RESEARCH | Egyptian Journal of Agricultural Research | HORTICULTURE

Improving storability of the flame seedless grap by some postharvest applications

Thanaa Sh.M. Mahmoud[1]*, *Gehan A.M. El-Hadidy*[2], *Nahed A.A. Mohamed*[2] *and Manal A. El-Gendy*[3]

Address:
[1]*Horticultural Crops Technology Department, Agriculture and Biology Research Institute, National Research Centre, 33 El-Behooth St., Egypt.*
[2]*Horticulture Research Institute, Agricultural Research Center, Giza, Egypt*
[3] *Food Technology Research Institute, Agricultural Research Center, Giza, Egypt*
* Corresponding author: ***Thanaa Sh. M. Mahmoud,*** *thanaa_3000@yahoo.com*
Received: 12-12-2021; **Accepted**: 28-01-2022; **Published**: 18-02-2022 doi:10.21608/ejar.2022.108780.1182

ABSTRACT
Alternative postharvest treatments can reduce the decay of grapes maintaining the quality without a negative impact on both consumers and the environment. Therefore, the response of 'Flame Seedless' grape was tested to some postharvest application by salicylic acid (SA) 2 mmol L^{-1}, Aloe Vera gel 20% (w/v), and ethanol 10 % and calcium chloride (CC) 1% compared with control (SO_2) under cold storage at 0°C for 4 weeks. The tested treatments reduced weight loss percentage, delayed changes in firmness; soluble solids content, total acidity, and reduced PPO and POD activities during storage periods, especially SA and Aloe Vera gel treatments when compared to the control. It is concluded that dipping 'Flame Seedless' grape in SA 2 mmol L^{-1}or Aloe Vera gel 20% (w/v) are safe and healthy alternatives to chemicals and fungicides for extending the storage life of table grapes and maintaining their quality during cold storage.
Keywords: Table grapes, 'Flame Seedless', Salicylic Acid, Aloe Vera gel, Ethanol, Calcium chloride, SO_2, PPO, POD, Postharvest quality, Cold storage.

INTRODUCTION
In Egypt, "Flame Seedless" (*Vitis vinifera* L.) is an important table grape for local consumption and export. It ripens early, has a heavy bearing, and has excellent taste qualities. Berry texture is crunchy and firm, with excellent flavour and a high content of soluble solids at harvest. Also, it is suitable for early access to the market window in the European Union when prices are high (Mohsen, 2021). Due to water loss, skin browning, berry shattering, and fungus decay, table grapes have a relatively short shelf life after harvest. Scientists estimate that losses due to fungal decay account for 10–40% of total grape production worldwide (Sonker *et al.,* 2015), making post-harvest fungal diseases one of the most serious causes of fruit production losses (Mansour *et al.,* 2018). Moreover, these fungi have a strong ability to produce mycotoxins in infected fruits, which can have serious health consequences (Leong *et al*., 2006). So, reducing fungal decay is a major goal of table grape post-harvest technology, which seeks to use safe and effective methods to control contamination and spoilage growth while maintaining quality (Martínez-Romero *et al.*, 2007). Application of chemicals such as carbon dioxide, fungicides, and growth regulators is essential to maintain fruit quality during transportation and long-term storage (Asghari *et al*., 2013). In recent years, the use of fungicides has become increasingly restricted and the use of sulphur dioxide (SO_2) is not permitted on organic grapes, which has made it imperative to search for natural alternatives to synthetic fungicides that are also safe for humans (Domingues *et al*., 2018).

Salicylic acid, a natural and safe phenolic compound, has a high potential for controlling postharvest losses and enhancing resistance to pathogens, as well as reducing fungal decay, stimulating antioxidant enzymes, and remarkably preserving fruit quality during the storability of many fruits (Fatma *et al*., 2020). Furthermore, it has been demonstrated that Aloe Vera gel edible coating prevents moisture and firmness loss, extends storage/ shelf life, maintains quality, and reduces decay symptoms (Thanaa *et al*., 2019). Several inorganic salts, including calcium chloride, have antimicrobial properties against a variety of pathogenic fungi. Calcium chloride treatments have been proposed as a safe and effective alternative to control postharvest decay in some grape cultivars (Abd Elwahab *et al*., 2014). Cleansing agents such as ethanol are also used to fruit surface sterilization, and have demonstrated great success in inhibiting and controlling grape decay (Romanazzi *et al*., 2016).

The goal of this experiment was to study the response of table grape cv. Flame Seedless to postharvest application of salicylic acid, *Aloe vera* gel, calcium chloride, and ethanol in comparison with using SO_2-generating pads for quality preservation during cold storage.

MATERIAL AND METHODS

Fruit material and experimental design:

Flame Seedless' grapes (*Vitis Vinifera* L.) were harvested at maturity in the second week of June 2019 and 2020 seasons from a commercial orchard on Alexandria Desert Road (about 130 kilometers from Cairo), Egypt. Uniform fruits were selected in size and free from visual symptoms of disease or mechanical damage and transported directly to the laboratory of the Fruit Handling Dept., Horticulture Research Institute, Agricultural Research Center, Giza, Egypt. Clusters were cut to obtain samples ranging from 300 to 500g. The selected clusters were divided into five groups at random so that each group contained 12 clusters. They were distributed according to a completely randomized design (CRD) with three replications of four clusters as experimental units.

Treatments and storage fruits:

The following treatments were assessed:

1. Control: SO_2-generating pads slow release (Uvasys Slow®) contain 3.85 g $Na_2S_2O_5$ (sodium metbisulfite) and was used as half of at the top and the other at the bottom of the bunches inside the box.
2. Dipping the bunches in salicylic acid at 2 mmol L^{-1} for 5 min.
3. Coating the bunches with Aloe Vera gel at 20% (w/v) for 5 min.
4. Spraying the bunches with ethanol at 10% for 1 min.
5. Spraying the bunches with calcium chloride at 1% for 1 min.

After 1 hour of air drying at room temperature, all treated clusters were carefully placed in perforated cartoon boxes (30×40×20 cm) in one layer. Each treatment had 3 boxes each box had 4 clusters; one box was used to determine weight loss percentage while the other boxes were used to study the physical and chemical properties every week during the period of cold storage. All treatments were kept at 0 °C and 85-90 % relative humidity for four weeks.

Measurements:

Physical properties:

Weight loss: It was calculated as a percentage of the average loss in fruit weight for each treatment separately at the examined date in comparison to the starting weight at the start of the experiment.

Berry firmness: It was measured on two opposite sides of 10 berries per replicate using a hand Magness Taylor pressure tester with a 4 mm diameter probe that measures the force required just to break the berry and expressed as g/cm^2.

Berry peel color (Hue angle, h°): It was estimated using a Minolta calorimeter (Minolta Co. Ltd., Osaka, Japan) on two points of each berry in the sample as described by (Mc Gire, 1992).

Chemical properties:

Soluble Solid Contents (SSC, %): It was determined in berries using an Abbe-digital refractometer.

Total Acidity (TA, %): It was determined by titrating grape juice against 0.1 N sodium hydroxide using phenolphthalein as an indicator as described by (AOAC, 1990) and expressed as percentages of anhydrous tartaric acid using the equation below:

$$\text{Total acidity (\%)} = \frac{\text{ml of NaOH x 0.0075}}{\text{ml juice used}} \times 100$$

Polyphenol oxidase (PPO) and peroxidase (POD) enzymes activity:

PPO (EC 1.14.18.1) was extracted from treated or untreated fruit samples using a 1.5-time (0.1 M, pH 6.5) sodium phosphate solution containing 30 mM sodium ascorbate and 0.4 M sucrose at 25 ° C. The crude extraction was filtered and refrigerated till used within 24 h. *Doğan et al*. (2002) determined that PPO enzyme activity was determined by mixing catechol as a substrate (1.5 mL, 80.0 mM) dissolved in the phosphate buffer with 0.5 mL of enzyme extract and 0.25 mL of distilled water (control) or inhibitor solution. phosphate buffer with 0.5 mL of enzyme extract and 0.25 mL of distilled water (control) or inhibitor solution. Phosphate buffer was used as a blank. Increased absorbance by 0.01 per minute at 420 nm in the specified condition was defined as one unit of PPO activity.

Peroxidase (POD): POD was determined according to the method described by Clemente (1998). 0.2 mL of the sample, 2.7 mL of 0.1% solution of H_2O_2 in sodium phosphate buffer (100 mM, pH 6.0), and 0.1 mL of an alcoholic solution of ortho-dianisidine 1.0% were mixed with the extracts. Reading was performed at 460 nm and 1 unit of POD activity was defined as the increase of absorbance mL^{-1} sample per minute.

Statistical analysis

The obtained data from both seasons were subjected to a variance analysis in accordance with (Snedecor and Cochran, 1980). Duncan's multiple range tests were used to compare treatment means at a 5% probability level.

RESULTS

Physical properties:

Weight loss:

The results in **Table 1** demonstrate that fruit weight loss increased significantly as the storage period progressed. At the end of storage periods, salicylic acid (SA) at 2 mmol L^{-1} recorded the lowest significant weight loss, followed by 20% Aloe Vera gel, followed by 10% ethanol and 1% calcium chloride, respectively, compared to SO_2 (control), which gave the highest significant percentage of weight loss in both seasons. In terms of interaction, significant differences in the interaction between the two studied factors were discovered (treatments and storage periods) during the two seasons. Untreated fruits (control) had the highest weight loss percentage (4.10 & 5.03%) in the first and second seasons, respectively. On the other hand, the fruits treated with SA had the lowest weight loss percentage (0.29 & 2.23%) in the first and second seasons, respectively.

Table 1. Effect of some postharvest applications on weight loss of 'Flame Seedless' grapes during cold storage at 0°C and 85-90% RH.

Treatments	**Storage periods (weeks)**					**Means**
	2019					
	0	1	2	3	4	
Control (SO_2)	0.00l	1.50i	2.10e	2.53c	4.10a	**2.05A**
Salicylic acid	0.00l	0.29k	0.38jk	0.50j	1.65h	**0.57E**
***Aloe Vera* gel**	0.00l	0.33k	0.34k	1.80g	2.07ef	**0.91D**
Ethanol	0.00l	1.65h	1.83hi	1.94f	2.20e	**1.47C**
Calcium chloride	0.00l	1.64hi	2.10e	2.37d	3.00b	**1.82B**
Means	**0.00E**	**1.08D**	**1.35C**	**1.83B**	**2.61A**	
2020						
Control (SO_2)	0.00l	4.49bc	4.63b	4.65b	5.03a	**3.76A**
Salicylic acid	0.00l	2.23k	2.30jk	3.28gh	4.01e	**2.36E**
***Aloe Vera* gel**	0.00l	2.45j	3.02i	3.20hi	4.08e	**2.55D**
Ethanol	0.00l	2.38jk	3.25gh	4.00e	4.40cd	**2.81C**
Calcium chloride	0.00l	3.28gh	3.30g	3.63f	4.27d	**2.90B**
Means	**0.00E**	**2.97D**	**3. 30C**	**3.75B**	**4.16A**	

Different lowercase letters within the rows and columns indicate significant differences for the interactions between the five treatments and storage periods at level P = 0.05; different capital letters within the column indicate statistically significant differences at level P = 0.05 between the mean effects of treatments in the same period and within the row between the periods of the same treatment.

Berry firmness:

The firmness Table (2) decreased with progress periods of storage. Upon 4 weeks of storage, the maximum value of berry firmness were obtained by application of SA (31.66 & 34.00 g/cm²) followed by Aloe Vera gel (31.33 & 32.13 g/ cm²) and calcium chloride (31.07& 31.13 g/ cm²), then ethanol (30.06 & 30.27 g/ cm²) during both seasons, respectively. While the control treatment recorded minimum value of berry firmness (28.92 & 30.13 g/ cm²) in both seasons, respectively. The interaction at the end of cold storage after 4 weeks shows that the SA and Aloe Vera gel recorded the highest significantly of firmness in comparison with SO_2(control) followed by calcium chloride in both seasons.

Table 2. Effect of some postharvest applications on berry firmness of Flame Seedless grape fruits during cold storage at 0°C and 85- 90% RH

Treatments	**Storage periods (weeks)**					**Means**
	2019					
	0	**1**	**2**	**3**	**4**	
Control (SO_2)	36.33a	28.67jk	28.00kl	26.00mn	25.67n	**28.92C**
Salicylic acid	34.33b	33.00c	31.33ef	30.33gh	29.33ij	**31.66A**
***Aloe Vera* gel**	34.00b	32.33cd	31.00fg	30.00hi	29.33ij	**31.33AB**
Ethanol	34.00b	32.33cd	30.33gh	29.67hi	26.67m	**30.06B**
Calcium chloride	34.67b	32.00de	31.00fg	30.00hi	27.67l	**31.07AB**
Means	**34.67A**	**31.67B**	**30.33C**	**29.20D**	**27.43E**	
2020						
Control (SO_2)	37.00ab	30.33ij	29.00k	28.67k	25.67l	**30.13E**
Salicylic acid	36.33b	34.33b	33.67cd	33.33d	32.33ef	**34.00A**
***Aloe Vera* gel**	36.33b	33.00de	31.00gh	30.33ij	30.00ij	**32.13B**
Ethanol	36.33b	31.00gh	29.33jk	29.00k	25.67l	**30.27D**
Calcium chloride	37.67a	31.67fg	31.00gh	29.00k	26.33l	**31.13C**
Means	**36.73A**	**32.07B**	**30.08C**	**30.07C**	**28.00D**	

Different lowercase letters within the rows and columns indicate significant differences for the interactions between the five treatments and storage periods at level P = 0.05; Different capital letters within the column indicate statistically significant differences at level P = 0.05 between the means effect of treatments in the same period, and within the row between the periods in the same treatment.

Berry peel color:

Hue angle *(h°):*

With advance storage period, the h° was decreased (the density of red color increases). There was an interactive effect among treatments and cold storage periods on the color of the peel berry **Table (3).** In the two seasons, the berry treated with salicylic acid had the lowest h° (high density of red color). The highest h° was found in the control (SO_2) fruits during both seasons. As for interaction, there was a significant effect between the treatments and storage periods on h°. It is clear from Table 3 that in the end of storage period, treatment with SO_2 recorded highest values of hue angle in the two seasons. While, salicylic acid treatments gave the least values of hue angle in the first and second seasons.

Table 3. Effect of some postharvest applications on Hue angle (h°) of Flame Seedless grape fruits during cold storage at 0°C and 85- 90 % RH

Treatments	Storage periods (weeks)					Means
	2019					
	0	1	2	3	4	
Control (SO_2)	334.43b	329.9c	328.2d	288.9h	278.2i	**311.93A**
Salicylic acid	343.1a	327.57d	317.1g	230.4m	225.3n	**228.69E**
***Aloe Vera* gel**	340.87ab	327.57d	323.9f	243.77k	228.5m	**292.92D**
Ethanol	343.1a	330.87c	325.07e	249.6j	236l	**296.93B**
Calcium chloride	341.5ab	329.2c	323.87f	244.81k	229.4m	**293.76C**
Means	**340.6A**	**329.02B**	**323.63C**	**251.50D**	**239.48E**	
	2020					
Control (SO_2)	350.13b	347.97d	344.47e	330.23g	321.43k	**338.85A**
Salicylic acid	354.2a	343.8e	327.47i	322.7k	297.63n	**329.16E**
***Aloe Vera* gel**	351.8b	344.07e	329.07h	324.2j	309.53m	**331.73D**
Ethanol	354.57a	346.97d	338f	328.7h	320.6k	**337.77B**
Calcium chloride	349.93c	345.37e	343.57ef	325.7ij	318.2l	**336.55C**
Means	**352.13A**	**345.64B**	**336.52C**	**326.31D**	**313.48E**	

Different lowercase letters within the rows and columns indicate significant differences for the interactions between the five treatments and storage periods at level P = 0.05; Different capital letters within the column indicate statistically significant differences at level P = 0.05 between the means effect of treatments in the same period, and within the row between the periods in the same treatment.

Chemical properties:

Soluble solid content (SSC, %):

Table (4) shows that the SSC of berry gradually significantly increased with extend of storage period during 2019 & 2020 seasons. In the first season, treated clusters by salicylic acid recorded the highest values of SSC% followed by Aloe Vera gel, ethanol and calcium chloride. In the second season, clusters treated with SO_2 showed an increase in SSC as compared with calcium chloride treatment and no significant difference between Aloe Vera gel and ethanol. Regarding the interaction between the two studied factors at the end of storage period, there were no significant differences between salicylic acid, Aloe Vera gel and ethanol in the effect on soluble solid contents percentage of berry, also between calcium chloride and control in the first season. In second season the percentage of soluble solid was significantly affected as a result of the interaction between treatments and storage periods, where ethanol recorded the highest significant value followed by salicylic acid (22.37 and 22.23%) respectively, while calcium chloride recorded the lowest significant value (21.40 %).

Table 4. Effect of some safe alternative postharvest applications on SSC% of Flame Seedless grape fruits during cold storage at 0°C and 85- 90% RH

Treatments	**Storage periods (weeks)**					**Means**
	2019					
	0	**1**	**2**	**3**	**4**	
Control (SO_2)	20.33i	20.70h	21.13fg	21.16fg	21.27ef	**20.92D**
Salicylic acid	21.00fgh	21.83bc	22.07ab	22.20a	22.40a	**21.90A**
***Aloe Vera* gel**	21.53cde	21.60cde	21.67cd	21.70c	22.17a	**21.73B**
Ethanol	20.20ij	20.77h	20.90gh	21.33def	22.27a	**21.09C**
Calcium chloride	19.10l	19.73k	19.97jk	20.07ij	21.30ef	**20.03E**
Means	**20.43E**	**20.93D**	**21.15C**	**21.29B**	**21.88A**	
	2020					
Control (SO_2)	20.33jk	20.80hi	21.40g	21.67efg	22.00bcd	**21.24C**
Salicylic acid	21.00h	22.07abd	22.10abc	22.20ab	22.23ab	**21.92A**
***Aloe Vera* gel**	21.47fg	21.60efg	21.63efg	21.77def	21.87cde	**21.67B**
Ethanol	20.20k	21.47fg	22.10abc	22.27ab	22.37a	**21.68B**
Calcium chloride	19.10l	20.13k	20.40jk	20.60ij	21.40g	**20.33D**
Means	**20.42E**	**21.21D**	**21.53C**	**21.70B**	**21.97A**	

Different lowercase letters within the rows and columns indicate significant differences for the interactions between the five treatments and storage periods at level P = 0.05; Different capital letters within the column indicate statistically significant differences at level P = 0.05 between the means effect of treatments in the same period, and within the row between the periods in the same treatment.

Total acidity percentage (TA, %):

Total acidity percentage was significantly decreased with prolonging cold storage periods during both seasons **Table (5).** All postharvest treatments delayed the decrease in concentrations of titratable acidity compared with control. Moreover, it could be noticed that there were no significant differences in acidity levels between the salicylic acid and Aloe Vera gel treatments during the two seasons of investigation. In both seasons, the interaction between treatments and storage time period at the end of storage was significant effect on total acidity percentage of berry in comparison with SO_2 (control).

Table 5. Effect of some postharvest applications on total acidity% of Flame Seedless grape fruits during cold storage at 0°C and 85- 90% RH

Treatments	**Storage periods (weeks)**					**Means**
	2019					
	0	**1**	**2**	**3**	**4**	
Control (SO_2)	0.690a	0.667abc	0.643f	0.633abcd	0.513e	**0.627A**
Salicylic acid	0.550e	0.450f	0.410g	0.393fgh	0.387gh	**0.438D**
***Aloe Vera* gel**	0.540e	0.510e	0.443f	0.367hi	0.317i	**0.436D**
Ethanol	0.680ab	0.597d	0.517e	0.360hi	0.310i	**0.494C**
Calcium chloride	0.690a	0.627bcd	0.617d	0.423fg	0.343hi	**0.540B**
Means	**0.630A**	**0.570B**	**0.525C**	**0.434D**	**0.374E**	
	2020					
Control (SO_2)	0.690a	0.443c	0.320d	0.227fgh	0.197fgh	**0.376A**
Salicylic acid	0.450c	0.320d	0.223efg	0.200fgh	0.167gh	**0.272C**
***Aloe Vera* gel**	0.543b	0.313d	0.253defg	0.193fgh	0.180fgh	**0.294BC**
Ethanol	0.683a	0.260def	0.243defgh	0.200fgh	0.163h	**0.308B**
Calcium chloride	0.690a	0.303de	0.243defgh	0.190fgh	0.160h	**0.316B**
Means	**0.610A**	**0.326B**	**0.254C**	**0.202D**	**0.174D**	

Different lowercase letters within the rows and columns indicate significant differences for the interactions between the five treatments and storage periods at level P = 0.05; Different capital letters within the column indicate statistically significant differences at level P = 0.05 between the means effect of treatments in the same period, and within the row between the periods in the same treatment.

POD and PPO activities:

Effects of salicylic acid, Aloe Vera gel, calcium chloride and ethanol treatments on POD and PPO enzymes are presented in **Figs. (1 and 2).** PPO and PPO increased in treated and control clusters with prolonging storage periods during both seasons. In both seasons, the treatments significantly reduced POD and PPO compared to the control. Salicylic acid had the lowest level of POD and PPO activity, followed by Aloe Vera gel, ethanol, and calcium chloride. Evaluating the interaction effect between storage periods and the tested treatments, results show that the interactions of four weeks cold storage period, salicylic acid, Aloe Vera gel, ethanol and calcium chloride registered lower values of PPO and PPO activities compared to SO_2, especially salicylic acid in both seasons.

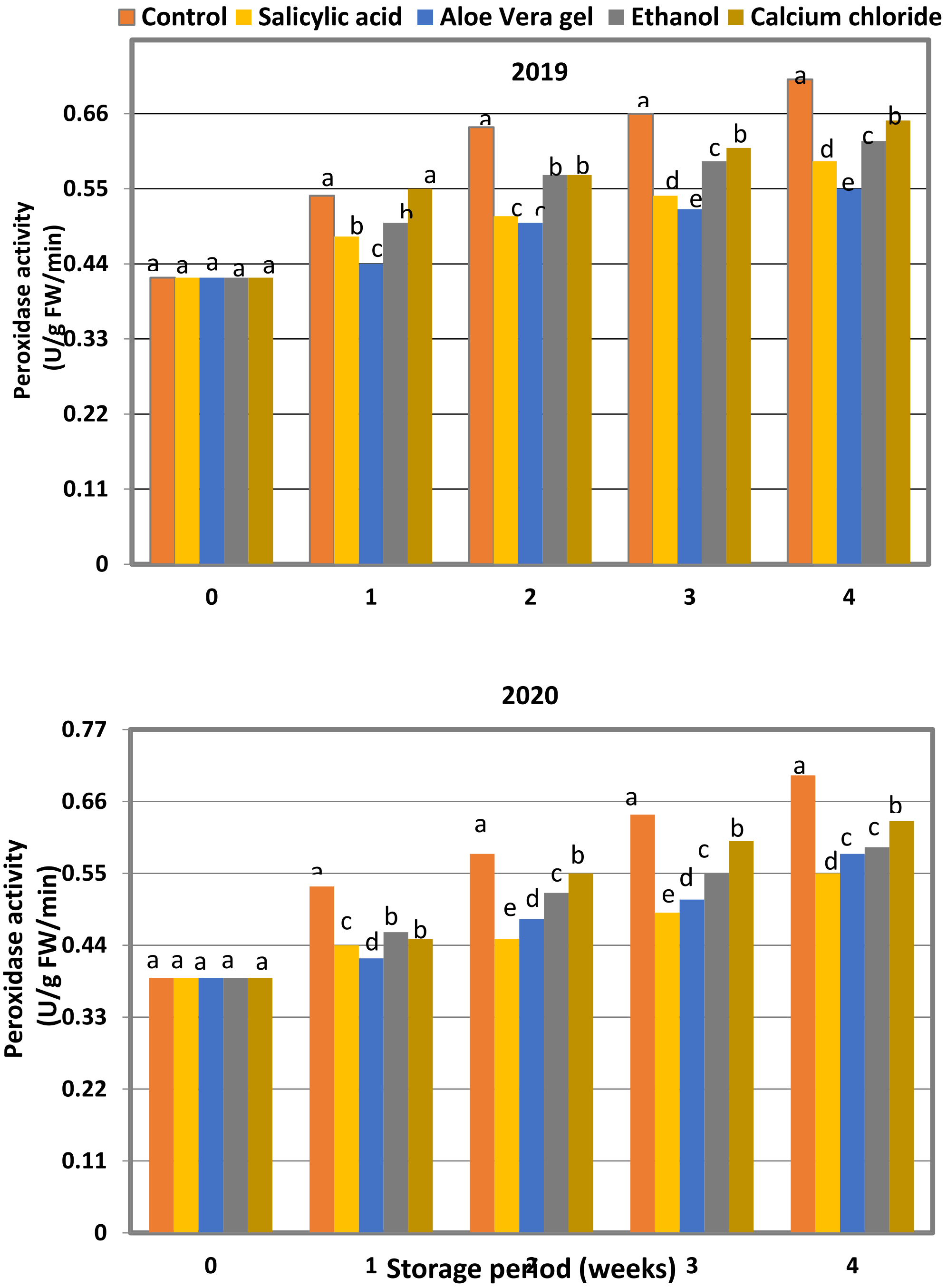

Fig. 1 Effect of some postharvest applications on peroxidase activity of Flame Seedless grape fruits during cold storage at 0°C and 85- 90% RH. Similar letters in the same period show are not significantly differences between treatments according to Duncan's multiple range tests at level P = 0.05

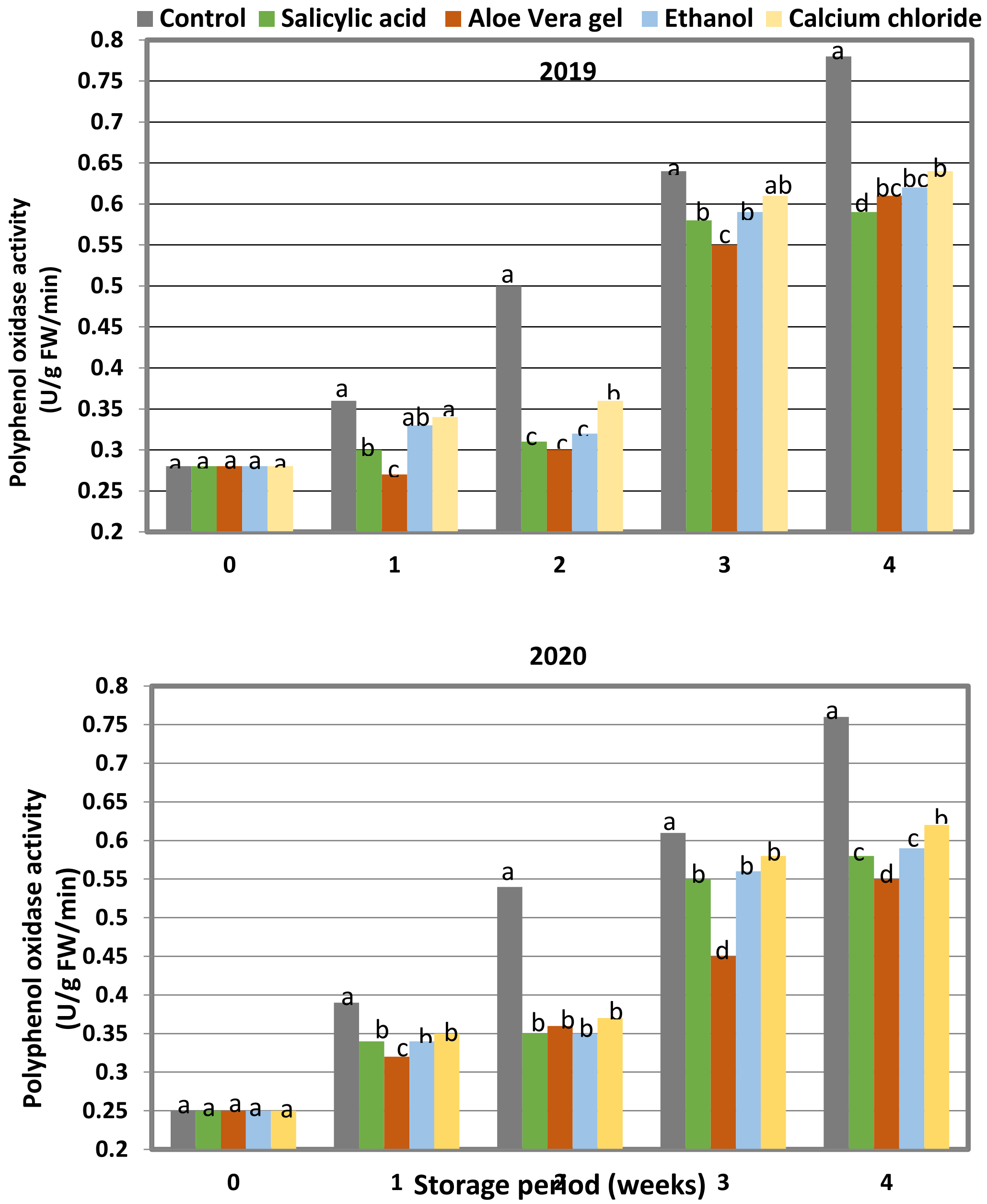

Fig. 2 Effect of some postharvest applications on polyphenol oxidase activity of Flame Seedless grape fruits during cold storage at 0°C and 85- 90% RH. Similar letters in the same period show are not significantly differences between treatments according to Duncan's multiple range tests at level P = 0.05

DISCUSSION

Results of the present study suggested that dipping Flame Seedless grape in 2 mmol L^{-1} salicylic acid or Aloe Vera gel 20% (w/v) or spraying with ethanol 10% or calcium chloride 1% significantly enhanced storage life compared to control (SO_2). This results agree with the findings of (Abd Elwahab *et al.*, 2014) they found that, ethanol and calcium chloride were not negatively effect on quality attributes of berries like; firmness, total soluble solids %, acidity, TSS/acid ratio, pH, Ascorbic acid, total phenols and soluble tannins. However, in the current investigation, application of SA or *Aloe vera* gel was more effective than spray of both CC and ethanol in overall quality characteristics; weight loss %, firmness, color, and SSC %, TA %, PPO and POD of Flame Seedless berries during cold storage period. These findings are consistent with (Asghari *et al.*, 2013; Peyro *et al.*, 2017). Salicylic acid treatment significantly increased the storage life and overall quality of Flame Seedless grapes, most likely by influencing secondary metabolites as well as antimicrobial and antioxidant properties (Asghari *et al.*, 2013). Previous studies had demonstrated that application of SA delayed ripening by reducing ethylene production (Peyro *et al.*, 2017) decreased fruit softening rate by affecting the activity of major cell wall degrading enzymes activity like cellulase, polygalacturonase and xylanase (Ranjbaran *et al.*, 2011), caused phenolic compound accumulation, delayed discoloration with browning inhibition and increased resistance to chilling injury (Wang *et al.*, 2006). Furthermore, (Qin *et al.*, 2003) shown that SA has been to increase the antioxidant capacity of cells by stimulating the synthesis of antioxidant enzymes and catalyzing PPO activity. The decrease in percentage of weight lost and maintain firmness during cold storage in clusters treated by Aloe Vera gel may be due to that the coating made a barrier to O_2 and CO_2 in the surface of berry, and enabled epidermal tissues to control water loss and reduce respiratory exchange, as well as contains antimicrobial compounds, and thus prevents decay, browning, softening, growth of yeast and molds, and improved textural quality (Bagheri *et al*., 2015).

Application of salicylic acid or Aloe Vera gel in 4 weeks increased the percentage of SSC to the highest level. SSC may augment during fruit ripening because of the action of sucrose-phosphate synthase (SPS), a key enzyme in sucrose biosynthesis. The enzyme activity is under the influence of ethylene and the ripening process itself during storage. (Asghari *et al*., 2013) suggested that salicylic acid reduced ethylene production and this may cause decrease in SPS enzyme activity leading to decrease in sucrose synthesis. Meanwhile, the increase in concentration of SSC during storage in fruit treated by Aloe Vera gel this is may be because of modified atmospheric conditions created by this coating which caused decrease of respiration, slowing down metabolism activity, and delay in the ripening process and senescence (Ergun and Satici, 2012). Moreover, it helps on retain volatile compounds, taste and aroma (Zafari *et al*., 2015; Thanaa *et al*., 2019).

The catalytic activity of enzymes such as PPO and POD increases during the fruit ripening process and senescence (Bowler *et al.*, 1992). Increased POD and PPO activities can decrease the fruit quality significantly by causing browning, loss of sensorial characteristics such as color, smell, and texture, and loss of nutrients during storage (Simes *et al., 2015*). Therefore, the activities of PPO and POD of Flame Seedless grape were evaluated during storage periods. The results indicated that all postharvest treatments significantly enhanced the activities of PPO and POD through delaying the increase in their activity during storage periods. At the end of the storage periods, clusters treated with salicylic acid presented the lowest values of PPO and POD activity compared with the other treatments. This may be due to the interaction of salicylic acid with the enzymes mentioned above, resulting in high levels of H_2O_2 accumulating in the cells, which leads to the fruit's resistance against pathogens by activating protective enzymes and PR-proteins (Asghari *et al.,* 2013). These results were supported by Peyro *et al.* (2017), who demonstrated that application of SA significantly reduced the activity of PPO and POD compared to the control.

CONCLUSION

In this study, results indicated that the treated clusters of Flame Seedless grape with salicylic acid (2 mmol L^{-1}) or *Aloe vera* gel (20 w/v) were more effective in maintaining quality and reducing PPO and POD enzyme activity of grape fruits during cold storage at 0°C and 85–95% RH for 4 weeks. Therefore, it can be recommended as a safer natural alternative to both humans and the environment to synthetic fungicides and sulphur dioxide to reduce postharvest decay and improve the quality of Flame Seedless table grapes.

REFERENCES

Romanazzi, G., & Awad, M. (2014). Using safe alternatives for controlling postharvest decay, maintaining quality of Crimson seedless grape. *World Applied Sciences Journal*, *31*(7), 1345-1357.

AOAC (Association of Official Analytical Chemists). (1990). Official methods of analysis.

Asghari, M., Ahadi, L., & Riaie, S. (2013). Effect of salicylic acid and edible coating based aloe vera gel treatment on storage life and postharvest quality of grape (*Vitis vinifera* L. cv. Gizel Uzum). *International Journal of Agriculture and Crop Sciences (IJACS)*, *5*(23), 2890-2898.

Bagheri, M., Esma-Ashari, M.,& Ershadi, A. (2015) Effect a porta rest calcium chloride Lestmenten storage and quaky of person fruits cv. Karaj. *International Horticulture Science and Technology*, (26),15-26.

Bowler, C., Montagu, M. V., & Inze, D. (1992). Superoxide dismutase and stress tolerance. *Annual Review of Plant Biology*, *43*(1), 83-116.

Clemente, E. (1998). Purification and thermostability of isoperoxidase from oranges. *Phytochemistry*, *49*(1), 29-36.

Doğan, M., Arslan, O., & Doğan, S. (2002). Substrate specificity, heat inactivation and inhibition of polyphenol oxidase from different aubergine cultivars. *International Journal of Food Science & Technology*, *37*(4), 415-423.

Domingues, A. R., Roberto, S. R., Ahmed, S., Shahab, M., José Chaves Junior, O., Sumida, C. H., & De Souza, R. T. (2018). Postharvest techniques to prevent the incidence of Botrytis mold of 'BRS Vitoria'seedless grape under cold storage. *Horticulturae*, *4*(3), 17.

Ergun, M., & Satici, F. (2012). Use of *Aloe vera* gel as biopreservative for 'Granny Smith'and 'Red Chief'apples. *Journal of Animal and Plant Sciences*, 22, 363–368.

Fatma, K. M. Shaaban, El-Hadidy, G. A. M., & Thanaa, Sh. M. Mahmoud (2020). Effects of salicylic acid, putrescine and moring leaf extract application on storability, quality attributes and bioactive compounds of plum cv.'Golden Japan'. *Future of Food: Journal on Food, Agriculture and Society*, *8*(2). July

Leong, S. L. L., Hocking, A. D., Pitt, J. I., Kazi, B. A., Emmett, R. W., & Scott, E. S. (2006). Australian research on ochratoxigenic fungi and ochratoxin A. *International Journal of Food Microbiology*, *111*, S10-S17.

Mansour, A.H.A., Ghada, A.M.,& Asmaa, A.M. (2018) Evaluation of natural oils impact on Flame Seedless grape quality at harvest and storage marketing process. *Asian Journal of Biological Sciences*, 11, 228-235.

Mc Gire, R. G. (1992). Reporting of objective color measurements. *HortScience*, *27*(12), 1254-1255.

Mohsen, F. S. (2021). Effect of some rootstocks on the performance of flame seedless grapevines. *Egyptain Journal of Horticulture* 48, 1-8.

Peyro, H., Mirjalili, S. A., & Kavoosi, B. (2017). Effect of salicylic acid and aloe vera gel on postharvest quality of table grapes (*Vitis Vinifera*). *Trakia Journal of Sciences*, *15*(2), 154-159.

Qin, G. Z., Tian, S. P., Xu, Y., & Wan, Y. K. (2003). Enhancement of biocontrol efficacy of antagonistic yeasts by salicylic acid in sweet cherry fruit. *Physiological and Molecular Plant Pathology*, *62*(3), 147-154.

Ranjbaran, E., Sarikhani, H., Wakana, A., & Bakhshi, D. (2011). Effect of salicylic acid on storage life and postharvest quality of grape (*Vitis vinifera* L. cv. Bidaneh Sefid). *Journal of the Faculty of Agriculture, Kyushu University*, *56*(2), 263-269.

Romanazzi, G., Smilanick, J. L., Feliziani, E., & Droby, S. (2016). Integrated management of postharvest gray mold on fruit crops. *Postharvest Biology and Technology*, *113*, 69-76.

Martínez-Romero, D., Guillén, F., Valverde, J. M., Bailén, G., Zapata, P., Serrano, M., Castillo, S., & Valero, D. (2007). Influence of carvacrol on survival of Botrytis *cinerea* inoculated in table grapes. *International Journal of Food Microbiology*, *115*(2), 144-148.

Simões, N., Moreira, S.I., Mosquim, P.R., Nilda de Fátima, F.S.& Puschmann, R. (2015) The effects of storage temperature on the quality and phenolic metabolism of whole and minimally processed kale leaves Adriano do. *Acta Scientiarum Agronomy Maringá*, 37(1): 101-107.

Snedecor, G.W., & Cochran, W.G. (1980) Statistical Methods. 6th the Iowa State Univ Press Ames USA pp 593.

Sonker, N., Pandey, A. K., & Singh, P. (2015). Efficiency of Artemisia nilagirica (Clarke) Pamp. essential oil as a mycotoxicant against postharvest mycobiota of table grapes. *Journal of the Science of Food and Agriculture*, *95*(9), 1932-1939.

Thanaa, Sh. M. Mahmoud, Abd El-Moniem, E. A., Yousef, A. R., & Saleh, M. M. S. (2019). Enhancing storage efficiency of pomegranate fruits using aloe vera gel and some natural oils. *Plant Archives*, *19*(2), 188-193.

Wang, L., Chen, S., Kong, W., Li, S., & Archbold, D. D. (2006). Salicylic acid pretreatment alleviates chilling injury and affects the antioxidant system and heat shock proteins of peaches during cold storage. *Postharvest Biology and Technology*, *41*(3), 244-251.

Zafari, E., Mohammadkhani, A., Roohi, V., Fadaei, A., & Zafari, H. (2015). Effect of exogenous putrescine and Aloe vera gel coating on post-harvest life of strawberry (*Fragaria ananassa* Duch.) fruit, cultivar Kamarosa. *International Journal of Agriculture and Crop Sciences (IJACS)*, *8*(4), 578-584.

تحسين القدرة التخزينية لعنب الفيليم سيدليس بواسطة بعض تطبيقات ما بعد الحصاد

ثناء شعبان محمد محمود [١] ، جيهان عبد الملك الحديدى [٢] ، ناهد أحمد أحمد محمد [٢] ، منال عباس الجندي [٣]
[١] .قسم تكنولوجيا الحاصلات البستانية - معهد البحوث الزراعية و البيولوجية – المركز القومى للبحوث ٣٣ ش البحوث، الدقي، الجيزة، مصر.
[٢] .معهد بحوث البساتين - مركز البحوث الزراعية – مصر.
[٣] .معهد بحوث تكنولوجيا الأغذية - مركز البحوث الزراعية – مصر.
بريد المؤلف المراسل: thanaa_3000@yahoo.com

الملخص

يمكن لمعاملات ما بعد الحصاد بإستخدام البدائل الآمنة أن تقلل من تلف العنب و المحافظة على صفات الجودة دون التأثير السلبي على كل من المستهلكين والبيئة. لذلك ، تم اختبار استجابة عنب الفيليم سيدليس لبعض تطبيقات ما بعد الحصاد باستخدام حمض الساليسيليك بتركيز2مليمول/ لتر ، و جل الصبار بتركيز 20 ٪ (وزن / حجم) ، و الإيثانول بتركيز 10٪ ، وكلوريد الكالسيوم بتركيز 1 ٪ مقارنة مع الكنترول (المعامل بالتبخير بـ ثانى أكسيد الكبريت) تحت ظروف التخزين البارد عند 0 درجة مئوية و رطوبة نسبية 85-90 % لمدة 4 أسابيع.

أوضحت النتائج أن المعاملات المختبرة خفضت من نسبة الفقد فى الوزن ، وتأخير التغيرات التى تحدث في الصلابة ،و نسبة المواد الصلبة الذائبة ، ونسبة الحموضة الكلية ،كما أدت أيضا إلى تقليل نشاط إنزيمات البوليفينول أوكسيديز و البيروكسيديز خلال فترات التخزين خاصة المعاملة بحمض الساليسيليك و جل الصبار بالمقارنة مع الثمار المعاملة بـ ثانى أكسيد الكبريت. و لذلك يمكن الاستنتاج بأن معاملة الفيليم سيدليس بحمض الساليسيليك بتركيز 2 مليمول / لتر أو جل الصبار بتركيز 20٪ (وزن / حجم) بديل آمن وصحي للتبخير بـ ثانى أكسيد الكبريت من أجل إطالة عمر تخزين عنب المائدة والحفاظ على جودته أثناء التخزين البارد.

الكلمات المفتاحية: عنب المائدة، الفيليم سيدليس، حمض الساليسيليك، جل الصبار، الإيثانول ، كلوريد الكالسيوم ، ثانى أكسيد الكبريت، إنزيم البوليفينول أوكسيديز، إنزيم البيروكسيديز ، جودة ما بعد الحصاد ، التخزين البارد.