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Pre-harvest Application of Essential Oil for Maintaining Quality of "Flame Seedless" Grapes during Cold Storage

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ABSTRACT

The present study was conducted during the two seasons of 2020 and 2021 to determine the effects of pre-harvest treatment with thyme oil on grape (*Vitis vinifera*) Flame seedless cv. fruit quality during cold storage conditions (0±1°C and 90±5% RH).Clusters were sprayed with thyme oil at 0.2% 48 hours before harvest, while the control was sprayed by water. Fruit quality was measured at harvest time and then every 15 days of cold storage. This experiment was arranged in a factorial design with three replicates. The results in this study confirmed that grape clusters treated with thyme oil at 0.2%recorded the highest marketable percentages and visual appearance of clusters. In addition, this treatment recorded the highest berry contents of ascorbic acid and total soluble solids (TSS/TA) comparable to the control. Thus, it could be recommended to use thyme at 0.2% as safe pre-harvest treatment maintains the quality of Flame Seedless grapes during cold storage.

Keywords:
Grapes, Flame Seedless, thyme oil, cold storage, fruit quality.

1. INTRODUCTION

Grape (*Vitis vinifera* L.) is non-climacteric fruits with a relatively low physiological activity that widely cultivated in the world **(Karimi, 2020)**. It is one of the most economic and important fruit in the world and the fourth important fruit in Egypt, represented important source of antioxidant **(Baiano and Terracone, 2011)**.About 50% of global grape production almost consumed as wine, while the other half of grape production consumed as raisins, juices, direct consumption, and jams. **(Bucić-kojić et al., 2009)**.The total harvested area of grape in 2020 was 6.95 million hectares while the total harvested area in Egypt in the same year was 71889 hectares **(FAOSTAT, 2020)**.

Grape berries loss large part of their weight easily during transportation and shelf life, which is due to the high enzymes activity (such as polyphenol oxidase) and pathogenic infection **(Feliziani et al., 2013)**. In general, fungal disease causes more than 12% post-harvest losses of world crops **(Agrios, 1997)**. This loss made fruits post-harvest diseases the most severe

reasons of fruits production loss. These molds have a great ability to produce mycotoxins in the infected fruits which have serous effects on human health **(Leong et al., 2006)**.

Essential oils are eco-friendly material where they are safe for environment and human health **(Campos et al.,2011)**. They characterized as natural products which distillated from different parts of plants. They have oily texture and low density (volatile) **(Pourmortazavi and Hajimirsadeghi, 2007)**. Essential oils almost used as anti-cancer, antifungal, antioxidant and insect repellent **(Adorjan and Buchbauer, 2010)**. The volatile natural of essential oils make them able to disrupt the fungal cell membrane lipid structure, cell structures and made them highly permeable in addition to essential oils can inhibit some enzymes activity involved in metabolic pathways **(Lambert et al.,2001)**. Natural essential oils also had benefit effects on most fruits physical and chemical properties. In the previous study fruits treated with essential oil had higher TSS and TA contents than control fruits **(Marjanlo et al.,2009)**. Fruit decay and weight loss percentage were less in fruits treated with essential oils after harvesting **(Wang, 2003)**. Therefore, the present study aims to evaluate the role of pre-harvest application with essential oil of Thyme on Grapes "Flame Seedless" cv.quality during cold storage.

2. MATERIALS AND METHODS

The present study was carried out in a private orchard at Markaz Badr distract, El-Beheira Governorate, Egypt during the2020 and 2021 seasons to determine the effects of thyme oil pre-harvest treatments compared with control on grapes (Vitis vinifera) Flame seedless cv. fruit quality during cold storage. In both seasons, clusters were sprayed with thyme oil (produced from EL-Masrayia Company for natural oils, Egypt)at concentration of 0.2% 48 hours before harvest while the control was sprayed by water. Clusters were sprayed until runoff. Thymol, p-cymene and γ-terpinene are the three most important active ingredients in thyme oil. After 48 hours of treatments; grapes were picked during the first half of July from vines free from fungi and virus diseases as well as insect infestation. Grape clusters used in this study were approximately uniformed in size and free of visible symptoms of infection. Selected grape clusters were transferred to the experimental lab after harvesting in plastic boxes (5 kg capacity). A total of 36 Kg clean and sound clusters from each treatment was divided into three equally replicates, each replicate was 3 kg of fruits packed in foam plates and covered with perforated polyethylene sheets and then put in cardboard boxes in one layer. All experimental boxes were stored at 0±1°C and 90±5% RH for 45 days. Fruit quality was measured at harvest time and then every 15 days from the beginning of cold storage until the end of the cold storage period.

3. MEASUREMENT OF PHYSICAL AND CHEMICAL PROPERTIES

1- **Marketable** (%): it was calculated by the following formula:

"$\boldsymbol{Marketable}$ (%)
= " "$\boldsymbol{Weight\ of\ sound\ clusters\ at\ specified\ storage\ period}$"
/"$\boldsymbol{Initial\ weight\ of\ stored\ clusters}$" "$\boldsymbol{x}$**100**"

2- **Cluster visual appearance (score):** it was measured by a rating system, fruit scored: very good = 9, good = 7, acceptable = 5, unacceptable = 3 and poor = 1 **(Abd El-Khalek, 2018).**

3- **Ascorbic acid content (AsA):** it was determined according to AOAC (2000) and was calculated as mg/100 ml of the juice.

4- **TSS/TA ratio:** it was calculated from the values recorded for fruit juice TSS and TA percentages were determined.

Experimental design and statistical data analysis

This experiment was arranged in a factorial design with three replicates. Different attributes were analyzed statistically by

analysis of variance (ANOVA) using the MSTAT-C statistical package. Then means of storage periods was compared by Duncan's multiple range test (DMRT) at probability ≤ 0.05.

4. RESULTS AND DISCUSSION

1. Effect of pre-harvest applications of thyme oil on grapes quality during cold storage.

1.1. Marketable Clusters (%)

The results showed that marketable clusters significantly affected by cold storage periods, pre-harvest application treatments in both seasons (Table 1 and Fig. 1).Grape marketable clusters gradually decreased with the extension of cold storage period and the highest percentages were recorded at the beginning of the cold storage period and decreased gradually and reach their lowest values after 45 days of cold storage in both seasons. Marketable percentages significantly differ under pre harvest application treatments. The highest marketable percentages were recorded under the pre-harvest application with thyme at 0.2% with averages of 95.51 and 94.98 % in 2020 and 2021 seasons, respectively compared with the control. In the previous work essential oil showed excellent effect in delayed or decrease the changes caused by the environmental impact on fruit physical properties as marketable percentage **(Burt, 2004)**. Our results are in the same trend with those reported by **Rattanapitigorn et al., (2006)** who revealed benefits due to reduced weight loss percentage in cherry and grape with significant increase in marketable percentage. In the same way, **Valero et al., (2006)** grape berries in a modified atmosphere package with eugenol or thymol had the highest marketable percentage throughout storage. Also, **Abdollahi et al. (2012)** showed that the essential oils, especially of thyme increase grape berries marketable percentage and had no considerable adverse effect on the flavor of the fruits. **Mansour et al., (2018)** indicated that spraying natural oils especially garlic oil significantly improved grape berries quality in terms of their increasing marketable percentage compared to unsprayed ones. **Das et al. (2021)** reported that coating of essential oil is efficient in the protection of physicochemical characteristics, viz., marketable percentage along with maintenance of organoleptic attributes and nutritional qualities of stored grape fruits.

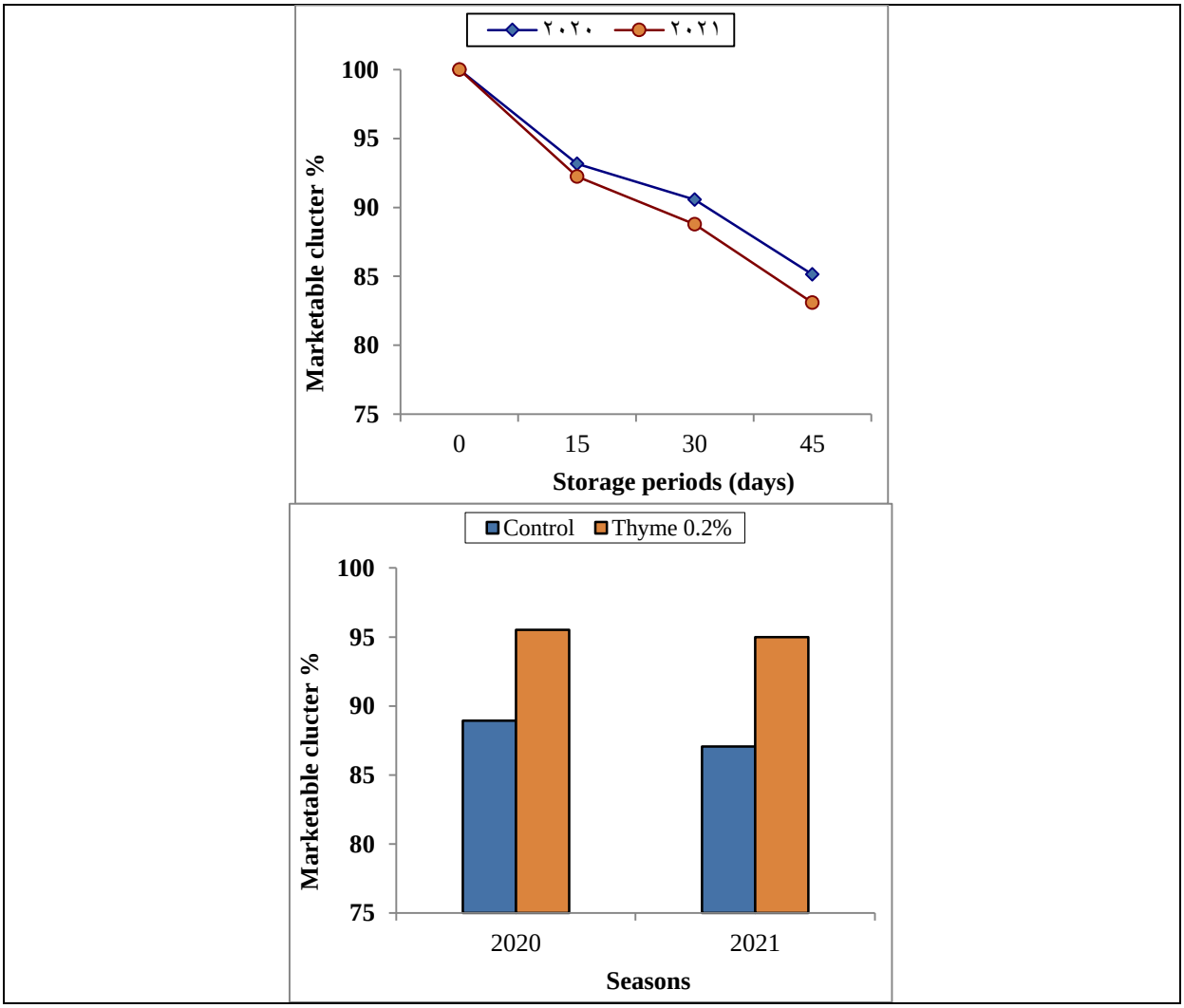
1.2. Visual appearance clusters

The results in Table 1 and Fig. 1 indicate a gradual reduction in grape clusters visual appearance with the increase of cold storage period and significantly affected by pre-harvest treatments in both seasons. The highest visual appearance score of grape clusters was noticed with treatment of thyme oil at 0.2% and recorded 8.17 and 8.00in the first and second seasons, respectively in comparison to control. In the present study, thyme oil led to preservation of the visual appearance of grape berries compared to control in both seasons. Essential oil showed good effects to delayed or decrease the changes on fruit visual appearance caused by the environmental impact **(Burt, 2004)**. Similar results were shown by **Rattanapitigornetal. (2006)**, **Valero et al. (2006)**, Abdollahi et al. (2012) and **Mansour et al. (2018)** they showed that the essential oils, especially of thyme increase grape berries visual appearance and had no considerable adverse effect on the flavor of the fruits. Also, **Das et al. (2021)** reported that coating of essential oil is efficient in the protection of physicochemical characteristics as visual appearance along with maintenance of organoleptic attributes and nutritional qualities of stored grapes. Similar results were obtained by **Hassani et al. (2012)** in apricot fruit and **Geransayeh et al. (2015)** in strawberry.

Table 1: Effect of pre-harvest applications of thyme on Flame Seedless grapes marketable and visual appearance during cold storage (0±1°C and 90±5% RH)

Treatment (T)	Marketable Clusters (%)				*Visual appearance			
	2020		2021		2020		2021	
Control	88.94	b	87.07	b	6.92	b	6.58	b
Thymeat 0.2%	95.51	a	94.98	a	8.17	a	8.00	a
Storage period (day) (S)								
0	100.00	a	100.00	a	9.00	a	9.00	a
15	93.17	b	92.23	b	7.83	b	7.67	b
30	90.57	c	88.77	c	7.00	bc	6.67	c
45	85.15	d	83.10	d	6.33	c	5.83	d
T*Significantly	**		**		ns		**	

*Visual appearance of cluster was measured by a rating system, fruit scored: very good = 9, good = 7, acceptable = 5, unacceptable = 3 and poor = 1. Means followed by the same lettersin each season within storage periods are not significantly different according toDMRTat level $P \leq 0.05$.



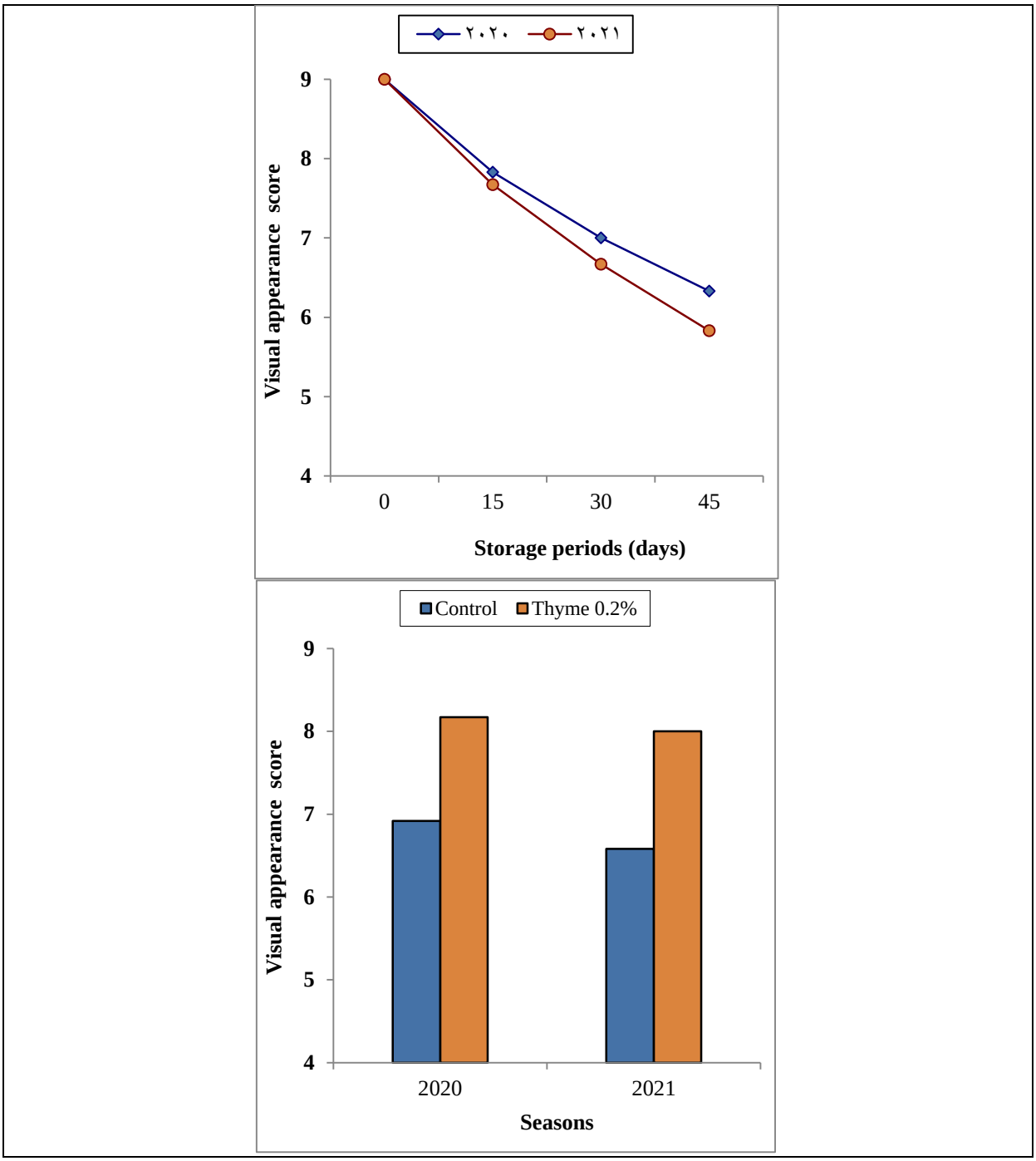


Fig. 1: Effect of treatments and storage periods of Flame Seedless grapes marketable and visual appearance during cold storage (0±1°C and 90±5% RH)

1.3. Ascorbic acid (mg/100 ml juice)

Grape berries content of ascorbic acid decreased gradually with the increase of cold storage period in both seasons (Table 2 and Fig. 2).The results confirmed that the lowest content of ascorbic acid was recorded after 45 days of cold storage period in two seasons. This was associated with the reduced capability of preventing oxidative damage and with the incidence of physiological disorders during storage.

The degradation of ascorbic acid in the control treatment was the highest probably because of physiological disorders, weight loss and decay. In addition, the high respiration rate of fruit in the control treatment probably exacerbated the

deteriorative oxidation reaction of ascorbic acid **(Lee et al., 2007)**.

In the present study grape berries that treated with 0.2% thyme oil had the highest contents of ascorbic acid compared with the controlling both seasons (Table 2 and Fig. 2). In the previous study, essential oils delayed the changes caused by the environmental impact on fruit content of ascorbic acid and nutrition values **(Burt, 2004)**. These results are in harmony with those reported by **Abd El Wahab (2015)** who mentioned that ascorbic acid content of nectarine increased with increasing storage and marketing periods. Moreover, coriander oil delayed the changes in ascorbic acid compared with control during cold storage. **Nabifarkhani, et al. (2015)** showed that thyme oil had significant effects in comparison with control in ascorbic acid content of sweet cherry**. Behshti et al. (2020)** indicated that treated grapes with marjoram oil had more ascorbic acid content in comparison to control.

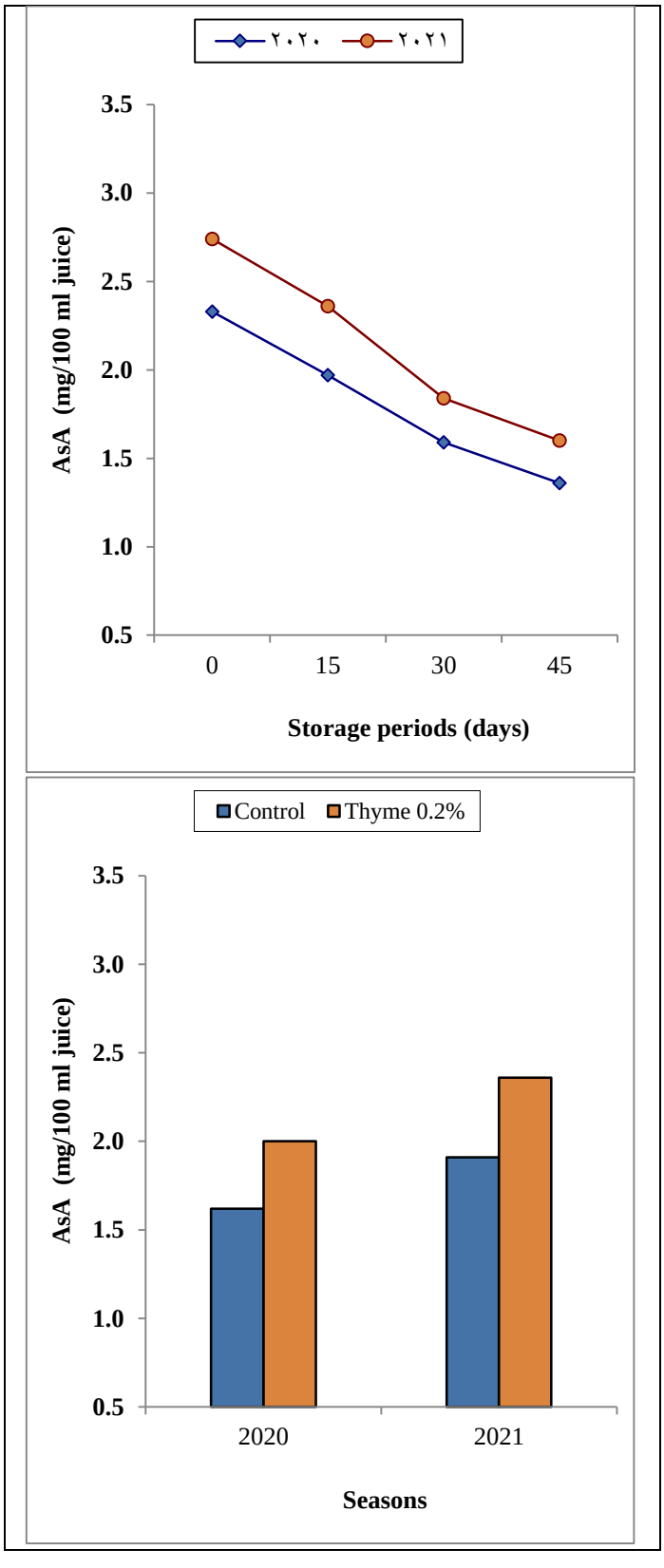
1.4. TSS/TA ratio

Data in Table 2 and Fig.2 reveal that there are significant effects of cold storage periods and pre-harvest treatment on the TSS/TA ratio of grape berries in both seasons. The results confirmed that a gradual increase in TSS/TA ratio was observed with the increase of cold storage period in both seasons and detected its peak at 45 days of cold storage. Our findings confirmed that grape berries that treated pre-harvest with thyme at 0.2% had the significantly lowest TSS/TA compared with control that recorded the highest this ratio (Table 2 and Fig. 2). Similar results were obtained before by Hassani et al. (2012) found that application of thymeoil on apricot fruit showed a significant effect on fruit quality retention as evaluated with total soluble solids, titratable acidity and maturity index. On the other side, Abdolahi et al. (2009) who confirmed that application of thyme oil had significant efficacy on quality parameters of grape fruit where it increased the maturity index levels in treated fruits in comparison with controls.

Table 2: Effect of pre-harvest applications of thyme on ascorbic acid (AsA) and total soluble solids/titratable acidity (TSS/TA) ratio during cold storage (0±1°C and 90±5% RH)

Treatment (T)	Ascorbic acid content (mg/100ml juice)				TSS/TA			
	2020		2021		2020		2021	
Control	1.62	b	1.91	b	32.08	a	34.27	a
Thymeat 0.2%	2.00	a	2.36	a	22.26	b	23.67	b
Storage period (day) (S)								
0	2.33	a	2.74	a	16.47	d	16.72	d
15	1.97	b	2.36	b	25.58	c	27.44	c
30	1.59	c	1.84	c	31.54	b	34.04	b
45	1.36	d	1.60	c	35.10	a	37.69	a
T*Significantly	*		*		**		**	

Means followed by the same lettersin each season within storage periods are not significantly different according toDMRTat level $P \leq 0.05$.


٢٠٢٠
٢٠٢١
3.5
3.0
2.5
2.0
1.5
1.0
0.5
AsA (mg/100 ml juice)
0
15
30
45
Storage periods (days)
Control
Thyme 0.2%
3.5
3.0
2.5
2.0
1.5
1.0
0.5
AsA (mg/100 ml juice)
2020
2021
Seasons

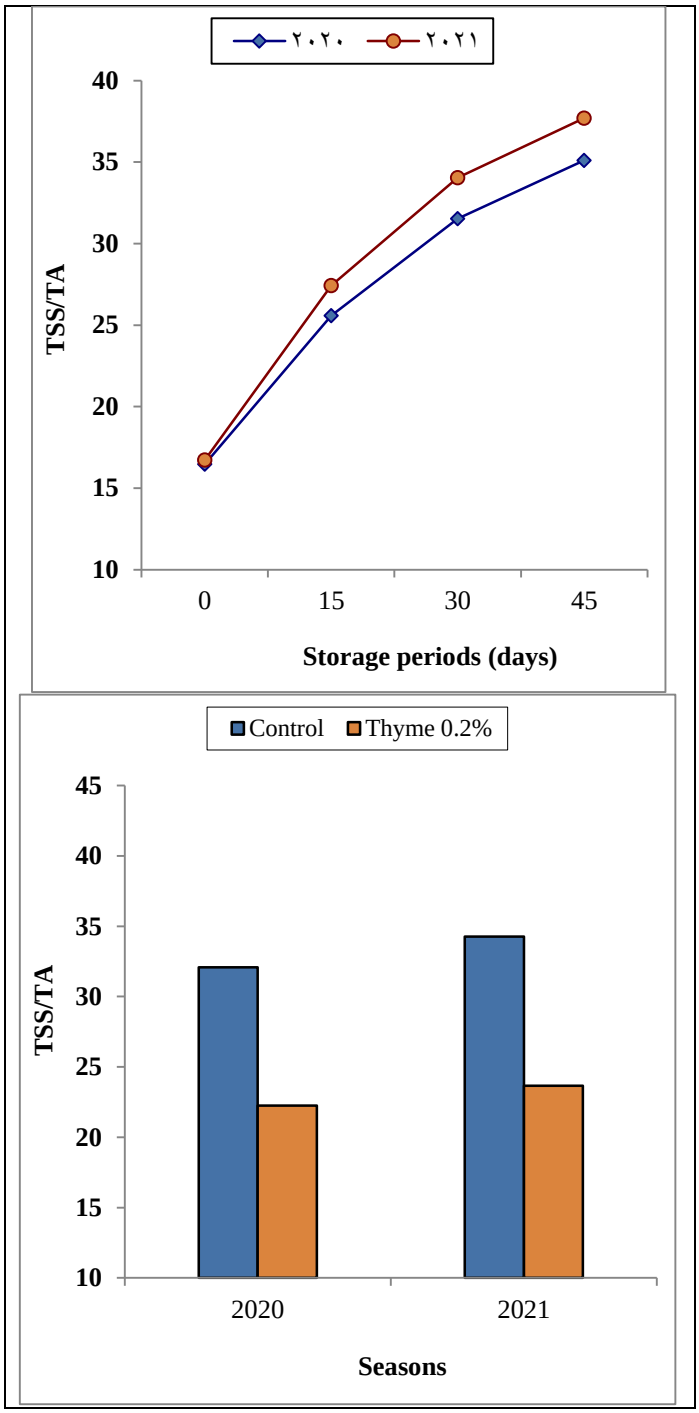


Fig. 2: Effect of treatments and storage periods of Flame Seedless grapesAsA (mg/100 ml juice) and TSS/TA during cold storage (0±1°C and 90±5% RH).

5. CONCLUSIONS

In this study, eco-friendly application of thyme essential oil had a positive effect on maintaining grapes quality during cold storage. Based on this research, it can be concluded that pre-harvest treatment of 0.2% thyme cv. Flame Seedless 48 hours before harvest can reducing the deterioration of fruit quality including, marketable percentage, visual appearance score, ascorbic acid and TSS/TA ratio during cold storage at 0°C.

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Conflicts of interest: The author declares that there are no conflicts of interest related to the publication of this study.

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التطبيق الآمن لمعاملة الزيت العطري قبل الحصاد للمحافظة على ثمار العنب "فليم سيدلس" أثناء التخزين المبرد

أحمد فتحي عبد الخالق،أسامة كمال العباسي ومحمد عادل محمد عبد الحميد

قسم البساتين -كلية الزراعة–جامعة طنطا– مصر.

J.Sust.Agri.Env.Sci (JSAES)

الملخص العربي

أجريت الدراسةالحالية في مزرعة خاصة تابعة لمركز بدر بمحافظة البحيرة خلال موسمي٢٠٢٠و٢٠٢١ وذلك لتحديد تأثير معاملة ما قبل الحصاد ب ٤٨ ساعة بزيت الزعتر بتركيز ٠,٢٪ مقارنة بالكنترولعلى جودة ثمار العنب صنف فليم سيدلستحتظروفالتخزينالمبرد علي صفر درجة مئوية.وقد أكدتالنتائجأنالمعاملة بزيت الزعتر قد أعطت أعلى نسبة للثمار القابلة للتسويق وكذلك المظهر البصري للعناقيد،كما سجلت ثمار العنب التى عوملت بزيت الزعتر أعلى محتوى للثمار من حمض الأسكوربيكو كذلك أعلى نسبة من المواد الصلبة الذائبة الكلية الى الحموضة، لذا يوصي بالرش بزيت الزعتر بتركيز ٠,٢٪قبل الحصاد بيومين للحفاظ على جودة ثمارالعنب فليم سيدلس أثناء التخزين المبرد.