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Effect of jasmine oil and active dry yeast as a preharvest spray on alleviating chilling injury in cucumber fruits during cold storage

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ABSTRACT

Cucumber (*Cucumis sativus*, L.) Hesham F1 hybrid plants were grown under plastic house condition at Experimental Farm for Central Lab. For Agri. Climate in Giza Governorate during two successive seasons of 2015and 2016 to study the effect of jasmine oil (2 and 4 m/L) and active dry yeast (10 and 20 g/L) as a preharvest foliar spray beside untreated control to alleviating chilling injury (CI) and extend the shelf life of cucumber fruits during cold storage at 5°C (chilling temperature) for 12 days plus two days at 15°C (shelf life). Results showed that cucumber fruits obtained from plants treated with jasmine oil 4m/L did not develop any symptoms of CI during all storage period and shelf life. The onset of CI symptoms in cucumber fruits was delayed by jasmine oil at 2 m/L and active dry yeast treatments (10 and 20 g/L), also, these treatments reduced the rate of CI development. Jasmine at oil 2 or 4 m/L treatments retained more green color during storage and shelf life, while untreated control had less green color. Fruits obtained from plants treated with jasmine oil 4 m/L or active dry yeast 20 g/L resulted in prominent reduction in weight loss percentage and maintaining fruit firmness during storage and shelf life. The decayed fruits started to be observed clearly after 8 days at 5°C + 2days at 15°C for untreated control and active dry yeast 10 g/L. However, no decay was observed in fruits obtained from plants treated with jasmine 4 m/L till the end of storage period and shelf life. Cucumber fruits obtained from plants sprayed with jasmine oil 4 m/L was the most effective treatment in maintaining quality (reducing weight loss, color change and firmness loss) and gave fruits with good appearance without decay and CI symptoms till 12 days at 5°C + 2days at 15°C.

Key words: Cucumber (*Cucumis Sativus*, L), Jasmine oil, Yeast, Spray, Chilling injury, Quality, Cold storage, Shelf life.

Introduction

Temperature plays an important role in the metabolism of fruits and vegetables. Low temperature storage reduce metabolism of produce and as a result shelf life is prolonged. Refrigeration is the principal tool used to extend the shelf life of produce. However cucumber fruits, being of tropical origin is susceptible to chilling injury (CI) if held at low temperature (Kader 1986).The optimal storage temperature recommended in literature in cucumber fruits ranged between 10-13 °C (Hardenburg *et al*, 1986).So, cucumber fruits are injured if held at temperature lower than 10°C for more than 3 days (Eaks and Morries , 1956). Chilling sensitive crops can develop symptoms of CI either during storage at chilling temperature or subsequently during marketing condition at non chilling temperature. The main CI symptoms in cucumber fruits include surface pitting, the formation of sunken, dark colored, watery areas, rapid chlorophyll breakdown and increased susceptibility to decay and fungal growth (Cabrera and Saltveit, 1990). Thus, for this reason, this work has been done include jasmine oil and active dry yeast as preharvest foliar application to reduce symptoms of chilling injury in cucumber fruits during cold storage.

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Jasmonic acid (JA) and metyl jasmonate (MeJA), are cyclopentanonc compounds and are regarded as naturally occurring plant growth regulators (Sembdner and Parthier,1993)Methyl jasmonate, the effective component of jasmine oil , is alleviating CI by increasing the expression of a set of defenses genes and enhancing the antioxidant capacity in horticultural crops .Ghasemnezhad and Javaherdashti (2008) were expressed that MeJA could enhance the total phenolics and therefore induce the defense mechanism of raspberry against low temperature stress. Metyl jasmonate seem to be effective in delaying the onset and reducing the severity of CI symptoms in zucchini squashes (Wang, 2006), also Wang and Buta (1999) found that zucchini squash fruit treated with MeJA ,before being stored at 5°C, reduced CI symptoms for 8 days of storage + 2 days at 20 °C also they found that the reduction of chilling injury in jasmonate treated squash was accompanied by higher level of abscisic acid and polyamines . Hamdy *et al*. (2015) on squash decreased the incidence of CI symptoms and decay of fruit during cold storage at 5°C .MJ play an integral role in the intracellular signal transduction cascade which acts in the inducible defense mechanisms that plants have developed against pathogens and other stresses.

Yeast extract is considered bio-stimulants to enhance the yield and fruit quality and improve storability of vegetables and fruits (Shaaban *et al*., 2015). It is positive factors that minimize utilization of inorganic and chemical fertilizers and safe for human and environment. Also, yeast has been used as an efficient and safe food additive to reducing the chilling injury of fruit and vegetables such as cucumber fruits during storage (Dong *et al*., 2012), control postharvest diseases of tomato (Yan *et al*., 2008), maintained fruit firmness of papaya (Guo *et al*., 2013) and decreased the weight loss of orange fruits during storage (Sallam *et al*., 2012). In this respect, Dong *et al*.,(2012) showed that yeast saccharide (YS) could have potential postharvest application for reducing chilling injury in cucumber fruits. Furthermore YS-induced cod tolerance is linked with the induction of endogenous nitric oxide (NO) accumulation. Xu *et al*., (2012) reported that endogenous NO played roles in modulating cold tolerance in loquat fruits during postharvest storage. These findings imply that it might be possible to enhance cold tolerance of fruit by triggering endogenous NO generation.

The objective of this study was to develop preharvest management options using jasmine oil and active dry yeast as a foliar application to reducing chilling injury and extend the shelf life of cucumber fruits during cold storage and thereby the marketing period.

Materials and Methods

Cucumber (*Cucumus sativus*, L.) Hesham F1 hybrid plants were grown under plastic house condition at Experimental Farm for Central Lab. For Agri. Climate in Giza Governorate during two successive seasons of 2015and 2016. Seeds were sown in nursery on 4th and 6th at September 2015 and 2016, respectively. Seedlings were transplanted on 19th and 21st of September in the first and second season, respectively. Normal cultural practices were carried out wherever it was needed according to the recommendation of Ministry of Agriculture. Jasmine oil (2 and 4 ml/L)and active dry yeast (10 and 20 g/L) were applied as foliar spray beside untreated control (spraying with distilled water) .The treatments were applied after 25 days of transplanting and every 7 days for 3 times through the growing season. The experimental design was a complete randomized blocks with four replicates for each treatment.

From the previous treatments, fruits of cucumber for each treatment were harvested at the proper stage of maturity (50days after sowing) then transferred to laboratory of Postharvest and Handling of Vegetable Crops Department Hort. Res. Inst. at Giza. Samples were selected for their uniformity of size (12 -14 cm in length and 3.5 – 4 cm in diameter) and free of visual damage of defects. All samples for pre-harvest treatment of cucumber fruits were placed in polypropylene bags (25 × 30 cm) and 20 mm thickness. Each bag contain 6 fruits represented as experimental unit (EU) .Twelve EU were prepared for each treatment and stored at 5°C and 95% relative humidity (RH). Samples were taken randomly in three replicates EU and were arranged in complete randomized design. Measurement, were examined immediately after harvest and at 4 days intervals (0,4,8 and 12 days)of storage at 5°C in addition to 2 days at 15°C (shelf life conditions) for the following characteristics.

Weight loss (%): It was calculated according to the equation:

$$\text{Weight loss \%} = \frac{\textit{Initial weight of fruits- Weight of fruits at sampling datal}}{\textit{Initial weight of fruits}} \text{ x100}$$

Decay score:

Decay was measured on a scale of 1= none, 2= slight, 3= moderate, 4= severe, 5= extreme. (Risse and Miller, 1986).

General appearance:

General appearance was evaluated using a scale from (1-9) with 9= excellent, 7= good, 5=fair 3= poor, 1=unsalable, and fruits rating (5) or below were considered unmarketable.

Chilling injury:

The degree of chilling injury, as judged by the extent of surface pitting, was evaluated five hours after transfer of cucumber fruits from storage chambers to room temperature(20°c) by rating scale of 1 to 5, where 1= no pitting, 2= 10% of the surface area pitted, 3= 11-25% of the surface area pitted, 4= 26-50% of the surface area pitted 5= ≥ 50% of the surface area pitted (as describe by Wang and Qi, 1997).

Color:

Color was measured on two sides of each fruit by using Tistimulus Hunter colorimeter Minolta, Ramsey, N.J. (Model Dp 9000which measured H* and L* value) (McGuire,1992).

Fruit firmness:

Fruit firmness was measured in Lb/in^2 by Magness and Ballouf pressure tester equipped with 3/16 inch plunger and adjusted in Newton (as recommended by ASHS post harvest working Group).
All data were subjected to the statistical analysis according to the method described by Sendecor and Cochran (1980).

Results and Discussion

Weight loss (%)

Data in Table (1) showed that weight loss percentage of cucumber fruits increased considerably and consistently with the prolongation of storage periods and shelf life. The weight loss is a natural consequence of the catabolism of horticultural, products the loss in weight may be attributed to respiration and other senescence related metabolic processes during storage (Watada and Qi, 1999) . Similar results were reported by Shehata *et al*. (2009).

Concerning the effect of preharvest treatments, data revealed that cucumber fruits obtained from plants treated with all preharvest treatments retained their weight during storage and shelf life as compared with those obtained from untreated control, however, fruits obtained from jasmine oil 4 m/L or active dry yeast 20g/L resulted in prominent reduction in weight loss percentage with significant differences between them in the two season. The highest value of weight loss percentage was recorded from fruits obtained from untreated plants .These results were in agreement with Hamdy *et al*. (2015) found that exposing squash fruits to jasmine oil was effective in reducing weight loss , shriveling and maintained better quality of fruits after 9 days of storage at 5°C(chilling temperature).

The positive effect of yeast on decreased weight loss percentage might be attributed to making a thin film of yeast surrounding the fruit peel, meanwhile induced a modification of microclimatic of

fruits, so reduced respiration rate which in turn reduced weight loss during storage (Dong *et al*., 2012) on orange fruits.

In general, the interaction between preharvest treatments and storage period was significant in the two seasons. After 12 days of storage at 5 °C + 2 days at 15 °C, data reveled that cucumber fruits obtained from plants treated with jasmine oil 4 m/L or active dry yeast 20 g/L showed significant effect in minimizing weight loss % with no significant differences between them in the two season followed by jasmine oil 2 m/L or active dry yeast at 10 g/L with no significant differences between them in the two seasons.

Table 1: Effect of jasmine oil and active dry yeast as a preharvest spray on weight loss % of cucumber fruits during storage at 5 °C plus 2 days shelf life at 15 °C in 2015 and 2016 seasons.

Treatments	Storage period in days			
	4+2	8 + 2	12 + 2	Mean
		2015		
Jasmine oil 2m/L	2.23	3.53	5.70	3.82
Jasmine oil 4m/L	1.79	3.10	5.36	3.42
Active dry yeast 10g/L	1.91	3.65	5.86	3.81
Active dry yeast 20g/L	1.81	3.38	5.50	3.56
Control	2.55	5.71	7.20	5.15
Mean	2.06	3.87	5.93	
		2016		
Jasmine oil 2m/L	2.70	3.80	5.70	4.07
Jasmine oil 4m/L	1.96	3.56	5.63	3.72
Active dry yeast 10g/L	2.24	3.83	5.95	4.01
Active dry yeast 20g/L	2.13	3.55	5.66	3.78
Control	2.83	5.92	7.81	5.52
Mean	2.37	4.13	6.15	

LSD at .05 level	2015	2016
Treatments(T)	0.03	0.05
Storage periods(S)	1.51	1.88
S *T	0.31	0.37

Decay

Data in Table (2) showed that decay (score) of cucumber fruits increased considerably and consistently with the prolongation of storage period. This finding may be due to the continuous chemical and biochemical changes happened in fruits such as transformation of complex compounds to simple forms of a more liability to fungal infection (wills *et al* ., 1981).These results were true in the two seasons and in agreement with Shehata *et al*. (2009).

Regarding the effect of preharvest treatments, data showed that cucumber fruits obtained from all preharvest treatments had significant lower level of decay relative to those obtained from untreated plants .The decayed fruits started to be shown after 8days at 5°C+2 days at 15°C for untreated control and active dry yeast 10 g/L .Cucumber fruits obtained from untreated plants gave moderate score of decay after this period and had the highest score after 12 days of storage at 5°C+2 days at 15°C. However, no decay was observed in fruits obtained from plant treated with jasmine oil 4 m/L till the end of storage in the two seasons. Jasmine oil 4 m/L had shown promise in preventing postharvest disease in cucumber fruits and storability(Wang, 2006).In raspberry fruits ,it was demonstrated that MeJA increases the resistance of tissues against decay by enhancing their antioxidant system and their free radical scavenging capability(Ghasemnezhad and Javaherdashti,2008). also, Ding *et al*. (2002) reported that treatment of tomato fruits with MeJA induced the expression of pathogenesis related-proteins including B-1,3 glucanase and chitinass leading to increased chilling tolerance and resistance to pathogens , thereby reducing the incidence of fruit decay during storage.

The favorable effect of active dry yeast on decreasing fruit decay may be able to produce hydrolytic enzymes capable of attacking the pathogens cell walls and exracellular polymers that appear to have antifungal activity .It is possible to hypothesize the induction of resistance in the host

through the accumulation of phytoalexins like acoparone and scopoletin in citrus fruits (Sallam *et al*., 2012).

Table 2: Effect of jasmine oil and active dry yeast as a preharvest spray on decay score of cucumber fruits during storage at 5 °C plus 2 days shelf life at 15 °C in 2015 and 2016 seasons.

Treatments	Storage period in days				
	Starting	4+ 2	8 + 2	12 + 2	Mean
2015					
Jasmine oil 2m/L	1.00	1.00	1.00	2.00	1.25
Jasmine oil 4m/L	1.00	1.00	1.00	1.00	1.00
Active dry yeast 10g/L	1.00	1.00	2.00	2.33	1.58
Active dry yeast 20g/L	1.00	1.00	1.00	2.00	1.25
Control	1.00	1.00	2.67	3.33	2.00
Mean	1.00	1.00	1.53	2.13	
2016					
Jasmine oil 2m/L	1.00	1.00	1.00	2.00	1.25
Jasmine oil 4m/L	1.00	1.00	1.00	1.00	1.00
Active dry yeast 10g/L	1.00	1.00	2.00	2.33	1.58
Active dry yeast 20g/L	1.00	1.00	1.00	2.67	1.42
Control	1.00	1.00	2.67	3.00	1.92
Mean	1.00	1.00	1.53	2.20	
LSD at .05 level		2015		2016	
Treatments(T)		0.08		0.12	
Storage periods(S)		0.08		0.25	
S *T		0.09		0.12	

General appearance (score)

Data in Table (3) indicated that general appearance of cucumber fruits decreased with the prolongation of storage period and shelf life. Similar results were reported by Shehata *et al*. (2011) on cucumber. The decrease of general appearance of cucumber fruits during storage might be due to shriveling, pitting, color change of fruits and decay (Shehata *et al*., 2009).

Table 3: Effect of jasmine oil and active dry yeast as a preharvest spray on on general appearance score of cucumber fruits during storage at 5 °C plus 2 days shelf life at 15 °C in 2015 and 2016 seasons.

Treatments	Storage period in days				
	Starting	4 + 2	8 + 2	12 + 2	Mean
2015					
Jasmine oil 2m/L	9.00	8.33	7.67	6.33	7.83
Jasmine oil 4m/L	9.00	9.00	8.33	7.00	8.33
Active dry yeast 10g/L	9.00	7.67	6.30	5.67	7.16
Active dry yeast 20g/L	9.00	8.33	7.67	6.33	7.83
Control	9.00	7.67	5.00	3.00	6.17
Mean	9.00	8.20	6.99	5.67	
2016					
Jasmine oil 2m/L	9.00	9.00	7.00	5.67	7.67
Jasmine oil 4m/L	9.00	9.00	7.67	7.00	8.17
Active dry yeast 10g/L	9.00	8.33	6.33	5.00	7.17
Active dry yeast 20g/L	9.00	8.33	7.00	5.67	7.50
Control	9.00	7.00	4.76	3.00	5.94
Mean	9.00	8.33	6.55	5.27	
LSD at .05 level		2015		2016	
Treatments(T)		0.30		0.10	
Storage periods(S)		0.60		0.80	
S *T		0.10		0.90	

Concerning the effect of preharvest treatments ,general appearance of cucumber fruits obtained from all preharvest treatments were better than those obtained from untreated plants during storage and shelf life. In another word, these treatments gave the highest score of appearance, while untreated control obtained the lowest ones in this concern. However, cucumber fruits obtained from plants treated with jasmine oil 4 m/L was the most effective treatment for maintaining general appearance compared with the other treatments or untreated control. These results were true in the two seasons and in agreement with Wang (2006) for methyl jasmonate.

In general, there were significant differences between preharvest treatments and storage period in general appearance. Cucumber fruits obtained from plants treated with jasmine oil 4 m/L did not exhibit any changes in their appearance till 8 days of storage at 5°C +2 days at 15°C and showed good appearance after 12 days at 5°C+2 day at 15°C, meanwhile, those treated with jasmine oil 2 m/L or active dry yeast 20 g/L treatment recorded good appearance after 8 days at 5°C +2 days at 15°C. However, fruits obtained from untreated plants dropped to poor level after 12 days at 5°C +2 days at 15°C, indicating the absence of freshness and hardly acceptable or unacceptable appearance for marketing. Jasmine oil had a certain beneficial impact on opposing senescence effect of ethylene and keep freshness of the product in agreement with (Wang 2006). Hamdy *et al*. (2015) had reported similar results on summer squash, by applying jasmine oil to alleviate CI on fruits when stored at 5°C for 9 days +2 days 15°C.

Chilling injury (CI)

Surface pitting is the most common form of CI in many tropical and subtropical fruits such as cucumber. Data in Table (4) showed that cucumber fruits obtained from all preharvest treatments appeared normal without any symptoms of CI within 4days of storage at 5°C+2 days at 15°C. The differences in the severity of CI among different treatments became more appearance as time progressed. Traces of pitting were detected on the skin of fruits held at 5°C after 4 days +2 days at 15°C and the symptoms of CI developed slight to moderate pitting with numerous sunken suggested areas was observed after 12 days at 5°C +2 days at 15°C. Yang *et al*. (2009) found that CI is related with the damage of cell structure under stress. These results were in agreement with Shehata *et al*. (2009).

Table 4: Effect of jasmine oil and active dry yeast as a preharvest spray on chilling injury score of cucumber fruits during storage at 5 °C plus 2 days shelf life at 15 °C in 2015 and 2016 seasons.

Treatments	Storage period in days				
	Starting	4 + 2	8 + 2	12 + 2	Mean
2015					
Jasmine oil 2m/L	1.00	1.00	1.00	1.67	1.17
Jasmine oil 4m/L	1.00	1.00	1.00	1.00	1.00
Active dry yeast 10g/L	1.00	1.00	1.33	2.33	1.42
Active dry yeast 20g/L	1.00	1.00	1.00	2.00	1.25
Control	1.00	2.00	3.33	4.00	2.58
Mean	1.00	1.20	1.53	2.20	
2016					
Jasmine oil 2m/L	1.00	1.00	1.00	2.00	1.25
Jasmine oil 4m/L	1.00	1.00	1.00	1.00	1.00
Active dry yeast 10g/L	1.00	1.99	2.33	3.00	2.08
Active dry yeast 20g/L	1.00	1.00	1.00	2.33	1.33
Control	1.00	2.33	3.00	4.00	2.58
Mean	1.00	1.46	1.67	2.47	
LSD at .05 level		2015		2016	
Treatments(T)		0.17		0.21	
Storage periods(S)		0.15		0.05	
S *T		0.11		0.09	

Concerning the effect of preharvest treatment, data showed that cucumber fruits obtained from plants treated with jasmine oil 4m/L did not develop any symptoms of CI during all storage period.

These results were true in the two seasons and in agreement with Wang (2006) who found that MeJA treatment is even more beneficial in increasing the tolerance of zucchini squash. The onset of CI symptoms in cucumber was delayed by jasmine oil 2m/L or active dry yeast 10 g/L or 20 m/L, also ,these treatments reduced the rate of CI development. Chilling injury symptoms progressed rapidly in untreated control with increasing duration of storage. The favorable effect of jasmine oil in reducing CI may be due to MeJA reduced electrolyte leakage and this was associated with lower accumulations of malondialdehyde (MDA) in the pericarp. Parkin and Kuo (1989) reported that lipid oxidation is induced when plants respond to CI. Levels of lipid oxidation as demonstrated by MDA accumulation indicate that there is oxidation at double bonds in unsaturated fatty acid molecules. Also, Wang (2006) found that MJ was enhanced the resistance of tissues to chilling injury by increasing the gene expression of heat shock proteins, pathogenesis-related proteins, and alternative oxidase . The results also showed that MJ increased antioxidant capacities, antioxidant enzyme activities, and free radical scavenging capacities in the tissues, which in turn alleviation chilling injury.

Concerning the effect of active dry yeast in reducing CI Dong *et al*., (2012) show that ion leakage levels and malondialdehyde (MDA) content of the cucumber fruit pretreated with yeast were significant lower than those of control fruit during storage at 5°C which suggests that yeast ameliorates cold-induced membrane damage and electrolyte leakage in cucumber fruit(for ion leakage)and suppress the lipid peroxidation(for MDA content)in cucumber fruit.

Color

The color of cucumber fruits is one of the most important quality factors of fresh cucumber for consumer preference. Color was measured recording lightness (L value) and hue angle represent according to in a standardized color space.

The results in Table (5) showed that there was a significant decrease in L value with increasing storage period for all preharvest or control, showing darker fruits. These results were true in the two seasons and in agreement with Hirose (1985).

Table 5: Effect of jasmine oil and active dry yeast as a preharvest spray on color change (L*) of cucumber fruits during storage at 5 °C plus 2 days shelf life at 15 °C in 2015 and 2016 seasons.

Treatments	Storage period in days				
	Starting	4 + 2	8 + 2	12 + 2	Mean
2015					
Jasmine oil 2m/L	37.22	35.50	33.60	31.81	34.53
Jasmine oil 4m/L	39.74	37.80	35.37	33.87	36.69
Active dry yeast 10 g/L	35.74	33.97	32.20	31.57	33.37
Active dry yeast 20 g/L	36.80	34.40	33.37	32.43	34.25
Control	33.27	32.10	31.07	30.20	31.66
Mean	36.55	34.75	33.12	31.97	
2016					
Jasmine oil 2m/L	36.22	34.72	32.70	31.36	33.75
Jasmine oil 4m/L	38.37	36.60	34.83	33.26	35.76
Active dry yeast 10 g/L	34.66	32.87	31.96	30.81	32.58
Active dry yeast 20 g/L	35.97	33.90	32.66	31.95	33.62
control	32.90	31.37	30.60	29.91	31.19
Mean	35.62	33.89	32.55	31.46	
LSD at .05 level		2015		2016	
Treatments(T)		0.22		0.12	
Storage periods(S)		0.17		0.22	
S *T		0.13		0.20	

Concerning the effect of preharvest treatment cucumber fruits obtained from plants treated with jasmine oil 4 m/L had significantly higher L value indicating lighter fruits followed by Jasmine oil 2 m/L or active dry yeast 20 g/L with significant differences between them in the two seasons ,during cold storage and shelf life. While those obtained from untreated plants had darker color (low L value). Active dry yeast 10 g/L was less effective in this concern. The reduction of color development

in cucumber fruits treated with methyl jasmonate could be attributed to the slow rate of respiration rate and reduced ethylene production, thus delaying color changes (Wang and Buta, 1999).

Data in Table (6) indicated that significant decrease in hue angle values of cucumber fruits was noticed with prolongation of storage period and shelf life in the two seasons. The color of cucumber fruits showed much color deterioration after 12 days at 5°C+2 days at 15°C , these results were true in the two seasons and may be attributed to a gradual destruction by chlorophylls activity and transformation of chloroplast to chromoplast (Dong *et al* .,2004).

Concerning the effect of preharvest treatments, data show that cucumber fruits obtained from all preharvest treatments were significantly higher hue angle value as compared with untreated control, however fruits obtained from jasmine oil 4 m/L or 2 m/L were the most effective treatments in reducing the loss of hue angle value indicated that fruits retained more green color during storage and shelf life. While lower hue angle value were detected in the untreated control indicated that fruits had less green color. Cucumber fruits obtained from plants treated with Active dry yeast 10 g/L or 20 g/L were less effective in maintaining the green color during storage. This results were true in the two seasons and in agreement with Attia and Saleh (2016) found that, okra pods treated with MeJA at 500 ppm of maintained green color of pods (higher hue angle value) during storage.

Also, Hamdy *et al* .(2015) found that jasmine oil vapor effectively maintained squash fruit brightness for 9 days during cold storage period , as jasmine vapor exposed fruits displayed more shiny and bright appearance than control fruits.

The favorable effect of yeast treatments in reducing color change may be due to NO (which induced by yeast) reduced ethylene production (Guo *et al*.,2013), thus lower chlorophyllase enzyme action and chlorophyll degradation , so maintained green color of cucumber fruits (Dong *et al*.,2012).

Table 6: Effect of jasmine oil and active dry yeast as a preharvest spray on color change (h*)of cucumber fruits during storage at 5 °C plus 2 days shelf life at 15 °C in 2015 and 2016 seasons.

Treatments	Storage period in days				
	Starting	4 + 2	8 + 2	12 + 2	Mean
2015					
Jasmine oil 2m/L	126.96	125.91	125.18	124.72	125.69
Jasmine oil 4m/L	127.51	126.98	126.78	125.84	126.78
Active dry yeast 10 g/L	124.82	123.81	123.81	122.60	123.76
Active dry yeast 20 g/L	125.75	124.51	124.67	123.49	124.61
control	123.72	122.43	122.54	120.48	122.29
Mean	125.75	124.73	124.59	123.43	
2016					
Jasmine oil 2m/L	125.48	124.89	124.68	123.80	124.71
Jasmine oil 4m/L	126.42	125.53	125.36	124.80	125.53
Active dry yeast 10 g/L	124.74	123.80	122.90	122.73	123.54
Active dry yeast 20 g/L	124.96	123.92	123.55	123.04	123.87
control	122.95	121.79	120.73	120.82	121.57
Mean	124.91	123.98	123.44	123.04	
LSD at .05 level		2015		2016	
Treatments(T)		0.33		0.25	
Storage periods(S)		0.89		0.38	
S *T		1.08		0.87	

Firmness

Data in Table (7) reveled that significant reduction in fruit firmness had occurred by prolongation of storage period and shelf life. These results were in agreement with Shehata *et al*. (2009)and may be due to gradual breakdown of protopectin to water soluble lower molecular weight fractions leading to the increase in the rate of fruit softening (wills *et al* ., 1981).

Concerning the effect of preharvest treatments, data showed that there were significant differences between all preharvest treatments and untreated plants in fruits firmness during storage and shelf life. However, cucumber fruits obtained from plants treated with jasmine oil 4 m/L or active dry yeast 20g/L were the most effective treatments in reducing the loss of fruit firmness during storage and

shelf life with significant differences between them in the two seasons, while the other treatments were less effective in this concern. The lowest value of fruit firmness was recorded from fruits obtained from untreated plant. The favorable effect of MeJA on maintained fruit firmness Feng *et al*.(2003) reveled that MeJA maintained higher pectinasterase and polyglaeturonase activities , thereby preventing the development of fresh firmness of peaches. Also, MeJA induce synthesis of abscisic acid and polyamines which act as free radical scavengers and membrane stabilizer as an indicator of membrane integrity were maintained (Wang,2006). Yeast treatment induced a marked increase in endogenous nitric oxide (NO) level (Xu *et al*.,2005). So, Guo *et al*.,(2013) found that papaya fruit treatment with NO had a significantly higher fruit firmness compared with untreated who also indicated that No treatment could slow down fruit ripening and softening via a lowered ethylene production, decrease in polygalacturonase, pectin methyl esterase, pectate lyase, which decreases the firmness less of fruits during storage.

The interaction between preharvest treatments and storage period was significant in the two seasons. After 12 days of storage at 5°C+2 days at 15°C, data revealed that cucumber fruit from plants treated with Jasmine oil 4m/L had significantly higher fruit firmness as compared with the other treatments or untreated control in the two seasons.

Table 7: Effect of jasmine oil and active dry yeast as a preharvest spray on firmness (Lb/in^2)of cucumber fruits during storage at 5 °C plus 2 days shelf life at 15 °C in 2015 and 2016 seasons.

Treatments	Storage period days				
	Starting	4 + 2	8 + 2	12 + 2	Mean
2015					
Jasmine oil 2m/L	3.60	3.27	3.10	2.80	3.19
Jasmine oil 4m/L	4.33	4.00	3.93	3.60	3.97
Active dry yeast 10g/L	3.43	3.10	2.93	2.43	2.98
Active dry yeast 20g/L	3.93	3.47	3.20	2.90	3.38
Control	3.10	2.87	2.50	2.37	2.71
Mean	3.68	3.34	3.13	2.82	
2016					
Jasmine oil 2m/L	4.00	3.70	3.50	3.13	3.58
Jasmine oil 4m/L	4.57	4.43	4.07	3.80	4.22
Active dry yeast10g/L	3.04	2.90	2.73	2.60	2.82
Active dry yeast 10 g/L	3.47	3.23	3.37	2.97	3.26
Control	2.87	2.53	2.70	2.10	2.55
Mean	3.59	3.36	3.27	2.92	
LSD at .05 level		2015		2016	
Treatments(T)		0.17		0.21	
Storage periods(S)		0.15		0.05	
S *T		0.11		0.09	

Conclusion

From the previous results, it could be concluded that, cucumber fruits obtained from plants sprayed with jasmine oil 4 m/L was the most effective treatment in maintaining quality (reducing weight loss, color change and firmness loss) and gave fruits with good appearance without decay and CI symptoms till 12 days at 5°C + 2days at 15°C.

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