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IMPACT OF SOME POSTHARVEST TREATMENTS WITH SALICYLIC ACID AND ESSENTIAL OILS ON DELAYING RIPENING AND CONTROL DECAY OF WILLIAMS BANANA FRUITS

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ABSTRACT

This experiment was carried out during 2012 and 2013 seasons on Williams banana fruits to study the effect of postharvest treatments with salicylic acid (SA)at 500 and 1000 uM for 5 min. and cinnamon (CM) oil at 0.3% or 0.1% (*V/V*) for 5min. for each and storing fruits at 13°C under 85 – 90% RH., to delay ripening and control decay of banana fruits. Decay, weight loss, firmness, color, total soluble solids, vitamin C, titratable acidity and carotenoids were also determined .The results indicated that there was no decayed fruits with all treatments until 21 days. It is also clear that both CM oil and SA treatments kept good appearance for treated fruits but untreated fruits became unattractive as a result of loss of its appearance.CM treated fruits at 0.3% (*V/V*) and SA treated ones at 1000 uM and stored at 13°C had lower percentage of weight loss compared with all other treatments in both seasons. CM at 0.1% (*V/V*) and SA at 1000 uM treatments had higher firmness and color index. SA treatments lowered significantly the soluble solids contents compared with all other treatments in both seasons. SA at 500 uM and CM at 0.3 or 0.1% (*V/V*) and control fruits had higher content of vitam. C and carotenoids. All other treatments had no significant effect on titratable acidity (TA) percentage in both seasons. In both seasons, firmness, vitam. C, TA were significantly decreased by the advancing of storage period. On the other hand, decay, weight loss, peel color, soluble soilds increased with storage period, but carotenoids content of fruits were increased in the beginning and decreased at the end of storage periods at 13°C.

Key words: Postharvest, salicylic acid, cinnamon oil, ripening, control decay, banana.

INTRODUCTION

Banana fruits *Musa* sp. is one of the major fruits in Egypt, has now moved from backyard to commercial production, with an annual production of 1.1 million tons for the local market. Banana being a delicate and highly perishable fruit, the local production is subjected to serious postharvest losses, mainly due to poor handling and storage practices and postharvest diseases (Ramma *et al*., 1998). Consumers demand high quality of food they consume such demands include taste, appearance or shape of banana. As it is known, food safety has become a very significant issue, particularly after the food scares in Europe. Consumers want to be informed about the food they are consuming through appropriate labeling and tracking and traceability schemes. Storage of banana is made difficult by the growth of fungi which cause postharvest diseases such as anthracnose and crown rot. The average postharvest loss of banana due to postharvest diseases, mechanical damage and improper storage (during1998) was 20%. Crown rot is a disease complex caused by the pathognic fungi *Colletorichum musae*, *Lasiodiploidia obromae*, *Fusarium proliferatum* and *Verticillium* sp. (Stour, 1972; Finaly and Brown, 1993; Ploetz *et al.*, 1994). Essential oils alternative postharvest treatments that are

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chemical free and toxic and acceptable to consumers. Essential oils are complex volatile compounds produced in different plant parts. *Cinnamomum zeylanicum* L., commonly known as cinnamon, is endemic to Sri lanka, cinnamon bark oil is rich in cinnamaldehyde.

Apart from these, B-Caryophylene, Linalool and other terpenese are present (Paranagama, 1991). *Syzygiumaro maticum* L. *Merretl*. Perry Contains a high percentage of eugenol, which has bean identified as compound exhibiting antifungal properties (Paranagama, 1991; Garg and Siddigui, 1992).

Salicylic acid (SA) is an important component in the signal transduction pathway and is also involved in local and systemic resistance to pathogens. Exogenous application of SA at non toxic concentrations could enhance the resistance of fruits to pathogens. Future studies should focus on the mechanisms of action of SA in systemic resistance of fruits using molecular.

The aim of the present work was to study the effect of salicylic acid (SA) and essential oil (Cinnamon) (CM) on ripening and decay of Williams banana fruits under safe temperature (13°C) to extend the storage life of mature green fruits.

MATERIALS AND METHODS

This investigation was carried out during 2012 and 2013 seasons on Williams banana fruits (*Musas* sp.). Bunches were harvested from plants grown in private orchards at El-Kanater' Horticulture Researches Station at mature green stage. Mature banana fruits for both seasons were harvested in first half of January (three quarter full 122 days after shooting and bunch weighted 23 – 27 Kg) with light green color (Stover and Simmonds, 1987). Bunches were immediately transported to the laboratory of Handling and postharvest at Hort. Res. Inst. of ARC at Giza, Egypt. Bunches were sorted for size uniformity and absence of defects. Sound selected Bunched banana were washed using fresh tap water and air dried. Then bunches were de-handed and each hand was divided into two parts, each part contained six fingers.

Banana handed received one of the following treatments as follows:

1. Dipping fruits in SA at 1000 uM for 5 min.,
2. Dipping fruits in SA at 500 uM for 5 min.,
3. Dipping fruits in CM at 0.3% (*V/V*) for 5 min.,
4. Dipping fruits in CM at 0.1%(*V/V*) for 5 min., and
5. Control (untreated fruits).

Each treatment was packed in three carton boxes at the dimensions of (50 × 30 × 20 cm), each box contained two half hands, represented one replicate and all treatments were stored at 13°C.

The changes in physical and chemical properties of fruits were followed up each seven days interval through the experimental period as follows:

Physical Characteristics

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

$$\text{Weight loss (\%)} = \frac{\text{Initial weight-weight at sampling date}}{\text{Initial weight}} \times 100$$

Ten fruits were labeled in each replicate and initially weighed to calculate the fruits weight loss percent during the cold storage in relation to its original weight

Decay Percentage

Incidence and external fruit appearance was estimated according to the following equation:

$$\text{Decay (\%)} = \frac{\text{Weight of decayed fruit}}{\text{Initial weight}} \times 100$$

Peel Color

Peel color fruit was measured by averaging two measurements taken on two opposite points of each fruit equator with a Minolta colorimeter (Minolta Co. Ltd., Osaka, Japan) on the basis of the CIELAB color system. In this system values of (a and b) specify the green-red and blue-yellow axis, while Hue (h°) determines the position of such vector. h° values were calculated based on a and b values according to the following equation: - $h° = 180 - \tan^{-1}(b/a)$. Values were determined and calculated according to McGuire (1992).

Firmness (g/cm^2)

Pulp texture: was determined by Lifra texture analyzer instrument using a penetrating cylinder of 1 mm in diameter, to a constant distance (2 mm) inside the pulp of fruits, and by a constant speed 2 mm per sec., and the peak of resistance was recorded per g.

Chemical Properties

Soluble solids content (SSC)

The obtained juice was used to determine the percentage of soluble solids content (SSC) by the use of a hand refractometer according to Chen. and Mellenthin (1981)

Titratable acidity (%)

Total acidity was determined by titrating 5 ml of the extracted juice against 0.1 N of NaOH using phenolphethalin indicator, titratable acidity was expressed as percentage of malic acid (g malic acid/100ml juice) according to AOAC (2005).

Ascorbic acid content

Five ml of sample of fruit juice + 5 ml metaphosphric acid were added to each sample was titrated with 2.6 dichlorophenolindophenol solution. Ascorbic acid content was expressed as milligrams of ascorbic acid per 100ml of fruits juice, according to AOAC (2005).

Carotenoids content

Carotenoids content of fruits pulp was extracted by direct dipping of 10 g of blended fruit pulp into solution containing 40 ml acetone, 60 ml hexane and 0.1 g Mg $C0_3$ and blended for 5 min., to determine by colorimeter according to AOAC (2005).

Statistical Analysis

The experimental design was factorial randomized complete block design (RCBD) with three replicates, and all the obtained data were statistically analyzed according to Snedecor and Cochran (1980). The individual comparisons were carried out by using the least significant difference (LSD) according to SAS Program (1985).

RESULTS AND DISCUSSION

Physical Characteristics

Fruit weight loss percentage

From the tabulated data in Table1it was noticed that weight loss percentages decreased in fruits which dipped in SA at 1000 µM and those dipped in CM at 0.3% (*V/V*) compared with all other treatments in both seasons. These results were in line with (Kazemi *et al.*, 2011) on apple, Shafie *et al.* (2010) on strawberry and Sarikhani *et al*. (2009) on grapes .The result of salicylic acid (SA) may be attributed to the decrease of respiration rate and weight loss through inhibition of ethylene biosynthesis (Srivastava and Dwiviedi, 2009) and closing stoma (Zheng and Zhang, 2004).

Cinnamon oil (CM) reduced significantly weight loss percentage. This result agree with that of Maqbool *et al.* (2011) on banana and papaya. The weight loss percentage was gradually increased as an average for all treatments by increasing the storage period. The differences among all storage periods were significant in both seasons of study. The weight loss attributed mainly to water loss from the fruit tissues and partially for the respiration and the higher storage temperature. The later result agree with those reported by El-Yaten and Kader (1984), Lopez *et al*. (2003), El-Saedy and El-Naggar (2005).

Fruit firmness

Data presented in Table 2 show that, in the two seasons, there were no significant differences between fruits dipped in SA at 1000 uM and those treated with CM oil at 0.3% compared with fruits dipped in SA at 500 uM and fruits treated with CM oil at 0.1%. This result was supported with Sartaj *et al.* (2013) on apricot. There were significant differences between control and all treatments. This result agreed with that of Lakshmie *et al*. (2005) and Zahra and El-Shadi (2013).

Oil CM significantly delayed fruit firmness and this result agreed with Maqbool *et al*. (2011) on banana and papaya.

Table 1. Effect of postharvest application of salicylic acid (SA) and cinnamon (CM) oil on weight loss percentage of banana fruit during 2012 and 2013 seasons

	Season (2012)	Period of storage (weeks)			
Treatment	**1**	**2**	**3**	**4**	**Means (B)**
SA 1000uM	0	4.33	12.26	43.06	14.91 b
SA 500uM	0	3.89	9.23	29.20	10.58 c
CM at 0.3% *V/V*	0	6.21	15.36	20.71	10.57 c
CM at 0.1% *V/V*	0	7.81	17.17	46.68	17.92 a
Control	0	9.47	22.81	24.32	14.15 b
Means (A)	0 d	6.34 c	15.37 b	27.93 a	
	Season (2013)	**Period of storage (weeks)**			
Treatment	**1**	**2**	**3**	**4**	**Means (B)**
SA 1000uM	0	7.70	13.06	44.60	16.34 b
SA 500uM	0	10.22	17.00	23.75	12.74 c
CM at 0.3% *V/V*	0	10.98	19.34	23.48	13.45 d
CM at 0.1% *V/V*	0	11.99	18.40	47.81	19.55 a
Control	0	10.76	26.80	28.52	16.52 b
Means (A)	0 d	10.33 c	18.92 b	27.93 a	

L.S.D	**A**	**B**
2012	13.00	4.52
2013	9.11	4.66

Table 2. Effect of postharvest application of salicylic acid (SA) and cinnamon (CM) oil on firmness of banana fruit during 2012 and 2013 seasons

	Season (2012)	Period of storage (weeks)			
Treatment	**1**	**2**	**3**	**4**	**Means (B)**
SA 1000UM	294.00	271.33	75.50	65.00	176.46 b
SA 500uM	294.00	283.50	82.67	72.50	183.167 ab
CM at 0.3% *V/V*	294.00	277.67	101.00	85.67	189.58 ab
CM at 0.1% *V/V*	294.00	279.83	75.00	65.17	178.50 ab
Control	294.00	288.00	70.00	53.00	176.25 ab
Means (A)	294.00 a	280.07 b	80.26 c	68.26 c	
	Season (2013)	**Period of storage (weeks)**			
Treatment	**1**	**2**	**3**	**4**	**Means (B)**
SA1000uM	285.33	258.17	74.67	62.67	170.21 a
SA 500uM	285.33	250.83	80.00	70.50	171.67 a
CM at 0.3% *V/V*	285.33	267.00	99.33	82.83	183.63 a
CM at 0.1% *V/V*	285.33	256.83	80.33	62.00	171.13 ab
Control	285.33	256.16	50.67	42.50	158.66 b
Means (A)	285.33 a	257.80 b	77.00 c	64.10 c	

L.S.D	**A**	**B**
2012	12.26	13.71
2013	18.21	20.36

Fruit firmness of all treated fruits was decreased with the duration in cold storage in both seasons. Similar results were found by Rippon and Trochoulias (2007) and Yassin and Tayel (2011). As a conclusion, loss in fruits firmness with the decomposition progress of storage period is mainly due to, enzymatic degredation of insoluble protopectins to more simple soluble pectin, solubilization of cell and cell wall contents as a result of the increasing in pectin esterase activity and subsequent development of juiciness and loss in peel and pulp hardness. These results were in agreement with those previously found by many researchers such as Ponomarev (1968) and Siddiqui *et al*. (1996).

Peel color

The tabulated date in Tables 3 and 4 showed the tendencies of external color changes as Hue angle (h^o) and (L) values of banana fruits. Fruits were dipped in salicylic acid (SA) at 1000 uM and those treated with Cinnamon oil(CM)at 0.1 had the highest change percentages of (L)value after 21 days ranged from 50.45 to 51.95% in the first season and 52.51 to 52.86% in the second one without significant differences between these two treatments in both seasons, compared with other treatments and control. On the other hand, percentage of (h^o) value showed no significant differences among all treatments in both seasons.

The visual observations of the external fruit color in this work showed that peal color was changed with the progress of the storage period and that was faster at 13^{o}C.The green fruits changed to the yellowish green and to the yellow color. In the two seasons the percentages of (L) value were significantly increased during storage periods whereas the percentages of (h^o) value were significantly decreased. These results supported that of Nurul and Mosharraf, 2012. The fruit color is one of the main attributes of banana fruits, which can determine the consumer acceptability and serving as an indicative of the harvest point of some fruits (Silva *et al*., 2009)

Decay percentage

Data in Table 5 indicate that, fruits treated with salicylic acid either at 500 or 1000 µM did not show any decay symptoms until the end of storage period at 13^{o}C in both seasons. In the first season fruits treated with Cinnamon oil (0.3 or 0.11) recorded decay percentage of 12.12 and 26.01% by the end of storage period due to cigar end tip rot. In the second season, decay percentage recorded (15.30%) and (20.18%). In both seasons control fruits recorded the highest decay percentage (62.18 and 50.10%) due to crown rot, the fruits were black at the crown tissues and spreads to the pulp through the pedicel, resulting rotting of the infected portion and separating the fingers from the hand

These results agree with Ranasinghe *et al*. (2002), Lakshmie *et al*. (2003), Suslali *et al*. (2004), Kyukyuwin *et al*. (2007) and Tian *et al*. (2007).

Chemical Characteristics

Soluble solids contents (SSC)

The data illustrated in Table 6 showed that soluble solids contents SSC in control (untreated) fruits were significantly higher compared with all other treatments in both seasons. Fruits dipped in salicylic acid (SA) at 1000µM had lowest SSC compared with all treatments in both seasons. These results agree with Sirvastava and Dwivedi (2000) on banana, Maqbool *et al.* (2011) on banana and papaya, and Muhammad *et al*. (2012) on peach. Fruits treated with cinnamon oil (CM) significantly delayed soluble solids percentage especially at 0.1 contained higher SSC than those treated with salicylic acid but lower than untreated fruits.

The data in Table 6 pointed out also that there was gradually and significantly increase in soluble solids concentration in both seasons. Since the SSC in the fruits by the end of storage period was more than three folds of its initial value at the beginning of the storage period. The above findings are in harmony with those of Lopez *et al*. (2003) on cactus pear and David and Whyte (2009) who reported that the increment in SSC in the fruit pulp as the storage period extends could be due to degradation of the complex in soluble compounds like sugars that are the major component of SSC content.

Vitamin (C)

The obtained data in Table 7 show that ascorbic acid content values of Williams banana, in both seasons were significantly higher with fruits which were treated with salicylic acid 500 uM and in untreated fruits without significant differences between other treatments , except

Table 3. Effect of postharvest application of salicylic acid (SA) and Cinnamon (CM) oil on color (L) value of banana fruit during 2012 and 2013 seasons

	Season (2012)		Period of storage (weeks)		
Treatment	**1**	**2**	**3**	**4**	**Means (B)**
SA 1000UM	35.70	50.90	62.10	59.10	51.95 a
SA 500UM	35.70	47.07	54.23	56.10	48.27 c
CM at 0.3% *V/V*	35.70	48.83	55.10	55.83	48.87 cb
CM at 0.1% *V/V*	35.70	44.83	61.33	59.96	50.45 ab
Control	35.70	53.10	55.76	54.53	49.77 cb
Means (A)	35.70 c	48.94 b	57.71 a	57.11 a	
	Season (2013)		**Period of storage (weeks)**		
Treatment	**1**	**2**	**3**	**4**	**Means (B)**
SA1000UM	42.90	51.63	58.43	58.47	52.87 a
SA 500UM	42.90	48.67	51.97	55.63	49.79 b
CM at 0.3% *V/V*	42.90	49.40	54.67	54.20	50.29 b
CM at 0.1% *V/V*	42.90	47.27	61.00	58.87	52.51 a
Control	42.90	52.37	51.83	52.37	52.86 a
Means (A)	42.90 c	49.87 b	55.58 a	55.91 a	

L.S.D	**A**	**B**
2012	1.75	1.96
2013	1.64	1.83

Table 4. Effect of postharvest application of salicylic acid (SA) and Cinnamon (CM) oil on color (H) value of banana fruit during 2012 and 2013 seasons

	Season (2012)		Period of storage (weeks)		
Treatment	**1**	**2**	**3**	**4**	**Means (A)**
SA 1000UM	119.00	115.00	93.23	88.60	103.95 a
SA 500UM	119.00	115.00	89.63	90.83	103.62 a
CM at 0.3% *V/V*	119.00	112.00	91.70	89.63	103.17 a
CM at 0.1% *V/V*	119.00	114.00	89.33	89.80	103.12 a
Control	119.00	110.00	92.87	88.33	102.55 a
Means (A)	119.00 a	113.33 b	91.35 c	89.44 c	
	Season (2013)		**Period of storage (weeks)**		
Treatment	**1**	**2**	**3**	**4**	**Means (B)**
SA1000uM	118.00	114.00	91.63	77.47	100.28 a
SA 500UM	118.00	114.33	90.07	89.40	102.95 b
CM at 0.3% *V/V*	118.00	110.33	93.30	88.00	102.41 b
CM at 0.1% *V/V*	118.00	113.00	88.43	88.80	102.06 a
Control	118.00	105.67	93.03	88.40	101.28 a
Means (A)	118.00 a	111.47 b	91.29 c	86.41 d	

L.S.D	**A**	**B**
2012	2.21	2.46
2013	3.25	3.64

Table 5. Effect of postharvest application of salicylic acid (SA) and Cinnamon (CM) oil on decay percentage of banana fruit during 2012 and 2013 seasons

	Season (2012)	Period of storage (weeks)		
Treatment	**1**	**2**	**3**	**4**
SA500 UM	0.00	0.00	0.00	0.00
SA 1000 UM	0.00	0.00	0.00	0.00
CM at 0.3% *V/V*	0.00	0.00	0.00	12.12
CM at 0.1% *V/V*	0.00	0.00	0.00	26.01
Control	0.00	0.00	0.00	62.18
	Season (2013)	**Period of storage (weeks)**		
Treatment	**1**	**2**	**3**	**4**
SA 500 UM	0.00	0.00	0.00	0.00
SA 1000 UM	0.00	0.00	0.00	0.00
CM at 0.3% *V/V*	0.00	0.00	0.00	15.30
CM at 0.1% *V/V*	0.00	0.00	0.00	20.18
Control	0.00	0.00	0.00	50.10

Table 6. Effect of postharvest application of salicylic acid (SA) and Cinnamon (CM) oil on total soluble solids percentage of banana fruit during 2012 and 2013 seasons

	Season (2012)		Period of storage (weeks)		
Treatment	**1**	**2**	**3**	**4**	**Means (B)**
SA1000UM	4.00	6.67	11.67	13.00	9.92 c
SA 500UM	4.00	8.00	14.00	15.00	10.25 c
CM at 0.3% *V/V*	4.00	8.00	12.67	15.00	10.33 c
CM at 0.1% *V/V*	4.00	12.00	20.67	22.00	12.67 b
Control	4.00	6.00	17.00	23.67	14.66 a
Means (A)	4.00 d	8.13c	15.20 b	17.73 a	
	Season (2013)		**Period of storage (weeks)**		
Treatment	**1**	**2**	**3**	**4**	**Means (B)**
SA1000UM	5.00	8.00	12.67	14.00	9.92 c
SA 500UM	5.00	8.67	14.33	15.33	10.83 b
CM at 0.3% *V/V*	5.00	8.33	13.67	15.67	10.67 b
CM at 0.1% *V/V*	5.00	7.00	14.00	19.00	11.25 b
Control	5.00	7.33	15.00	23.33	12.66 a
Means (A)	5.00 d	7.87 c	13.93 b	17.47 a	

L.S.D	**A**	**B**
2012	0.85	0.95
2013	1.02	1.15

fruits were treated with salicylic acid at 1000 uM which gained the lowest value. The above mentioned results agree with those of Bal and Celik (2010) on Kiwi fruit. Ascorbic acid content was sharply decreased from the beginning till the end. These results are in line with those observed by Nurul and Mosharraf (2012) on banana fruits.

The reduction in vitamin C content during ripening might be attributed to the oxidation of ascorbic acid as ripening proceeded .In the untreated fruits, vitamin C content was higher than those of the treated banana throughout the ripening phase and vitamin C was perhaps not fully oxidized leading to maximum vitamin C content at full ripening stage.

Titratable acidity (TA)

The changes in titratable acidity of banana fruits in the two seasons of the study are presented in Table 8. Generally, there were no significant differences among all treatments indicating that the tested treatments insignificantly affected TA percentage in banana fruits in both seasons. The obtained results are in agreement with Maqbool *et al.* (2011) and Muhammad *et al.* (2012). It was noticed significant decrease of TA values in both seasons during storage periods.

The data pointed out also that there was slight decrease in TA percentage as storage period advanced which could be due to the increase of its consumption in respiration activities as an organic substrate. This result agreed with those reported by Chen and Mellenthin (1981), Abd El-Migid (1986) on pear and El-Seidy (2000) on peach, Nurul and Mosharraf (2012) on banana and Muhammad *et al*. (2012) on peach.

Carotenoids

The data presented in Table 9 indicate that, in both seasons, fruits carotenoids content was significantly higher in all treatments compared with treated fruits with salicylic acid at 500 uM. This result agreed with Muhammad *et al*. (2012) on peach. On the other hand, Paula *et al*. (2012) on Papaya reported that essential oil did not affect color of papaya during the storage period. It was noticed that carotenoids content were significantly increased in the beginning of storage period but thereafter decreased significantly in both seasons. Similar results were found by Boon and Kanlayanarats (2009) on banana fruits, Rippon and Trochoulias (2007) and Clara *et al*. (2003).

Table 7.Effect of postharvest application of salicylic acid (SA) and Cinnamon (CM) oil on vitamin C (100 mg/ml) of banana fruit during 2012 and 2013 seasons

	Season (2012)	Period of storage (weeks)			
Treatment	**1**	**2**	**3**	**4**	**Means (B)**
SA 1000UM	137.50	46.67	36.00	42.00	65.54 b
SA 500UM	137.50	63.33	36.00	51.00	71.96 ab
CM at 0.3% *V/V*	137.50	56.67	51.00	36.00	70.29 ab
CM at 0.1% *V/V*	137.50	66.67	39.00	39.00	70.54 ab
Control	137.50	66.67	51.00	45.00	75.04 a
Means (A)	137.50 a	60.00 b	42.60 c	42.60 c	
	Season (2013)	**Period of storage (weeks)**			
Treatment	**1**	**2**	**3**	**4**	**Means (B)**
SA 1000UM	141.67	45.00	40.50	42.00	67.29 b
SA 500UM	141.67	68.33	46.50	60.00	79.13 a
CM at 0.3% *V/V*	141.67	60.00	64.50	37.50	75.92 ab
CM at 0.1% *V/V*	141.67	65.00	43.50	48.00	74.54 ab
Control	141.67	66.67	61.50	52.50	80.58 a
Means (A)	141.67 a	61.00 b	51.30 bc	48.00 c	

L.S.D	**A**	**B**
2012	7.95	8.89
2013	10.42	11.66

Table 8. Effect of postharvest application of salicylic acid (SA) and Cinnamon (CM) oil on titratable acidity percentage of banana fruit during 2012 and 2013 seasons

	Season (2012)		Period of storage (weeks)		
Treatment	**1**	**2**	**3**	**4**	**Means (B)**
SA1000UM	0.16	0.15	0.03	0.02	0.09 a
SA 500UM	0.16	0.15	0.02	0.04	0.09 a
CM at 0.3% *V/V*	0.16	0.15	0.01	0.03	0.08 a
CM at 0.1% *V/V*	0.16	0.14	0.02	0.04	0.09 a
Control	0.16	0.15	0.01	0.02	0.08 a
Means (A)	0.16 a	0.15 a	0.02 b	0.03 b	
	Season (2013)		**Period of storage (weeks)**		
Treatment	**1**	**2**	**3**	**4**	**Means (B)**
SA1000UM	0.06	0.05	0.04	0.02	0.04 a
SA 500UM	0.06	0.06	0.04	0.04	0.05 a
CM at 0.3% *V/V*	0.06	0.05	0.03	0.03	0.04 a
CM at 0.1% *V/V*	0.06	0.05	0.03	0.03	0.04 a
Control	0.06	0.05	0.03	0.03	0.04 a
Means (A)	0.06 a	0.05 a	0.03 b	0.03 b	

L.S.D	**A**	**B**
2012	0.14	0.09
2013	0.04	0.05

Table 9. Effect of postharvest application of salicylic acid (SA) and Cinnamon (CM) oil on carotenoids (100 mg/ml) of banana fruit during 2012 and 2013 seasons

	Season (2012)		Period of storage (weeks)		
Treatment	**1**	**2**	**3**	**4**	**Means (B)**
SA1000UM	8.04	20.12	10.13	18.86	14.29 a
SA 500UM	8.04	10.91	7.29	7.34	8.39 b
CM at 0.3% *V/V*	8.04	27.65	6.32	5.40	11.85 ab
CM at 0.1% *V/V*	8.04	34.25	6.30	7.10	13.92 a
Control	8.04	10.43	12.00	9.25	9.93 ab
Means (A)	8.04 b	20.67 a	8.41 b	9.59 b	
	Season (2013)		**Period of storage (weeks)**		
Treatment	**1**	**2**	**3**	**4**	**Means (B)**
SA 1000UM	10.61	20.23	10.98	18.29	15.03 a
SA 500UM	10.61	11.19	7.62	8.99	9.60 b
CM at 0.3% *V/V*	10.61	28.27	6.65	6.47	13.00 ab
CM at 0.1% *V/V*	10.61	35.18	6.52	5.86	14.54 a
Control	10.61	11.79	12.36	11.16	15.03 ab
Means (A)	10.61 b	21.33 a	8.83 b	10.16 b	

L.S.D	**A**	**B**
2012	4.23	4.72
2013	4.34	4.85

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تأثير بعض معاملات ما بعد الحصاد بحمض السلسليك والزيوت المعدنية على تأخير النضج والتحكم في عفن ثمار الموز صنف ويليامز

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أجريت هذه الدراسة خلال موسمي ٢٠١٢ - ٢٠١٣ علي ثمار الموز صنف ويليامز بهدف دراسة تأثير معاملات ما بعد الحصاد بغمس الثمار فى كلا من حمض السلسليك بتركيز ٥٠٠ ، ١٠٠٠ ميكرو مول لمدة ٥ دقائق وزيت القرفة بتركيز ٠,٣ و ٠,١% (حجمية/حجمية) لمدة ٥ دقائق ثم تخزينها علي درجة حرارة ١٣°م ورطوبة نسبية ٨٥-٩٠% لتأخير النضج والتحكم في عفن ثمار الموز، تم تقدير نسبة العفن ونسبة الفقد في الوزن والصلابة واللون والمواد الصلبة الذائبة الكلية وفيتامين ج والحموضة والكاروتينيات، وقد أظهرت النتائج أن الثمار المعاملة بحمض السلسليك وزيت القرفة لم تصب بالعفن حتى ٢١ يوما من التخزين وظلت الثمار ذات مظهر جيد بينما أصبحت ثمار الكنترول غير جذابة وحققت المعاملة بحمض السلسليك بتركيز ١٠٠٠ميكرومول والمعاملة بزيت القرفة بتركيز ٠,٣% أقل نسبة فقد في الوزن في الثمار مقارنة بالمعاملات الأخرى في كلا الموسمين، وكذلك أعطت المعاملة بحمض السلسيلك بتركيز ١٠٠٠ ميكرومول والمعاملة بزيت القرفة بتركيز ٠,١% أعلى نسبة معنوية في الصلابة واللون كما حققت معاملات حمض السلسليك بتركيز ٥٠٠ ، ١٠٠٠ ميكرومول أقل تأثير معنوي في محتوي المواد الصلبة الذائبة الكلية مقارنة بالمعاملات الأخرى والكنترول خلال موسمي التجربة وكان للمعاملات المختبرة تأثير على زيادة الثمار في كلا من محتوي فيتامين ج والكاروتينيات بينما لم يكن لها تأثير معنوي علي نسبة الحموضة في ثمار الموز خلال موسمي التجربة، كما وجد أن صلابة الثمار وفيتامين ج والحموضة انخفضت معنويا بينما ازدادت نسبة العفن ونسبة الفقد في الوزن ونسبة المواد الصلبة الكلية وتغير اللون مع زيادة فترات التخزين، أما محتوي الثمار من الكاروتينيات فكان مرتفعا في البداية ثم انخفض ثم ارتفع مرة أخرى في نهاية فترات التخزين علي درجة ١٣°م.

المحكمـــــون:

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