequencies.

Pathogenicity tests in the laboratory:

Pathogenicity tests of the isolates obtained during the present work were tested on mature colored pepper fruits. Notes recorded after 10 days, showed that at least four fungi were capable of causing severe or moderately severe rot to pepper fruits, namely *Botrytis cinerea*(87.5%) , *Alternaria solan*(37.5%) ,*Penicillium spp.* (12.5%) and *Cladosporium sp* (4%) . On the other hand, inoculation with. *Helminthosporium sp* resulted in very weak growth in the site of inoculation, whereas, *Rhizopus nigricans* produced essentially no rots.

The important of proper post-harvest handling, maturity stage, hot water treatment and temperature management are essential factors to, keep fruit quality and food safety for exportation to west Europe.

Table (6): Effect of cold storage on peroxidase activity in Red Embar, Yellow Velez and Orange Baramo stored at 8°C comparing with room temperature 19.9°C, mean of three replicates.

Period of determination	Peroxidase activity											
	Yellow (Velez)				Orange (Baramo)				Red (Embar)			
	Green Color	50% Color	100% Color	Mean	Green .Color	50% Color	100% Color	Mean	Green .Color	50% Color	100% Color	Mean
0 time	0.08	0.08	0.09	0.08	0.10	0.07	0.09	0.09	0.07	0.09	0.09	0.08
one week at 8°C	0.10	0.11	0.13	0.11	0.11	0.08	0.09	0.09	0.11	0.09	0.11	0.10
one week at room temperature	0.07	0.09	0.09	0.08	0.07	0.08	0.09	0.08	0.14	0.17	0.12	0.14
2 weeks at 8°C	0.10	0.08	0.10	0.09	0.10	0.09	0.09	0.09	0.10	0.08	0.10	0.10
2 weeks at room temperature	0.04	0.11	0.12	0.09	0.05	0.06	0.03	0.05	0.06	0.10	0.09	0.08

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عوامل تؤثر على جودة ثمار الفلفل الحلو المعد للتصدير لشرق أوروبا وتقليل الفاقد من أعفان الثمار بعد الحصاد

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يحتل تصدير الفلفل الملون مكانة عالية من بين محاصيل الخضر المختلفة وذلك لتصديره لدول اوروبا وكذلك الدول العربية والذى يحقق لمصر عائدا كبيرا من العملات الصعبة واوضحت النتائج ان ثمارالفلفل الاصفر صنف برنال سجلت اعلى نسبة للاصابه باعفان الثمار بعد الحصاد وعلى العكس وجد ان اقل نسبة اصابه سجلت على الصنف برامو البرتقالى يليه الصنف سيلكا الاحمر. دراسة تأثير التخزين المبرد للاصناف الثلاثةعلى درجات الحرارة المنخفضة ٨ درجة مئويه مقارنة بدرجة حرارة الغرفة ٢٠ مئوى اوضحت ان الفقد فى الوزن كان مرتفعا بالثمار التى تم تخزينها على درجة حرارة الغرفة مقارنة بالثمار التى تم تخزينها على درجة حرارة الثلاجة وذلك خلال خمسة اسابيع من التخزين. واوضح الصنف الاصفر فيليز والصنف البرتقالى برامو ان النقص فى وزن الثمار يزداد بزيادة نضج الثمار لكلا الصنفين. واتضح ان محتوى المواد الصلبة الذائبة فى الثلاثة اصناف من الفلفل الملون يزداد فى معظم الاصناف بزيادة درجة تلوين الثمار وبزيادة درجة نضج الثمار .وفى كلا الصنفين الاحمر انبار والاصفر فيليز تزداد نسبة العفن بزيادة فترة التخزين من ٢-٨ اسابيع على درجة حرارة ٨ درجة مئويه وكذلك على درجة حرارة الغرفة وان التخزين المبرد لثمار الفلفل يحافظ على الثمار من الاصابه بالفطريات حيث ان درجات الحرارة غير مناسبة لنمو معظم الفطريات بينما درجة حرارة الغرفة تناسب نموها مما تشجع على الاصابة والتسبب فى خسائر قد تصل الى ٨٠ % من الثمار مكتملة التلوين وزائدة النضج . المعاملة بالماء الساخن على درجة حرارة ٥٥±١ درجة مئويه لمدة ٢٠ ثانية كانت اكثر كفاءة فى خفض الفقد فى الوزن فى اصناف الفلفل الثلاثة الاحمر والاصفر والبرتقالى لفترة خمسة اسابيع من التخزين مقارنة بالماء العادى (ماء الصنبور). كذلك قللت المعاملة بالماء الساخن من نسبة اعفان الثمار خلال خمسة اسابيع وذلك عند مقارنتها بالماء العادى . صلابة ثمار الفلفل تتناقص بزيادة فترة التخزين من اسبوع الى ثلاثة اسابيع سواء على درجة ٨ درجة مئويه او على درجة حرارة الغرفة للاصناف الثلاثة تحت الدراسة. محتوى الثمار من حمض الاسكوربيك تناقصت بعد ٤ اسابيع من التخزين سواء المبرد او على درجة حرارة الغرفة. وسجلت ثمار الفلفل الاصفر فيليز اعلى كمية من حامض الاسكوربيك مقارنة بالصنف الاحمر انبار والبرتقالى برامو بعد اسبوعين من التخزين على درجة ٨درجة مئويه او على درجة حرارة الغرفة. محتوى الثمار من حامض الاسكوربيك يزداد زيادة معنويه بزيادة درجات النضج حيث سجل الحد الاقصى لحامض الاسكوربيك فى ثمار الفلفل الملون الاصفر والاحمر والبرتقالى . كذلك توجد زيادة ملحوظة فى محتوى المواد الصلبة الذائبة بزيادة فترات التخزين لثمار الفلفل حتى الاسبوع الرابع سواء كان التخزين مبرد او على درجة الغرفة واوضحت النتائج كذلك ان نشاط انزيم البيروكسديز كان مرتفعا نسبيا بثمار الصنف الاصفر فيليز بعد اسبوع من التخزين على ٨ درجة مئوية مقارنة بدرجة حرارة الغرفة. تم عزل الفطريات المصاحبة لثمار الفلفل المصاب طبيعيا اوضحت نتائج العزل وجود كل من الفطريات التالية *Alternaria solani .Cladosporium sp .Penicillum spp , Botrytis cinerea , Rhizoppus sp , Helminthosporium* واوضحت تجارب العدوى الصناعية التى تم اجراؤها على ثمار الفلفل مكتملة النضج بميسليوم الفطروجراثيمة انها قادرة على احداث الاصابه.