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INFLUENCE OF PRE- AND POST-HARVEST APPLICATIONS OF SOME ANTIOXIDANTS AND BIOCHEMICALS ON PROLONGING MARKETABLE LIFE OF WILLIAMS BANANA FRUITS

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ABSTRACT

This study was conducted during two successive seasons (2012 and 2013) on Williams banana plants in a private banana orchard located at Badaway village, near Mansoura, Dakahlia Governorate. This study was performed on the first and second ratoons. Mother plants planted at (3*3.5) m apart, three suckers per hole.

During storage period under room conditions of temperature 33±2 and (R.H)63±2%,theresponse of pre-harvest treatments and chitosan 1.5% after harvest significantly reduced weight loss percentage (WLP) %, and decay %of banana fruits. As for, chemical characteristics measured, exhibited significant positive effects on fruits during storage periods in terms of reducing degradation of total chlorophyll contents (a+b), starch % ,accumulation of soluble solid contents (SSC%) and total soluble sugars (TSS) %.In this respect, it was indicated that the applications of gibberellic acid and salicylic acid at pre-harvest combined with Chitosan 1.5% after harvest were the best performance treatments to prolong the marketing life and maintaining the quality attributes of Williams banana fruits.

INTRODUCTION

In Egypt, the total cultivated area of banana reached more than 55000 feddan produced more than 1.100.000 tons (FAO, 2010).Williams (Musa sp.) is one of the most important cultivars newly grown under the local condition, especially at the reclaimed soils under drip irrigation system.

Antioxidants such as Salicylic acid is a simple ubiquitous plant phenolic compound play an important role in the developmental processes and some of them havea key role in the mechanism leading to acclimation for changing environments. Results included that salicylic acid could be a promising compound for the reduction of abiotic stress sensitivity of plants, since under certain conditions it was found to mitigate the damaging effects of various stress factors in plants (Harvath *et al*., 2007) such as heavy metals, high temperature, chilling or salinity (Szepesi *et al*., 2009) by inducing a wide range of processes involved in stress tolerance mechanisms.

Moreover, ascorbic acid has auxinic action and also synergistic effect on flowering and fruiting of fruit trees. Recently antioxidants used instead of auxins and other chemicals for enhancing growth and fruiting of various fruit trees (El Sayed *et al.,* 2000). Ascorbic acid gave the best yield and quality of fruits, (Blokhine *et al.,* 2003) who stated that ascorbic acid is the most abundant antioxidant that protects plant cells. Therefore, it is currently considered to be a regulator for plant growth and development.

Vitamin E (α-tocopherols) is lipophilic antioxidant and synthesized exclusively by photosynthetic organisms, including plants, algae and some cyanobacteria (Flake and Munne´-Bosch 2010). In addition to its antioxidant characteristics, tocopherols have an important role in plant residence to different stress conditions (Peter, 2007; Shao *et al.,* 2008 and Tang *et al.*, 2011).

The discoveryof Gibberellins and cytokinins have commercial uses includingimprove shape of fruit, enhancing market value by reducing blemishes, improving tree architecture that may be accomplished by overcoming apical dominance(Greene, 2010).

Cytokinins are known to be involved in the regulation of many processes in plant growth and development (Davies, 2007). Cytokinins increases fruit size by stimulating additional cell division within the fruit (Greene, 1993 and Wismer *et al.,* 1995). Cell division during the early stages of fruit development may be played a major influence on final fruit size (Looney, 1993), So cytokinin is one of the major factors limiting fruit growth and final size and they are used to induce fruit set or parthenocarpic fruit development when applied exogenously (Khalid *et al*., 2012 and Ghazzawy, 2013).

Gibberellins are a group of growth substances, known to retardripening and senescence of fruits. The effect of GA_s seems to be mainlyon colour development, although other aspects of ripening processes arealso affected. GA_3 delays chlorophyll degradation and fruit softening(Khader 1992) and decreases sugar accumulation, SSCand sugar/ acid ratio in banana (Ahmed and Tingwa 1995).Gibberellins are used to increase fruit set, size,retention and yield (Kassem *et al.,* 2010 and Zhang and Whiting, 2011),improve fruit physico-chemical characteristics and ripening (Rizk-Alla *et al.,* 2011).

Chitosan is a modified natural carbohydrate polymer derived from chitin which has been found in a wide range of natural sources such as crustaceans, fungi, insects and some algae (Tolamite *et al*., 2000) and is used in medical or industrial products as a bioactive material (Struszczyk, 2002).This biodegradable cationic polysaccharide has three important roles to be effective at extending the shelf-life of fruits (Krajewska, 2004).

The present investigation was outlined to study the beneficial effects of some antioxidants (Salicylic acid, Ascorbic acid & V.E) and some growth regulators (GA_{4+7} &Cytokinin) on quality and marketable life of summer season fruits during pre-harvesting alone or combined with dipping in edible coating as chitosan (CH) to prolong the marketable life of fruits.

Keywords: bananas, antioxidants, salicylic acid, α-tocopherol, ascorbic acid, gibberellins, cytokininsand chitosan.

MATERIALS AND METHODS

This study was conducted during two successive seasons (2012 and 2013) on Williams banana plants grown in a clay loam soil under flood irrigation system, at private banana orchard located at Badaway village, near Mansoura, Dakahlia Governorate. This study was performed on the first and

second ratoons. Mother plants planted at (3*3.5)m apart, as three suckersper hole.

A factorial experiment in a randomized complete block design with 36 plants free fromdiseases, uniform in growth, divided into 6 groups, 3replicates and 2 plants per each to study the effects of spraying of some antioxidants and growth regulatorsafter harvest on fruit quality and their marketable life of banana fruits by using a chitosan 1.5% as an edible coating after ripening in initiation of ripening chamber with (ethylene gas $20cm^3/20m^2$ for 4 hours) to prolong the marketable life of fruits.

Treatments were applied as the following:

A-At pre harvest: Control plants were sprayed with tap water, other treatments sprayed with Salicylic acid solution (4 mmol), Ascorbic acid solution (1000 ppm), Cytokinin 50 ppm, VE (α-tochopherols) 200 ppm and GA_{4+7} 90 p.p.m.All treatments sprayed twice, first one at shootingon May and the second one at beginning of finger cycling stage on July(a month before-harvest), then the fruits harvested at august month.

B-After harvest: Afterripening initiation, fruit physical and chemical properties were measured (0day), theneach treatment divided into two parts during storage.Part 1(without): fruits didn't treated with chitosan which were representedT1(control), T3(SA), T5(AA), T7(CK), T9(V.E) and T11(GA_{4+7}). Part 2 (chitosan1.5%): fruits dipped in Chitosan (CH) solution 1.5% (w/vol) for 15 minutes which were represented T2(control+CH), T4(SA+CH), T6(AA+CH), T8(CK+CH), T10(V.E+CH) and T12(GA_{4+7}+CH). The physical and chemical properties measured on 3^{rd}`, 6^{th}, 9^{th} day during storage period.

All plants under investigation received the traditional and regular fertilization program applied in that location which comprised of 20 m^3/fed of farmyard manure recommended of fertilization according to the Ministry of Agriculture. The other agricultural practices (remove the male bud, weed and pests control ….etc.) were the same for all plants under investigation.

Harvest date was estimated when the angulation percent reached above 9% according to(Abou-Aziz *et al.,* 1993) and when fruit reached full maturity stage (4-quarters round) according to(Nakasone and Paull, 1998). The fruits harvested on the second half of August.

Measurements:

After ripening, samples from each replicate were taken to determine the physical and chemical parameters on mature fruits, then, bunch ripened and after ripening all the parameters were taken at 0, 3, 6 and 9 days during storage period in the laboratory with room temperature at 31-35 °C and 60-65% relative humidity (RH)to simulate marketability conditions.

- **Physical characteristics measured at harvest date, after ripening and during storage period**:-

1. **Weight loss% :**was calculated according to the following equation, then were evaluated subsequently at 3, 6 and 9 days from the beginning of storage period.

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

2. Decay percentage:

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

Both room temperature and humidity(RH) were determined using Thermo-hydrograph as follows:

Days	0 day	3 day	6 day	9 day
Temp (^{0}C)	35	31	33	33
RH (%)	63	65	63	65

- **Chemical characteristics measured after ripening and during storage :**

1.Soluble solids content (SSC) %: it was determined in the pulp fruit juice using a hand refractometer.

2.Chlorophyll pigments content were estimated as the method described by Goodwine (1965), the amount of chlorophyll is calculated as:

mg chlorophyll a/g tissues= 12.7 (A_{663})-2.69 (A_{645})×(v/(1000×w)

mg chlorophyll b/g tissues= 22.9 (A_{645})-4.68 (A_{663})×(v/(1000×w)

Where A=absorbance at specific wavelength.
V= final volume of chlorophyll extracted in 80% acetone.
W= fresh weight of tissues extracted.

3.Starch was determined by Anthrone reagent method according to Hodge and Hofreiter (1962)as described by Thayumanavan and Sadasivam (1984)the prepared sample measured at wavelengths 630-nm.

4.Total soluble sugars extracted by Ethanol and then determined by phenol-sulphuric acid methods as described by (Sadasivam and Manickam, 1996).

Statistical analysis:

All data of this study were statistically analyzed according to the technique of analysis variance (ANOVA) for factorial experiment in randomized block design and the least significant difference (LSD) at 5% was used to compare the deference between the means of treatment values to as described by Gomez and Gomez, (1984). All statistical analyses were performed using analysis of variance technique by means of COSTATE Computer Software.

RESULTS AND DISCUSSION

- **Physical characteristics measured after ripening and during storage period**:-

1. Weight loss percentage (WLP) %:-

Changes in weight loss is attributed to physiological loss in weight due to the different rates of respiration, transpiration of water through peel tissue and other biological changes taking place in the fruit (Bhalerao *et al*.,2011).Post-harvest researchers are interested to study water loss processes, since these changesmay affect fruit physiology during ripening and earlier ethylene synthesis or cause a rise in membrane deterioration (Paull 1999). In banana fruits, previously Lebibet *et al*. (1995) attributed the

higher weight loss at higher temperatures could be related to the higher evapo-transpiration. He also reported that skin bears stomata and transpiration continues after harvest and the maximum rise in water loss is in the senescence stage due to degenerative changes of the skin.

The concerned results of weight loss% in Table (2) indicated that with prolonging the storage period the weight loss percentage increased and all pre-harvest sprayed treatments gave a positive significant effect on decreasing (WLP) comparing with control. In this respect, GA_{4+7} (17.58-13.38) significantly reduced WLP comparing with all other pre-harvest treatments followed by SA (20.76-16.83) and the highest deterioration of (WLP) tabulated with control (29.13-25.97) followed by CK and V.E with insignificant difference between them, respectively, at 9^{th} day of storage under room conditions in both seasons. Also, AA gave an intermediate value in reducing WLP with (24.64-19-19),respectively, in both seasons. This result are in agreement with those of Osman and Goukh, (2008)who illustrated that GA_3 at 100ppm significantly delayed fruit ripening, maintained quality and extended shelf-life of bananas. Also, reduced weight loss% of fruits at end of storage at ambient temperature, Bhalerao *et al.,* (2011)concluded that the treatment of gibberellic acid (GA_3) 100 mg/l delayed the process of ripening and extended the shelf-life as well as also helped in reducing the weight losses of banana fruits cv. Grand Naine during storage under room temperature.

Regarding with treating after harvest with chitosan 1.5% gave a significant effects in reducing the weight loss percentage in 3^{rd}, 6^{th} and 9^{th} days of storage under room conditions with values (2.86-3.19), (6.29-5.99) and (16.71-15.62) in arrange, respectively, in 2012-2013 seasons comparing with untreated ones.

The obtained results are in accordance with the findings of Garcia *et al.,* (1998)andBaldwin *et al.,* (1999) who reported that chitosan film coating the surface of the fruit delayed migration of moisture from the fruit into the environment, thus reducing weight loss during storage from other commodities, Maqbool *et al.,* (2010)and Maqbool *et al.,* (2011) on banana, they reported that Chitosan (CH) at 0.75%, 1% and 2% significantly delayed ripening in terms of decreasing weight loss and decay and reducing the inferiority in fruit firmness during storage at ambient temperature.

As for the interaction effect between pre-harvest and Chitosan treatments data in (Table 2) indicated that at end of storage (9^{th} day)"T12" GA_{4+7} + CH at (10.54%-8.74%) gave a significant value of reducing WLP comparing with all other treatments followed by "T4" SA+ CH with values (14.31-11.46), respectively, in both seasons of this respect. Also, "T11"GA_{4+7} came at thethird rank with values (15.58-13.38), respectively, in seasons 2012 and 2013. The highest values of WLP were obtained from "T1"control (tap water only) which were (29.13-25.97), respectively in both seasons. Furthermore, all treatments led to a significant decreasing in weight loss percentage comparing with "T1"control in both seasons. As a matter of fact, results also cleared that adding chitosan significantly degraded from loosing weight of fruits comparing with untreated fruits at end of storage in both seasons. In connection with the obtained results, Asghari *et al*., (2009)

showed that after harvest treatment of table grapes with SA before coating with Chitosan significantly enhanced the efficiency of coating and decreased weight loss and fruit decay by stimulate the synthesis of antioxidant enzymes. Also, Gol and Rao, (2011)on banana, who concluded that coating with chitosan1.5%+gibberellic acid 100ppmsignificantly decreased WLP reducing decay percentage, prolong the shelf life, and preserve valuable attributes of banana fruits during storage at ambient temperature comparing with control and control+chitosan1.5%.

Table 2: Effect of pre-harvest applications with some antioxidants and biochemicals on Weight loss % of banana fingers during storage under simulated marketing conditions.

Weight loss %										
Treatments			**0 day**		**3 days**		**6 days**		**9 days**	
			1st	**2nd**	**1st**	**2nd**	**1st**	**2nd**	**1st**	**2nd**
Control			0.00	0.00	6.98	7.30	14.85	14.67	29.13	25.97
S.A			0.00	0.00	2.30	2.97	7.72	7.50	20.76	15.83
A.A			0.00	0.00	3.60	4.46	12.50	11.46	24.64	19.19
CK			0.00	0.00	5.36	6.05	13.95	13.83	27.17	23.07
V.E			0.00	0.00	5.97	5.49	13.67	13.51	26.55	21.89
GA_{4+7}			0.00	0.00	1.44	2.30	6.10	5.29	15.58	13.38
LSD 5%			-	-	0.36	0.76	0.43	0.56	0.53	0.86
Without			0.00	0.00	4.27	4.76	11.47	11.04	23.97	19.89
Chitosan 1.5%			0.00	0.00	2.86	3.19	6.29	5.99	16.71	15.62
Ftest			NS	NS	*	*	*	*	*	*
Control	Without	T1	0.00	0.00	6.98	7.30	14.85	14.67	29.13	25.97
	Chitosan 1.5%	T2	0.00	0.00	4.78	5.42	7.23	9.01	22.08	21.94
S.A	Without	T3	0.00	0.00	2.30	2.97	7.72	7.50	20.76	15.83
	Chitosan 1.5%	T4	0.00	0.00	1.37	1.65	4.60	3.66	14.31	11.46
A.A	Without	T5	0.00	0.00	3.60	4.46	12.50	11.46	24.64	19.19
	Chitosan 1.5%	T6	0.00	0.00	2.98	2.78	7.01	5.79	16.30	14.23
CK	Without	T7	0.00	0.00	5.36	6.05	13.95	13.83	27.17	23.07
	Chitosan 1.5%	T8	0.00	0.00	3.52	4.30	8.71	8.53	19.40	19.42
V.E	Without	T9	0.00	0.00	5.97	5.49	13.67	13.51	26.55	21.89
	Chitosan 1.5%	T10	0.00	0.00	4.11	4.61	8.04	7.58	17.60	17.94
GA_{4+7}	Without	T11	0.00	0.00	1.44	2.30	6.10	5.29	15.58	13.38
	Chitosan 1.5%	T12	0.00	0.00	0.40	0.41	2.13	1.38	10.54	8.74
LSD 5%			-	-	0.54	1.38	0.63	0.95	0.99	1.01

2. Decay %:-

With observing data presented at Table (3), there was an increase in values of decay percentage with prolonging the storage period after 3rd till 9thday under room condition. As for pre-harvest treatments all treatments significantly reduced from fruit decay % comparing with control except CK and V.E with values (37.5-27.96) and (28.93-25.88) in arrange, respectively

in both seasons. It was cleared that GA_{4+7} (0.00-7.40) exhibited the best storage performance in reducing the decay percentage followed by SA (7.23-11.13), respectively, comparing with all other treatments sprayed alone at pre harvest with chemicals. Also, CK showed the highest decay percentage in season 2012 with insignificant difference between CK and control (32.37-28.12) which gave the highest decay percentage in season 2013.Many studies showed that GAs played an important role in reducing fruit decay by reducing the internal browning (Koukourikou-Petridou *et al.,*2007). Also,it prevented the development of botrytis Gianfanga, (1995) and Looney, (1993) reported thatGA_3possessed antifungal properties so it used on several crops to improve fruit appearance and quality in addition to their potential to reduce pesticide usage. The obtained results are in agreement with the findings on banana, Kumar and Brahmachari, (2006) who found that pre-harvest application of GA_3 at 200 ppm had greater potentiality in delaying ripening, prolonging postharvest life and maintaining quality characters of banana fruits during storage at room temperature. This treatment was most effective in minimizing physiological weight loss and decay and Zomo *et al*., (2014) who showed that Gibberellic acid (GA_3 150 ppm at 15 or 30°C) treatment exhibited the best storage performance as well as reducing the increase of softening, decay, weight loss and gave the longest shelf life (16.25 days) with banana fruits cv. Sabri.

On the other hand, fruits treated after harvest with chitosan significantly decreased the decay percentage with values (6.11-6.97)and (9.52-10.84) in arrange at 6^{th} and 9^{th} day of storage, respectively, in both seasons. These results are consistent with many reports which proved that Chitosan has antimicrobial properties and it has been utilized to control disease or reduce their spread by (Rabea *et al*., 2003andKrajewska, 2004).

Furthermore, the data of interaction effect between pre-harvest and Chitosan treatments in Table (3) pointed to that at end of storage all treatments reduced the fruit decay comparing with "T1"control (tap water) except "T7"CK, "T9"V.E in season 2012 and "T7", "T9" and "T5"AA in season 2013. Also, "T12"GA_{4+7} +CH1.5% at pre-harvest gave significantly the lowest fruit decay %. It not only reduced the decay % but prevented it till the end of storage period with values (0.00-0.00) followed by "T4"SA+CH (0.00-3.31) and "T11"GA_{4+7} (0.00-7.40) with insignificant difference between them, respectively, in both seasons of the study. In addition, "T7"CK gave the highest value of decay (37.5) in season 2012 and "T1" control (28.12) in season 2013. These results indicated that pre-harvest treatments enhanced the role of chitosan in reducing decay during storage which prolonging marketable life of banana fruits.These obtained results are in accordance with (Maqbool *et al.,* 2010 and Maqbool *et al.,* 2010a). Also, Gol and Rao, (2011) on banana, evaluated that coatings of chitosan1.5% + gibberellic acid100ppm reduced the weight loss percentage, control decay percentage, prolong the shelf life, and preserve valuable attributes of banana fruits than treated with chitosan1.5% during storage at ambient temperature and Asghari *et al* (2013) on grape cv. Gizel Uzum, mentioned that combined between SA (2mmol/L)combined with edible coating of aloe vera gel 33% increased

storage life of table grapes and maintaining their quality as well as scoring the lowest PPO and catalase, reducing the Soluble solid content, weight loss and decay percentage comparing with fruits treated with SA only.

Table 3: Effect of pre-harvest applications with some antioxidants and biochemicals on Decay % of banana fingers during storage under simulated marketing conditions.

Decay %										
Treatments			0 day		3 days		6 days		9 days	
			1st	2nd	1st	2nd	1st	2nd	1st	2nd
Control			0.00	0.00	0.00	0.00	20.7	16.17	32.37	28.12
S.A			0.00	0.00	0.00	0.00	7.23	6.46	7.23	11.13
A.A			0.00	0.00	0.00	0.00	12.08	14.23	14.60	23.27
CK			0.00	0.00	0.00	0.00	20.87	17.39	37.50	27.96
V.E			0.00	0.00	0.00	0.00	19.03	15.30	28.93	25.88
GA_{4+7}			0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.40
LSD 5%			NS	NS	NS	NS	3.94	2.96	6.58	4.70
Without			0.00	0.00	0.00	0.00	13.31	11.59	20.11	20.66
Chitosan 1.5%			0.00	0.00	0.00	0.00	6.11	6.97	9.52	10.84
F test			NS	NS	NS	*	*	*	*	*
Control	Without	T1	0.00	0.00	0.00	0.00	20.7	16.17	32.37	28.12
	Chitosan 1.5%	T2	0.00	0.00	0.00	0.00	11.73	12.3	20.77	16.87
S.A	Without	T3	0.00	0.00	0.00	0.00	7.23	6.46	7.23	11.13
	Chitosan 1.5%	T4	0.00	0.00	0.00	0.00	00.0	0.00	0.00	3.31
A.A	Without	T5	0.00	0.00	0.00	0.00	12.08	14.23	14.60	23.27
	Chitosan 1.5%	T6	0.00	0.00	0.00	0.00	2.50	7.13	6.23	11.47
CK	Without	T7	0.00	0.00	0.00	0.00	20.87	17.39	37.50	27.96
	Chitosan 1.5%	T8	0.00	0.00	0.00	0.00	11.93	13.70	18.27	19.23
V.E	Without	T9	0.00	0.00	0.00	0.00	19.03	15.30	28.93	25.88
	Chitosan 1.5%	T10	0.00	0.00	0.00	0.00	10.50	8.71	11.86	14.20
GA_{4+7}	Without	T11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.40
	Chitosan 1.5%	T12	0.00	0.00	0.00	0.00	00.0	0.00	00.0	0.00
LSD 5%			NS	NS	NS	NS	5.05	4.34	5.28	5.29

- **hemical characteristics measured after ripening and during storage :**

1- oluble solid content (S.S.C %):-

The obtained results presented in Table (4) illustrated that storage caused a progressive increase in accumulation of SSC% in fruits during 3rd, 6th and 9th days of storage under room conditions. Atend of storage (9th day) all pre-harvest treatmentssignificantly retarded the accumulation of fruits SSC% except CK at season 2012 with value (23.23) comparing with control (tap water) in both seasons of study. Also, treatment of GA_{4+7} significantly gave the lowest values (19.07-19.93) followed by SA with value (19.78-20.57), respectively, in seasons 2012-2013. The natural increase of soluble solids content with advancing storage period reported by Siriboon and

Banlusilp, (2004) on banana, who statedthat the increase of SSC%in fruits during ripening might be due to the degradation of starch to soluble sugar with a sharp rise in the first three days of respiration rate and an osmotic movement of water from the fruit peel into the flesh caused an increasing in the metabolic processes in the cell which contributed to the increase of SSC% at first days of storage and continous even full ripening stage.These results are in harmony with those of (Tourky *et al.,*2014 andZomo *et al*., 2014).

With regard to the combined between treatments of banana fruits with chitosan after harvest significantly reduced of SSC% accumulation during 3rd, 6th and9th day of storage with values (13.93-14.67), (16.36-17.44) & (19.55-20.68) in arrange, respectively, in seasons 2012-2013.The decrease in SSC accumulation as a result of chitosan treating probably due to the slowing down of respiration and metabolic activity and hence retarding the ripening process (Dong *et al.,*2004).The obtained results are in line with those of Our results were in line with those of Maqbool *et al.,* (2011) on banana fruits, illustrated that chitosan (1.0%) delayed color development, reduced the rate of respiration and ethylene evolution during storage as compared to the control. Also, the results showed that after 33 days of storage at 13$\pm$1^{o}C and 80$\pm$3% (RH) the weight loss and soluble solids content of fruits treated with 1.0% CH composite coating were 24 and 54% lower, whereas fruit firmness, total carbohydrates, and reducing sugars were 31, 59, and 40% higher than the control, respectively. during storage as compared to the control other tested treatments. Also, Hong *et al.,* (2012) on pearl guava and Shweta *et al.* (2014) on Gwalior mango.

As for interaction effect between pre-harvest and chitosan treatments, data in the same (Table 4) indicated that at end of storage all treatments significantly reduced SSC accumulation in fruits except "T7"CK at season 2012 only comparing with "T1"control. The treatment of "T12"GA_{4+7} +CH 1.5% significantly exhibited the best storage performance in reducingthe natural increment of SSC and recorded values (17.83-18.70) followed by "T4"SA+CH 1.5%in the second rank with values (18.2-19.8) and also, "T11"GA_{4+7} at (19.07-19.93), respectively, in 2012 and 2013 seasons came in the third rank with insignificant difference between T4 and T11 only in season 2013. Data also, indicated that the highest values were obtained from "T1" control treatment (tap water) at (23.30-24.53) for 2012 and 2013, respectively. Moreover from observing the data it cleared that adding chitosan 1.5% significantly reduced SSC accumulation in all CH treated fruits comparing with without treated fruits in both seasons. These results were in harmony with Gol and Rao, (2011) on banana, who mentioned that banana fruits coated with chitosan 1.5%, chitosan 1.5% + GA_3 100 ppm, and jojoba experienced a slower increase of SSC during the 10 days of storage under room temperature with decline rates 1.4, 1.5 and 1.5 times lower than the SSC values of control samples without coating. He enhanced that to the effect of the semi-permeable chitosan film, which formed on the surface of the fruits, causing the modification of internal atmosphere and the endogenous CO_2 and O_2 concentrations of the fruit, thus caused a slowing down of respiration rate and metabolism processes which reflected on

retarding ripening process. He found also thatthe combined treatment of chitosan and GA_3 had agreater effect in reducing the SSC during storage compared to other testedtreatments. During the 10 days of storage, the least amount of SSC (14.0%) was seen in treatment of chitosan 1.5% + GA_3 100 ppm banana fruits and, Asghari *et al.,* (2013) on Gizel Uzum grape, reported that edible coating of aloe vera gel at concentration of 33% and 2mmol/L salicylic acid treatment after harvest retained SSC% of berries at end of storage. The author proposed that SA reduced ethylene production which reflected in decreasing sucrose-phosphate synthase (a key enzyme in sucrose biosynthesis) enzyme activity and leading to decrease in sucrose synthesis. Moreover, the decrease in SSC might be due to modified atmospheric conditions created by Aloe vera gelcoating, which might decrease respiration and eventually catabolism of soluble solids including sugars and organic acids.

Table 4: Effect of pre-harvest applications with some antioxidants and biochemicals on S.S.C% of banana fingers during storage under simulated marketing conditions.

S.S.C%										
Treatments			**0 day**		**3 days**		**6 days**		**9 days**	
			1st	**2nd**	**1st**	**2nd**	**1st**	**2nd**	**1st**	**2nd**
Control			8.00	8.13	16.70	15.53	21.17	22.50	23.30	24.53
S.A			10.00	12.23	13.87	14.37	11.53	16.93	19.78	20.57
A.A			8.20	9.70	14.57	15.60	17.50	18.33	20.33	21.73
CK			9.83	11.77	16.57	17.93	19.90	20.43	23.23	24.87
V.E			8.67	8.60	16.03	17.67	18.00	19.07	22.10	23.50
GA_{4+7}			11.90	13.63	13.00	14.53	15.17	15.23	19.07	19.93
LSD 5%			0.56	0.53	0.14	0.22	0.25	0.23	0.23	0.17
Without			9.43	10.68	15.12	15.94	17.21	18.75	21.30	22.52
Chitosan 1.5%			9.43	10.68	13.93	14.67	16.36	17.44	19.55	20.68
F test			NS	NS	*	*	*	*	*	*
Control	Without	T1	8.00	8.13	16.70	15.53	21.17	22.50	23.30	24.53
	Chitosan 1.5%	T2	8.00	8.13	16.93	18.00	19.00	20.17	20.4	21.5
S.A	Without	T3	10.00	12.23	13.87	14.37	11.53	16.93	19.78	20.57
	Chitosan 1.5%	T4	10.00	12.23	12.17	12.57	15.80	16.50	18.2	19.8
A.A	Without	T5	8.20	9.70	14.57	15.60	17.50	18.33	20.33	21.73
	Chitosan 1.5%	T6	8.20	9.70	12.53	13.63	16.73	16.73	19.8	20.0
CK	Without	T7	9.83	11.77	16.57	17.93	19.90	20.43	23.23	24.87
	Chitosan 1.5%	T8	9.83	11.77	15.37	16.20	18.00	18.33	20.6	22.3
V.E	Without	T9	8.67	8.60	16.03	17.67	18.00	19.07	22.10	23.50
	Chitosan 1.5%	T10	8.67	8.60	15.00	15.60	17.70	18.43	20.5	21.8
GA_{4+7}	Without	T11	11.90	13.63	13.00	14.53	15.17	15.23	19.07	19.93
	Chitosan 1.5%	T12	11.90	13.63	11.60	12.03	10.93	14.50	17.83	18.70
LSD 5%			NS	NS	0.34	0.27	0.24	0.42	0.33	0.18

2. Total Chlorophyll contents (a+b)mg/g F.W:-

During banana ripening, the change of color of bananas from green to yellow is a well-known first visual sign of their ripening. Indeed, color is an important criterion for fruit ripeness and quality **(Moser *et al.*,2012)**.

Table 5: Effect of pre-harvest applications with some antioxidants and biochemicals on Total chlorophyll (a+b) mg/g F.W in peel of banana fingers during storage under simulated marketing conditions.

Total chlorophyll (a+b) mg/g F.W										
Treatments			0 day		3 days		6 days		9 days	
			1st	2nd	1st	2nd	1st	2nd	1st	2nd
Control			0.414	0.447	0.277	0.297	0.203	0.227	0.019	0.022
S.A			0.570	0.628	0.504	0.521	0.363	0.409	0.162	0.187
A.A			0.489	0.528	0.458	0.476	0.323	0.372	0.088	0.107
CK			0.514	0.547	0.359	0.388	0.234	0.288	0.018	0.027
V.E			0.455	0.482	0.324	0.360	0.247	0.285	0.033	0.050
GA_{4+7}			0.622	0.677	0.559	0.582	0.432	0.507	0.253	0.268
LSD 5%			0.018	0.014	0.007	0.018	0.008	0.015	0.006	0.004
Without			0.511	0.552	0.414	0.437	0.300	0.348	0.096	0.110
Chitosan 1.5%			0.511	0.552	0.443	0.462	0.337	0.385	0.131	0.152
F test			NS	NS	*	*	*	*	*	*
Control	Without	T1	0.414	0.447	0.277	0.297	0.203	0.227	0.019	0.022
	Chitosan	T2	0.414	0.447	0.307	0.326	0.234	0.285	0.044	0.050
S.A	Without	T3	0.570	0.628	0.504	0.521	0.363	0.409	0.162	0.187
	Chitosan	T4	0.570	0.628	0.528	0.553	0.416	0.461	0.225	0.238
A.A	Without	T5	0.489	0.528	0.458	0.476	0.323	0.372	0.088	0.107
	Chitosan	T6	0.489	0.528	0.495	0.493	0.359	0.410	0.126	0.140
CK	Without	T7	0.514	0.547	0.359	0.388	0.234	0.288	0.018	0.027
	Chitosan	T8	0.514	0.547	0.396	0.421	0.251	0.312	0.040	0.058
V.E	Without	T9	0.455	0.482	0.324	0.360	0.247	0.285	0.033	0.050
	Chitosan	T10	0.455	0.482	0.345	0.369	0.274	0.310	0.063	0.096
GA_{4+7}	Without	T11	0.622	0.677	0.559	0.582	0.432	0.507	0.253	0.268
	Chitosan	T12	0.622	0.677	0.589	0.613	0.488	0.529	0.287	0.330
LSD 5%			NS	NS	0.010	0.019	0.008	0.024	0.006	0.006

Data presented at Table (5) indicated that storage significantly caused a progressive breaking down in total chlorophyll (a+b) in the peel of fingers at 3 days intervals for 9 days during storage under room conditions. As for pre-harvest spraying of antioxidants and growth regulators, all treatments significantly declined from total chlorophyll pigments degradation in the peel of summer season'sfingers.At end of storage 9th day

GA_{4+7}significantly degraded of total chl. breaking down and gave the lowest pigments degradation with values (0.253-0.268) followed by SA in the second rank with values (0.162-0.187), respectively, in 2012-2013 seasons. These results were proved by Jacobo-wilk *et al.,* (1999) who reported that (anti-senescence) GA_3 delayed the natural loss of Chl. by inhibiting the ethylene-induced accumulation of chlorophyllase mRNA. Chlorophyllase (Chlase.) enzyme anchored to the chloroplast inner envelope membrane and contacted with Chl. pigment complexes by a kind of carrier protein that accumulated towards ripening,(Huang, and Jiang, 2012 and Huang *et al.,* 2014) on banana fruits, indicated that GA_3 at (100 ppm) significantly decreased the degradation of chlorophyll and photosynthesis-relative protein to slow down the fruit color change and chlorisis. Also, showed that the degradation of chlorophyll may relate to the accumulation of soluble sugars and the content of soluble sugar increased slowly after treatment, followed by a stable content of chlorophyll and an extending degradation progress which was very important for sustaining fruit flavor and quality and extending the shelf life of banana fruits stored at room temperature under 23 ± 2 ◦C and 75–95% relative humidity(RH).

Concerning the results of dipping in chitosan 1.5% after harvest in Table (5), it is shown that the combined between pre-harvest treatments and chitosan 1.5% after harvestsignificantly reduced fromtotal chl. (a+b) degradation as compared with fruits (without treating)during 3^{th}, 6^{th}, 9^{th} periods of storage under room conditions with values (0.443-0.462),(0.337-0.385)&(0.131-0.152)in arrange, respectively, in both seasons.The obtained data are in accordance with those respected by (Prange *et al.,* 2002 and Ahmad *et al.,*2006).

Also, results are in harmony with those of Wills and Joyce (1998) who showed that hydrophilic edible coatings as Chitosan had a good resistance toward oxygen and carbon dioxide transfer, changed the internal atmosphere of coated banana fruits by raising the level of carbon dioxide and decreasing the level of oxygen inside the coated banana, reduced respiration rate and the endogenous production of ethylene in the storage atmosphere which delayed ripening and suppressed the activities of some enzymes as chlorophyllase (responsible about chlorophyll degradation during ripening) and caused a delayed of color changes in peel of coated banana than un-coated fruits, Baez-Sanudo *et al.,* (2009) on banana, revealed that chitosan coating with 1.5% significantly delaying respiration rate (CO_2 production), ethylene evolution, changes in peel color change which caused by a decrease in the chlorophyll degradation of the peel tissue during storage at $22^oC\pm2$, 85%RH, Maqbool et al., (2011) mentioned that dipping banana cv.Pisang Berangan on CH at 1% Delayed color development in fruits in terms of slow rate of chlorophyll degradation of fruit's peel stored 13 ± 2^oC and 80 ± 3% relative humidity (RH) for 28 days and afterward for 5 days at simulated marketing conditions (25 ± 2^oC, 60% RH) and Hong *et al.,* (2012) onguava, who illustrated that chitosan at 2.0% chitosan significantly reduced firmness, weight loss, delayed changes in chlorophyll, soluble solids content (SSC), and retarded the loss of titratable acidity (TA) and vitamin C during 12 days of storage. This treatment could induce a significant increase in the

activities of peroxidase (POD), superoxide dismutase (SOD) and catalase (CAT), and inhibited superoxide free radical (O_2^-) production.

With regard to the combined among between pre-harvest and chitosan treatments, data in Table (5) obtained that at end of storage (9^{th} day) under room condition all treatments significantly declined of total chl. degradation except "T7"CK (0.018-0.027)mg/g F.W comparing with "T1"control (tap water), respectively, in two seasons. The treatment of "T12" GA_{4+7} +CH 1.5% significantly reduced total chl. degradation comparing with all other treatments. This treatment recorded (0.287 -0.330) mg/g F.W during two seasons of the study, respectively. Data also indicated that the lowest values were obtained from "T1" control with values (0.019-0.022) mg/g F.W for 2012 and 2013, respectively. In addition, "T11"GA_{4+7} came in the second rank which recorded (0.253-0.268) mg/g F.W followed by "T4"SA+CH1.5% in the third rank with values (0.225-0.238) mg/g F.W in that respect during 2012-2013 seasons, respectively. Also, data cleared that adding Chitosan 1.5% significantly reduced from the inferiority of total chl. comparing with (without treating fruits) in both seasons of this respect.

These results proved by Gol and Rao (2011) on banana, who showed that dipping in chitosan 1.5% or chitosan 1.5%+GA_3 significantly regarded from chl. a, b, total (a+b) degradation in the peel of fruits during storage at ambient temperature(34 $\pm$ 1◦C and 70–75%RH) and attributed that to delay ripening by retarding the enzymatic oxidation and chlorophyll degradation in treated fruit comparing with control. CH (1.5)+$GA_3$100ppm was significantly the superior in reducing chl. degradation during storage period.

3. Starch %:-

Unripe bananas have a large amount of starch, with a content of 20–25% found in the pulp of the fruit. During the climacteric, the accumulated polysaccharide is rapidly degraded and most of it converted into soluble sugars Cordenunsi and Lajolo(1995) and Srivastava *et al* (2009) cleared that in green bananas starch and plain sugars are in the ratio of (20:3) whereas in yellow fruits the proportion is reversed into(3:20)and this process lasts in average (4 to 8) days depending on the program of initiation ripening.

The presented data in (Table 6) clearly indicated that during storage periods there was a significant deterioration in the amount of starch content in banana fruits with advancingthe storage period at two seasons of the study. The highest rate of starch degeneracy was at 6^{th} day and with the progress of storage period it reached to the minimum values at the end of the storage (9^{th} days). As for pre-harvest sprayed of some antioxidants and growth regulators all treatments significantly decreased the starch content that converted to sugars except VE, CK treatments in season 2012 and CK treatment in season 2013 comparing with control (tap water) at (9^{th} day). GA_{4+7} significantly reduced starch conversation and gave the highest value of starch% in fruit pulp and scored (10.63-11.26) followed by SA in the second rank with values (8.27-8.84), respectively, in both seasons at end of storage. These results are coinciding with (Purgatto *et al.,* 2001and Mota *et al.*, 2002) who indicated that starch phosphorylases are not under allosteric control, it can be argued that protein synthesis makes a contribution to regulating

phosphorylase activity in banana fruit and that hormones, like gibberellic acid and indole-3-acetic acid, may play a regulating role in starch breaking down. Also, Rossetto *et al.,* (2003) on banana, also reported that GA_3 clearly affected the triggering of starch breakdown and sucrose synthesis. It was a modulation of the activities of some both starch degradative enzymes such as phosphorylases and control in gene expression of sucrose biosynthesis as (sucrose synthase) SuSy and SPS (sucrose–phosphate synthase), (Huang et al 2014and Tourky *et al.,* 2014) concluded that GA_3 at different concentrations, especially 50 mg/l delayed color change, transformation of starch to sucrose, and maintained high contents of ascorbic acid of banana fruit during storage at ambient temperature. It suggested that GA_3 treatment retarded the ethylene peak for 4 days later than control so, it might be a promising postharvest handling to maintain quality and extend shelf life of banana fruit.

Table 6: Effect of pre-harvest applications with some antioxidants and biochemicals on Starch % in pulp of banana fingers during storage under simulated marketing conditions.

Starch %										
Treatments			0 day		3 days		6 days		9 days	
			1st	2nd	1st	2nd	1st	2nd	1st	2nd
Control			19.45	20.58	14.15	15.84	8.42	8.94	3.85	3.10
S.A			23.78	25.36	20.91	21.25	13.69	15.32	8.27	8.84
A.A			22.72	23.92	16.50	17.80	12.58	13.78	6.71	7.24
CK			21.80	22.70	16.59	17.58	11.48	9.18	4.93	4.71
V.E			20.18	21.48	15.64	16.61	11.02	11.24	4.34	5.45
GA_{4+7}			26.33	27.52	21.83	22.57	14.75	15.29	10.63	11.26
LSD 5%			0.14	0.23	0.19	0.33	0.05	0.37	2.14	2.05
Without			22.38	23.59	17.60	18.61	11.99	12.27	6.46	6.77
Chitosan 1.5%			22.38	23.59	19.56	20.39	14.08	15.34	9.47	9.53
F test			NS	NS	*	*	*	*	*	*
Control	Without	T1	19.45	20.58	14.15	15.84	8.42	8.94	3.85	3.10
	Chitosan 1.5%	T2	19.45	20.58	16.93	17.67	11.63	12.55	5.45	4.94
S.A	Without	T3	23.78	25.36	20.91	21.25	13.69	15.32	8.27	8.84
	Chitosan 1.5%	T4	23.78	25.36	20.75	22.30	15.38	17.78	11.75	12.3
A.A	Without	T5	22.72	23.92	16.50	17.80	12.58	13.78	6.71	7.24
	Chitosan 1.5%	T6	22.72	23.92	18.57	19.45	14.72	15.45	9.26	9.55
CK	Without	T7	21.80	22.70	16.59	17.58	11.48	9.18	4.93	4.71
	Chitosan 1.5%	T8	21.80	22.70	19.42	20.52	13.36	14.17	7.75	8.22
V.E	Without	T9	20.18	21.48	15.64	16.61	11.02	11.24	4.34	5.45
	Chitosan 1.5%	T10	20.18	21.48	17.36	17.85	12.29	13.97	8.67	9.04
GA_{4+7}	Without	T11	26.33	27.52	21.83	22.57	14.75	15.29	10.63	11.26
	Chitosan 1.5%	T12	26.33	27.52	24.36	24.59	17.07	18.12	13.94	13.18
LSD 5%			NS	NS	0.26	0.22	0.05	0.28	1.34	1.08

With reference to dipping in Chitosan 1.5% after harvest led to a positive significant effects in reducing starch conversation to sugars in 3th, 6th and 9th days of storage under room conditions and recorded values (19.56-20.39), (14.08-15.34) & (9.47-9.53) in arrange, respectively, in 2012-2013 seasons comparing with (without treating fruits).

Moreover, coating with Chitosan gave a significant positive influence on delaying ripening and reduced starch degradation during at the end (9th day) of storage under room temperature. The basic composition of edible coating for fresh-cut fruits may include hydrocolloids and lipids. These hydrocolloids (proteins and carbohydrates) tend to form hydrophilic networks, usually being a good barrier to oxygen and carbon dioxide, but a poor barrier to water Krajewska (2004) so; low levels of oxygen and high levels of carbon dioxide around fruits inhibited the activities of such enzymes responsible for ripening as starch-sucrose transformation and allow retention of starch during storage. In agreement with these findings, Wang et al (2007) revealed that mango fruits treated with 2% chitosan and stored at 15$\pm^{o}$C and 85–90% RH for 35 days decreased the decay incidence, weight loss, delay the change in colour, pH, titratable acidity and significantly delayed the decline of starch content in the fruit of mango fruits during storage. While coating the fruit with chitosan 2% + 1% tea polyphenols was more effective at keeping quality of the fruit during storage.

On the other hand, the data of the interaction effect between pre-harvest and chitosan 1.5% treatments in Table (6) pointed to that at end of storage (9th day) all treatments significantly reduced from starch breaking down comparing with control treatment (T1) in both seasons of the respect except VE only in season 2012. The treatment of "T12"GA_{4+7}+ CH1.5% gave significantly the best performance in reducing starch degradation in fruits pulp comparing with all other treatments. This treatment recorded values of (13.94-13.18) during two seasons of the study, respectively while "T4"SA+CH1.5% came in second rank with values (11.75-12.3) followed by"T11"GA_{4+7} which came in third rank with values (10.63-11.26), respectively, in 2012-2013 seasons. In addition, the lowest values were obtained from "T1"control treatment (only tap water) and the values were (3.85-3.10) for 2012 and 2013, respectively.

These results were in harmony with Gol and Rao, (2011)who mentioned that degradation of starch in coated banana fruits were slow as compared with control fruit and accompanied by a delay in the increase of soluble sugar content. At the storage of 10 days interval, the fruits coated with chitosan1.5%+GA_3 and jojoba oil have shown the maximum amount of starch content (146.6 mg/g and 122 mg/g), respectively, and the least value of starch content was to control (34.4mg/g-52.2 mg/g) which indicated that the combined between chitosan and GA_3 increased the effectiveness of chitosan in delaying ripening than fruits treated with chitosan alone.

4. Total soluble sugars (TSS)%:-

The sweetness of a ripe banana is a consequence of soluble sugar accumulation (mainly sucrose), synthesized from the starch breaking down during the climacteric stage. The unripe fruit has a high content of starch (20–

25%) which is rapidly degraded during ripening as a result of the activities of several enzymes (**Seymour, 1993** and**Konishi *et al.*, 2001**)

Table 7: Effect of pre-harvest applications with some antioxidants and biochemicals on Total soluble sugars% in pulp of banana fingers during storage under simulated marketing conditions.

Total soluble sugars (TSS)%										
Treatments			0 day		3 days		6 days		9 days	
			1st	2nd	1st	2nd	1st	2nd	1st	2nd
Control			8.83	10.1	14.45	15.06	16.81	18.15	18.92	20.83
S.A			6.59	8.47	9.47	11.76	12.38	12.77	12.41	14.45
A.A			7.77	9.60	11.87	12.24	12.76	13.85	14.44	16.62
CK			8.14	9.86	12.37	14.54	15.19	17.66	16.11	19.55
V.E			7.53	9.11	10.92	13.45	13.91	15.02	14.80	17.65
GA_{4+7}			6.38	7.68	8.63	10.35	10.35	11.89	11.36	12.96
LSD 5%			0.07	0.08	0.23	0.18	0.09	0.06	0.03	0.07
Without			7.54	9.14	11.29	12.90	13.57	14.89	14.67	17.01
Chitosan 1.5%			7.54	9.14	9.65	11.88	12.21	13.38	13.16	15.53
F test			NS	NS	*	*	*	*	*	*
Control	Without	T1	8.83	10.1	14.45	15.06	16.81	18.15	18.92	20.83
	Chitosan 1.5%	T2	8.83	10.1	12.01	13.32	14.23	15.16	16.63	18.27
S.A	Without	T3	6.59	8.47	9.47	11.76	12.38	12.77	12.41	14.45
	Chitosan 1.5%	T4	6.59	8.47	7.65	10.25	10.32	11.49	11.15	13.25
A.A	Without	T5	7.77	9.60	11.87	12.24	12.76	13.85	14.44	16.62
	Chitosan 1.5%	T6	7.77	9.60	11.19	13.77	13.86	15.03	13.12	15.78
CK	Without	T7	8.14	9.86	12.37	14.54	15.19	17.66	16.11	19.55
	Chitosan 1.5%	T8	8.14	9.86	10.82	13.09	13.08	14.57	14.81	17.43
V.E	Without	T9	7.53	9.11	10.92	13.45	13.91	15.02	14.80	17.65
	Chitosan 1.5%	T10	7.53	9.11	9.26	11.92	11.93	13.13	13.03	16.25
GA_{4+7}	Without	T11	6.38	7.68	8.63	10.35	10.35	11.89	11.36	12.96
	Chitosan 1.5%	T12	6.38	7.68	6.94	8.93	9.82	10.87	10.21	12.04
LSD 5%			NS	NS	0.37	0.08	0.07	0.09	0.06	0.06

As for pre-harvest treatments, data presented at Table (7) clearly indicated that with prolonging the storage period thetotal soluble sugars increased in both seasons.At end of storage all treatments significantly declined from total soluble sugars accumulation in fruits pulp during seasons 2012-2013 of this respect. The treatment of GA_{4+7}significantly decreased from TSS accumulation and gave the lowest values (11.36-12.96) and followed by SA (12.41-14.45) in second rank comparing with other pre-harvest treatments for seasons 2012 and 2013, respectively.

Gibberellins may could be effective in modulating starch to sugars conversation by such mechanisms, it can be effective on decreasing starch degradation by its modulatory action on some starch degradative enzymes which observed by Mota *et al.*, (2002) who illustrated that GA_3 disturbed

starch phosphorylase activity and related protein synthesis during banana ripening. In addition, it can modify the pattern of activity and gene expression of some related enzymes Purgatto *et al* (2001) and Rossetto *et al* (2003) on banana,studied the effect of GA_3on some degradative enzymes as SPS, SuSy(sucrose synthase) and found that the activity and amount of SPS, respiration rates, ethylene production, and carbohydrate levels, were significantly delayed in banana fruits treated with GA_3 0.1 mM. He found also, that ethylene peak retarded for four days than control and insignificant effect on SuSy activity during ripening.

These results were in line with Hakim, *et al.,* (2012) showed that GA_3 at (400 ppm) and Maleic hydrazide significantly retarded the accumulation of total sugar content followed by other treatments at 6th and 9th days of storage, respectively in banana fruits, Tourky*et al.,* (2014) on banana, found that GA_3 and SA both at 50 ppm significantly decreased levels of total and reducing sugars in Williams banana while had an opposite effect on non reducing sugars, and Zomo *et al.,* (2014) on banana, showed that after harvest treated with gibberellic acid (GA_3 150 ppm) and stored on temperatures (15 or 30°C) exhibited the best storage performance as well as reducing the increase of softing, decay, weight loss ,total sugar content, reducing sugar content, non-reducing sugar content, S.S.C% and pulp pH.

With respecting to after treating with Chitosan 1.5%, a gradual increase was seen in the content of total sugars in coated and uncoated banana fruits, but dipping in Chitosan significantly reducedTSS% during two seasons comparing with (without treating fruits) at 3^{th}, 6^{th} and 9^{th} day of storage under room conditions during 2012 and 2013 seasons of the study with values (9.65-11.88), (12.21-13.38) &(13.15-15.53),respectively, in previous arrange.

These results agreed with,Maqbool *et al.,* (2011) on banana,illustratedthat fruits treated with chitosan 1% significantly reduced the inferiority in weight loss, SSC%, firmness, total carbohydrates and reducing sugar with ratio 24%, 54%, 31%, 59% and 40% in same arrange than control fruit during storage at $13\pm1^{o}C$ and 80%$\pm$3 RH, and El-Monem *et al.,* (2013) on mango, reported that treated with chitosan at (1.0 and 2.0%) gave the best fruit quality during cold storage in terms of reducing total sugars, respiration rate, water loss, decay percentage and maintained fruit firmness compared with the control.

Furthermore, the interaction effect between pre-harvest and chitosan treatments presented in Table (7) exhibited that at 9^{th} day of storage under room conditions all treatments gave significantly effects on retarding TSS accumulation in bulp fruits comparing with "T1" control treatment in both seasons of the study. Treatment of "T12" GA_{4+7}+CH 1.5% was significantly the best influential treatment in delaying sugars accumulation or starch-sugars conversation in fruits with values (10.21-12.04), respectively, for two seasons. Data also showed that "T4"SA+CH1.5% came in second rank only in season 2012 but "T11" came in second rank in 2013 season. The highest accumulated TSS was to "T1" control (only tap water) with values (18.92-20.83), respectively, in both seasons.

It was clear that combined between chitosan and GA_{4+7} was significantly the best influential treatment in delaying sugars accumulation or starch-sugars conversation in fruits probably due to the combined between GA as an anti-sensence and the semi-permeable chitosan film, which formed on the surface of the fruits, causing the modification of internal atmosphere and the endogenous CO_2 and O_2 concentrations of the fruit, thus retarding ripening, ethylene production, moisture loss and respiration rate in fruits during storage life. This view is supported by **Gol and Rao (2011)**on banana**,**who revealedthat the coatings of chitosan, chitosan + GA3, and jojoba wax were significantly found to be lower of the total sugars, reducing sugars, and non reducing sugars compared to un-coated fruits.

Table 7: Effect of pre-harvest applications with some antioxidants and biochemicals on Total soluble sugars% in pulp of banana fingers during storage under simulated marketing conditions.

Total soluble sugars (TSS)%										
Treatments			**0 day**		**3 days**		**6 days**		**9 days**	
			1st	**2nd**	**1st**	**2nd**	**1st**	**2nd**	**1st**	**2nd**
Control			8.83	10.1	14.45	15.06	16.81	18.15	18.92	20.83
S.A			6.59	8.47	9.47	11.76	12.38	12.77	12.41	14.45
A.A			7.77	9.60	11.87	12.24	12.76	13.85	14.44	16.62
CK			8.14	9.86	12.37	14.54	15.19	17.66	16.11	19.55
V.E			7.53	9.11	10.92	13.45	13.91	15.02	14.80	17.65
GA_{4+7}			6.38	7.68	8.63	10.35	10.35	11.89	11.36	12.96
LSD 5%			0.07	0.08	0.23	0.18	0.09	0.06	0.03	0.07
Without			7.54	9.14	11.29	12.90	13.57	14.89	14.67	17.01
Chitosan 1.5%			7.54	9.14	9.65	11.88	12.21	13.38	13.16	15.53
F test			NS	NS	*	*	*	*	*	*
Control	Without	T1	8.83	10.1	14.45	15.06	16.81	18.15	18.92	20.83
	Chitosan 1.5%	T2	8.83	10.1	12.01	13.32	14.23	15.16	16.63	18.27
S.A	Without	T3	6.59	8.47	9.47	11.76	12.38	12.77	12.41	14.45
	Chitosan 1.5%	T4	6.59	8.47	7.65	10.25	10.32	11.49	11.15	13.25
A.A	Without	T5	7.77	9.60	11.87	12.24	12.76	13.85	14.44	16.62
	Chitosan 1.5%	T6	7.77	9.60	11.19	13.77	13.86	15.03	13.12	15.78
CK	Without	T7	8.14	9.86	12.37	14.54	15.19	17.66	16.11	19.55
	Chitosan 1.5%	T8	8.14	9.86	10.82	13.09	13.08	14.57	14.81	17.43
V.E	Without	T9	7.53	9.11	10.92	13.45	13.91	15.02	14.80	17.65
	Chitosan 1.5%	T10	7.53	9.11	9.26	11.92	11.93	13.13	13.03	16.25
GA_{4+7}	Without	T11	6.38	7.68	8.63	10.35	10.35	11.89	11.36	12.96
	Chitosan 1.5%	T12	6.38	7.68	6.94	8.93	9.82	10.87	10.21	12.04
LSD 5%			NS	NS	0.37	0.08	0.07	0.09	0.06	0.06

CONCLUSION

This study aimed to improve fruit quality at harvest, prolong the marketable life, reduce losses and maintain fruits quality attributes after ripening process. Thus maximize the commercial returns for producers, traders and its presence during both seasons. The results indicated that there were distinctive responses with applications of growth regulators as gibberellic acid (GA_{4+7}) and salicylic acid (SA) at pre-harvest combined with Chitosan 1.5% after harvestto prolong the marketing life of Williams banana fruits.

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تاثير معاملات ما قبل و بعد الحصاد باستخدام بعض مضادات الاكسدة و الكيماويات الحيويه على اطالة العمر التسويقى لثمار الموز الويليامز.

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***قسم الفاكهة-كلية الزراعة - جامعة المنصورة**

****مركز البحوث الزراعية–الجيزة-مصر**

اجريت التجربه خلال الموسمين التاليين (٢٠١٢ و ٢٠١٣) على الموز المزروع في تربه طميبيه تحت نظام الرى السطحى و التى رويت بمياه النيل بقريه بدواي بالقرب من مدينه المنصوره بمحافظه الدقهليه. النباتات الام مزروعه فى مساحه ٣*٣.٥ مبمعدل ٣ نباتات فى الجورة.

صممت تجربه عامليه فى قطاعات كامله العشوائيه تحتوي على ٣٦ نبات خاليه من الامراض مقسمه الى ٦ مجموعات كررت ٣ مرات تحتوي كل مكرره على نباتين لدراسه تاثير الرش بمضادات الاكسده وبعض منظمات النمو خلال فتره الحصاد على جوده وتخزين ثمار الموز بعد اجراءعملية الانضاج بواسطة غاز الاثيلين ٢٠سم٣/٢٠سم٢ لمدة ٤ ساعاتثم تخزينها تحت الظروف المحاكية للتسويق التجارى من الحراره والرطوبه بعد معاملتها بالنقع فى محلول الشيتوسان ١.٥% لمدة ١٥ دقيقه ثم تجفيفها وتخزينها.

ا. **معاملات قبل الحصاد** (المقارنة الرش بمياه صنبور، حامض السالسيليك ٤ ملليمول، حامضالاسكوربيك ١٠٠٠ جزء فى المليون، السيتوكينين ٥٠ جزء فى المليون، فيتامينهـ ٢٠٠ جزء فى المليون ، و جبريللين ٤+٧٠٩ جزء فى المليون). جميع المعاملات رشت مرتين، الاولى فى مايو بعد خروج الكف الاخير والثانيه فى يونيو عند بدايةامتلاء الاصابع.

ب. **في مرحلة ما بعد الحصاد:** بعد النضج الصناعىتم قياس القياسات الفيزيائيه والكيميائيه للثمار ثم قسمتكل معامله الى جزئين. جزء ١ :(المخزن بدون معامله بعد الحصاد بالشيتوسان): ويضم T1 (المقارنة الرش بمياه صنبور)، T3 (حامضالسالسيليك ٤ ملليمول)، T5 (حامضالاسكوربيك ١٠٠٠ جزء)، T7 (سيتوكينين ٥٠ جزء فى المليون)، T9 (فيتامين هـ ٢٠٠ جزء فى المليون) وT11 (و جبريللين ٤+٧٠٩ جزء فى المليون) والجزء ٢:(المخزن بعد الغمس فى الشيتوسان ١.٥% لمدة ١٥دقيقه)ويضمT2 (الكنترول + الشيتوسان ١.٥%)، T4 (سالسيليك اسيد + الشيتوسان ١.٥%)، T6 (اسكوربيك اسيد + الشيتوسان ١.٥%)، T8 (سيتوكينين + الشيتوسان ١.٥%)، T10 (فيتامين هـ+ الشيتوسان ١.٥%) وT12 (جبريللين ٤+٧+ الشيتوسان ١.٥%). وقد اخذت القياسات الفيزيائيه والكيميائيه عند ٣، ٦، ٩ يوم خلال فترة التخزين لثمار الموسم الصيفى.

اوضحت النتائج خلال التجربه انه بعد وخلال التخزين تحت ظروف الغرفة من درجة الحرارة(٣٣±٢) والرطوبه(٦٣±٢%) وجد ان الجمع بين معاملات ما قبل الحصاد والشيتوسان بعد الحصاد قلل معنويا من نسبة زياده النسبه المئويه للمواد الصلبه الذائبهوالفقد فى الوزن و كذلك النسبه المئويه للثمار التالفه.اما بالنسبه للصفات الكيميائيه المقاسه كان هناك معنويا تاثيرات ايجابيه للمعاملات عن طريق خفض معدلات تكسر صبغات الكلوروفيل (أ + ب) و النشا مع تقليل معدلات تراكم المواد الصلبه الذائبه والسكريات الكليه الذائبهفى نهاية فترة التخزين.ومن هذه الدراسه وجد ان النتيجه المميزه من استخدام منظمات النمو مثل الجبريلين٤+٧و السالسيليك اسيد في مرحلة ما قبل الحصاد بالمشاركه مع الشيتوسان ١.٥% في مرحلة ما بعد الحصاد تعتبر افضل المعاملات المستخدمه لاطاله العمرالتسويقلثمار الموز مع الحفاظ على جودتها.