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EFFECT OF SPRAY WITH CALCIUM AND SOME POST-HARVEST TREATMENTS ON FRUIT QUALITY AND STORABILITY OF GUAVA FRUITS

BY

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ABSTRACT

Baladi Guava (*Psidium guajava* L.) (local cv.) trees of 10 years old were sprayed in 2003 & 2004 seasons with two concentrations (0.25, 0.50%) of calcium chelate (10% calcium EDETA) at three weeks after full bloom and repeated at four weeks prior to harvest. A group from every treatment was dipped in 3% rice starch solution as a post-harvest treatment. After harvest, all treatments were stored at 10 °C for 21 days. Results in both seasons showed that pre-and post-harvest treatments were effective in improving fruit quality and storability, especially 0.5% calcium with 3% rice starch, it was more effective in reducing decay and weight loss percentage.

Key words: Guava, foliar spray, calcium, fruit quality, dipping, rice starch, storability, respiration rate, decay percentage, shelf life.

INTRODUCTION

Guava (*Psidium guajava L.*) is an important tropical fruit crop. Guava fruits are quite popular in Egypt owing to its commercial, nutritional values and cheep price. In Egypt, total area of guava reached about 33371 feddans with total fruit production of 244575 tons and the exported quantities were 12909 tons (according to the statistics of the Ministry of agriculture, Egypt, 2002). In Nawa region in Qaluobia, Egypt, the growers used to force guava trees to yield at winter season, most of the yield is exported and the rest is locally sold at a good price. Guava fruits are markedly subjected to various post harvest disorders during marketing, transit and storage, with an average short shelf life, (Gupta and Mukherjee (1980).

Mishra *et al.* (2003) cleared that pre-harvest application of calcium nitrate increased the shelf life and reduced the physiological loss in weight of guava fruits. Aly and Ismail (2000) reported that guava fruits from trees treated with 0.5% $CaCl_2$ were firmer and of better quality than control fruits.

Baneh *et al.* (2003) stated that the foliar application of 1% $CaCl_2$ increased fruit firmness and had a significant effect on weight loss of apple fruit.

Hisaw (1991) observed that apple fruits having adequate tissue calcium concentrations were firmer and could be stored for longer periods than those of low calcium contents.

Moon (2002), made electron microscopic study of the cell walls and revealed the high integrity of middle lamella of liquid calcium-treated pear fruits compared with that of untreated. Youn (2000) reported that earlier foliar sprays of 0.3% $CaCl_2$ tended to decrease the incidence of physiological disorders during storage of pear fruits.

Nawar and Ezz, (1994) revealed that 3% $CaCl_2$ dipping treatment reduced fruit browning and improved fruit quality of guava fruits.

Calcium has wildly bean reported to play an important structural role in providing firmness and mechanical strength to cell walls, (Povaiah *et al.*, 1988). The fruits treated after harvest with either 3 % rice starch or with 12 % wax emulsion were found to retain good quality. It is suggested that a 3 % rice starch can be used as a substitute for wax emulsion treatment for extending the post harvest shelf life of guava fruits, (Singh and Mohammed, 1997).

Guava is a climacteric fruit and its shelf life at room temperature is only few days, but storage at low temperature extend it is life. Mehaisen and El-Sharkawy, (2005) found that Baladi guava fruits can be stored successfully for three weeks at 10°C and at 85-90% RH.

Vazquez-Ochoa and Colinas-Leon, (1990) reported that a temperature of 8-10°C is regarded to be the critical limit for limiting chilling injury for several cultivars of guava.

This investigation aims to maintain fruit quality specially fruit firmness beside reducing the losses (decayed fruits) after harvest and during marketing, transit and storage to increase the shelf life and the export of Baladi guava fruits by using pre-harvest calcium sprays, post harvest treatments and cold storage at 10°C.

MATERIAL AND METHODS

This study was carried out during two successive season (2003 & 2004) on 10 years old mature healthy Baladi guava trees (*Psidium guajava, L.*) (local cv.) Propagated by suckers and grown in a private orchard at Nawa region in Qaluobia governorate, Egypt. The experimented trees are grown on a clay soil, nearly uniform in vigour and received the same cultural practices, selected and divided into three groups, each group received one of the following treatments three weeks after full bloom and repeated at four weeks prior to harvest during both experimental seasons:

T1: Foliar sprays with 0.25 % calcium chelate (10% ca EDETA)
T2: Foliar sprays with 0.50 % calcium chelate (10% ca EDETA)
T3: Control trees were foliar sprayed with tap water

In both seasons, guava fruits were harvested at the first week of March at one green maturity stage and were directly transported to the laboratory Uniform fruits in each treatment were washed, air dried and divided into two groups the first group was dipped in 3% rice starch solution, as natural coating, meanwhile, the second one of fruits was left undipped In all treatments fruits were divided into three replicates, each replicate contained of two boxes and each box contained 24 fruits

Every fruit was surrounded with fine tissue paper (with the pedicel end vertically upwards) then packed in one layer inside carton boxes and stored at 10 °C with 85-90% RH

For physical and chemical determinations, a sample consisting of 3 fruits was taken randomly from each replicate within each treatment at 7 days intervals of storage

Fruit decay was calculated, fruit weight loss was recorded, fruit colour was measured using Hunter colorimeter Model Dp9000 fruit firmness was estimated by Lfra texture analyzer using a penetrating needle of 1mm of diameter, 5 mm in distance speed 2mm per second and the peak of resistance was recorded per gram Total soluble solids were determined by A bbe refractometer and total acids % according to Vogel (1968) ascorbic acid was determined according to (Horwitz, 1970)

Respiration rate (for second season) sample of fruits were taken from coated fruits and the control. CO_2 was determined according to Cross method (1966) The respiration rate was calculated as ml CO_2/kg /hr as follows

$$\frac{\text{(Concentration of } CO_2 \text{ for sample x 10) (free space volume of container in liters)}}{\text{(Product fruit weight in kg.) (time container enclosed in hours)}}$$

Shelf life a sample of ten fruits of each replicate was taken out at the end of storage at 10°C and left at room temperature (20-22°C) for three days, the percentage of decayed fruits were calculated and considered as an indicator for shelf life

The obtained data were statistically analyzed using randomized complete block design for factor A (pre-harvest treatments) with factor B (post harvest treatments) as a split plot on A and factor C (storage periods) as a split plot on B according to Snedecor and Cochran (1982) L.S.D method (at 5% level was used to compare the effects of pre-harvest treatments (A), post harvest treatments (B), storage periods (C) and their interactions

RESULTS AND DISCUSSION

1. Fruit physical comsposition:

1.1. Decayed fruit percentage:

Data presented in Table (1) showed that the decay percentage of fruits significantly increased as the storage period increased during storage at 10°C Foliar spray of calcium treatments (0.25% & 0.5%) showed lower values of decayed fruits percentage especially with the high concentration (7.6%) than control ones (21%) at the end of storage in both seasons The least percent of

decaying (6 %) was obtained when fruits from pre- harvest treatment (0.5 % $CaCl_3$) and dipped in (3%) rice starch as natural coating as a post-harvest treatment especially with 0.5% calcium (6%) than untreated fruits (14.6%) in both seasons. The interaction effect of storage periods and either pre- or post-harvest treatments was significant in both seasons in this work.

These observations are very close to those obtained by Kadir (2004) revealed that apple trees when sprayed one to 8 times with foliar applications of 8.97 kg calcium chloride/ha., reduced decayed fruits. Similar results were obtained by Ahmed Amen (1987).

1.2. The percentage of weight loss:

Data in Table (1) cleared that weight loss percentage significantly increased by prolonging the storage periods with pre- and post- harvest treatments during storage at 10 °C (storage life 21 days). Also, data showed that, the reduction in weight loss percentage was noticed when fruits of Ca (0.5%) were dipped in 3% Rice starch (3.6%) than the control (5.2%) in both seasons.

The interaction effect of storage periods and either pre- or post-harvest treatments was significant in the first season.

These results are in line with those suggested by Mishra *et al.*, (2003), as they reported that preharvest application of calcium nitrate 1.0% reduced the physiological loss in weight of guava fruits. Also, Baneh *et al.*, (2003) found that the effect of foliar spray of 1% $CaCl_2$ had a significant effect on weight loss at 5% level in storage. Tabatabaie and Malakouti (1998) reported that weight loss of apple fruits in storage was reduced by 30% compared with control when 1% $CaCl_2$ was applied.

1.3. Fruit colour:

Fig. (1) indicated that guava fruits sprayed with Ca had green colour at harvest and the changes in colour during storage at 10 °C, was restarted. On the other hand control fruits had yellow colour during storage than other treatments in both seasons.

The obtained data were in harmony with the result of Meheriuk (1990) found that pre-harvest foliar application of 10 g urea/liter or 7.5 g $Ca(NO_3)_2$ weekly for 5 consecutive weeks from late August increased green colour in Newtown apples at harvest and during storage for up to 180 days, compared with fruits from control trees.

1.4. Fruit firmness

Data in Table (2) showed that, flesh firmness of guava fruits significantly decreased by extending storage period with all treatments during storage at 10 °C. Pre-harvest treatments increased fruit firmness, especially fruits were sprayed with Ca 0.5% as they firmer (308 gm/cm^2) than control ones (248 gm/cm^2) at harvest time. On the other hand, fruits treated with Ca 0.5% and dipped in (3%) rice starch (as post-harvest treatment) exerted the highest values in fruit firmness (213.7 gm/cm^2) than other post-harvest treatments in both seasons during storage at 10°C. The interaction between pre- or post harvest treatments and storage periods was highly significant.

Table (1): Effect of some pre-and post-harvest treatments on Decayed fruits (%) and fruit weight loss (%) during storage at ambient temperature at 10C in (2003 & 2004 seasons)

Character		Decayed Fruits (%)																											
Season		1st season							2nd season							1st season							2nd season						
Treatment		Storage periods (C)				Mean			Storage periods (C)				Mean			Storage periods (C)				Mean			Storage periods (C)				Mean		
Pre-harvest (A)	Post harvest (B)	0	7	14	21	A	B	A x B	0	7	14	21	A	B	A x B	0	7	14	21	A	B	A x B	0	7	14	21	A	B	A x B
Control	Without	0.0	7.0	26.2	52.8	18.2	13.8	21.5	0.0	6.8	24.0	51.2	17.4	13.2	20.5	0.0	3.7	5.8	12.5	5.2	4.5	5.5	0.0	3.8	6.4	13.2	5.6	4.9	5.9
	Coated	0.0	6.4	17.0	36.4		10.1	15.0	0.0	5.5	16.2	35.0		9.8	14.2	0.0	3.2	5.0	11.4		4.2	4.9	0.0	3.4	5.6	12.0		4.5	5.3
Ca 0.25	Without	0.0	3.8	16.4	28.5	10.8		12.2	0.0	3.6	16.0	26.8	10.4		11.6	0.0	3.3	4.7	9.9	4.4		4.5	0.0	3.7	5.2	10.5	4.7		5.0
	Coated	0.0	3.0	12.8	22.0			9.5	0.0	3.1	12.7	21.0			9.2	0.0	2.9	4.6	9.7			4.3	0.0	3.3	4.5	10.1			4.5
Ca 0.50	Without	0.0	2.8	9.9	18.3	6.9		7.8	0.0	2.6	9.5	17.6	6.7		7.4	0.0	2.3	3.6	7.9	3.5		3.5	0.0	2.8	4.7	8.4	3.9		4.0
	Coated	0.0	2.2	7.9	14.0			6.0	0.0	2.4	7.5	13.8			5.9	0.0	2.1	4.3	7.5			3.5	0.0	2.7	4.4	7.9			3.8
Mean (C)		0.0	4.2	15.0	28.7				0.0	4.0	14.3	27.0				0.0	4.7	9.8					0.0	3.3	5.1	10.4			
Table of means																													
A C		0.0	6.7	21.6	44.6				0.0	6.2	20.1	43.2				0.0	3.5	5.4	12.0				0.0	3.6	6.0	12.6			
		0.0	3.4	14.6	25.3				0.0	3.4	14.4	23.9				0.0	3.1	4.7	9.8				0.0	3.6	4.9	10.3			
		0.0	2.5	8.9	16.1				0.0	2.5	8.5	15.7				0.0	2.2	4.0	7.7				0.0	2.7	4.6	8.2			
B C		0.0	4.5	17.5	33.2				0.0	4.3	16.5	31.9				0.0	3.1	4.7	10.1				0.0	3.5	5.4	10.7			
		0.0	3.9	12.7	24.1				0.0	3.7	12.1	23.3				0.0	2.7	4.6	9.5				0.0	3.1	4.8	10.0			

L.S.D. 0.05 %

Character	A	B	A x B	C	A C	B C	ABC	A	B	A x B	C	A C	B C	ABC
1st season	0.51	0.29	0.50	0.34	0.59	0.48	0.83	0.30	0.14	0.24	0.19	0.33	0.27	0.46
2nd season	0.49	0.38	0.67	0.37	0.63	0.52	0.90	0.18	0.26	N.S.	0.22	0.38	0.31	N.S.

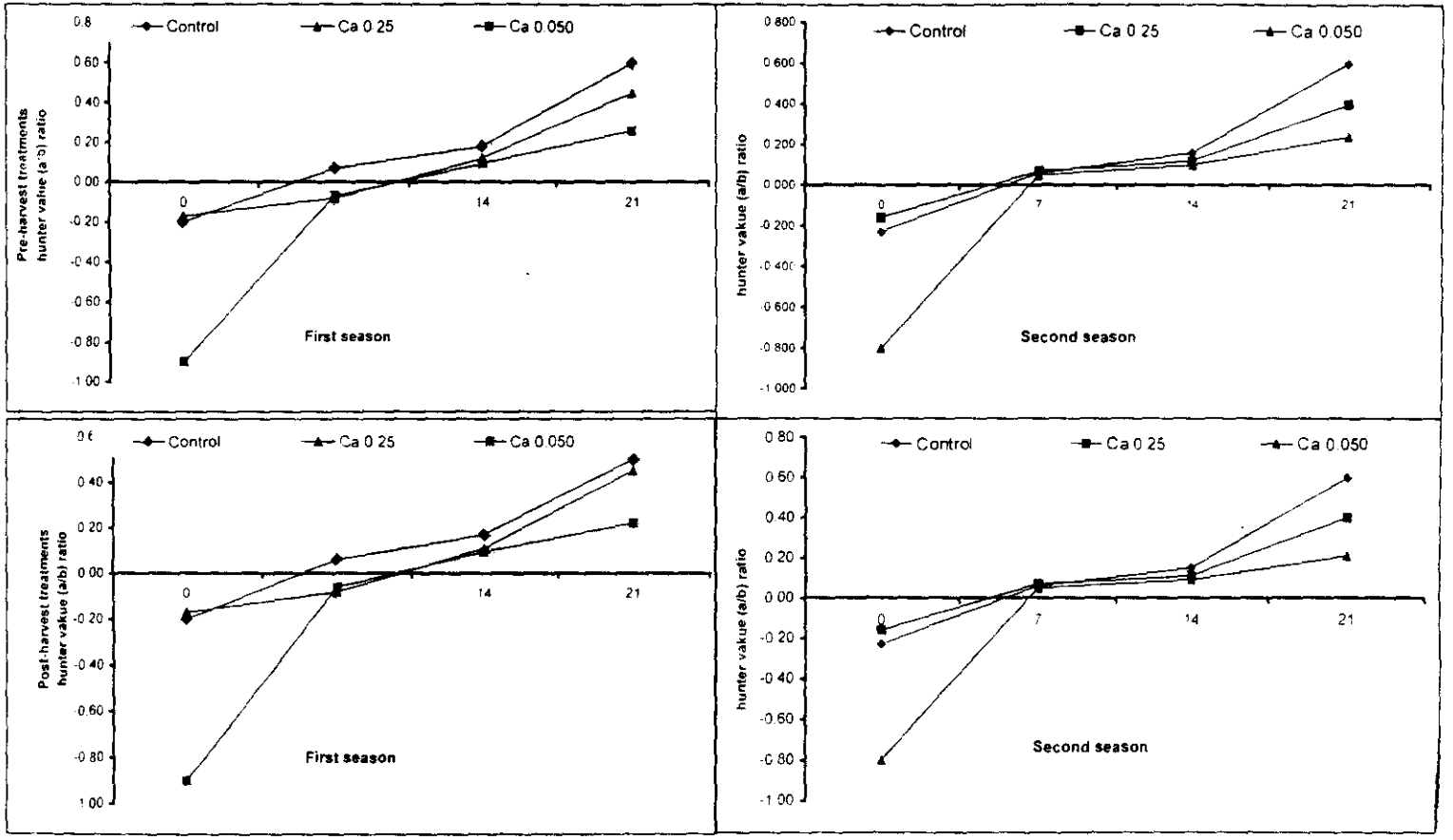

Fig. (1): Effect of pre- and post harvest treatments on fruit colour during storage at 10 °C in (2003 & 2004 seasons).

Table (2): Effect of some pre-and post-harvest treatments on fruit firmness (gm/cm2) and total soluble solids (TSS) % during storage at 10C in (2003 & 2004 seasons)

Character		Fruit firmness (gm/cm2)														Total soluble solids (TSS %)													
Season		1st season							2nd season							1st season							2nd season						
Treatment		Storage periods (C)				Mean			Storage periods (C)				Mean			Storage periods (C)				Mean			Storage periods (C)				Mean		
Pre-harvest (A)	Post harvest (B)	0	7	14	21	A	B	A x B	0	7	14	21	A	B	A x B	0	7	14	21	A	B	A x B	0	7	14	21	A	B	A x B
Control	Without	250.0	168.0	125.0	70.0	150.1	205.4	153.3	245.0	162.0	100.0	54.0	137.3	168.0	140.3	9.9	10.1	10.8	11.4	10.4	10.3	10.6	10.7	11.1	11.3	11.4	11.1	10.8	11.13
	Coated	250.0	159.0	118.0	61.0		199.6	147.0	245.0	154.0	93.0	45.0		164.0	134.3	9.9	10.1	10.5	10.7		10.1	10.3	10.7	11.0	11.2	11.4		10.7	11.08
Ca 0.25	Without	305.0	255.0	210.0	100.0	214.8		217.5	270.0	220.0	135.0	73.0	173.3		174.5	9.6	10.0	10.5	11.2	10.2		10.3	10.2	10.7	11.0	11.3	10.7		10.80
	Coated	305.0	250.0	205.0	88.0			212.0	270.0	216.0	132.0	70.0			172.0	9.6	9.9	10.4	10.8			10.2	10.2	10.5	10.8	11.0			10.60
Ca 0.50	Without	327.0	275.0	235.0	145.0	242.6		245.5	288.0	240.0	151.0	78.0	188.4		189.3	9.1	10.0	10.5	10.7	10.0		10.1	9.8	10.1	10.5	11.3	10.4		10.40
	Coated	327.0	270.0	222.0	140.0			239.8	288.0	238.0	148.0	76.0			187.5	9.1	10.0	10.3	10.5			10.0	9.8	10.0	10.4	11.2			10.40
Mean (C)		294.0	229.5	185.8	100.7				267.7	205.0	126.5	66.0				9.5	10.0	10.5	10.9				10.2	10.7	10.9	11.3			
Table of means																													
A C		250.0	163.5	121.5	65.5				245.0	158.0	96.5	49.5				9.9	10.1	10.7	11.1				10.7	11.1	11.3	11.4			
		305.0	252.5	207.5	94.0				270.0	218.0	133.5	71.5				9.6	10.1	10.5	11.0				10.2	10.6	10.9	11.2			
		327.0	275.5	228.5	142.5				288.0	239.0	149.0	77.0				9.1	10.0	10.4	10.6				9.8	10.0	10.5	11.3			
B C		394.0	232.7	190.0	105.0				267.7	207.3	128.7	68.3				9.5	10.0	10.6	11.1				10.2	10.6	10.9	10.3			
		294.0	226.3	181.7	96.3				267.7	202.7	124.3	63.7				9.5	10.0	10.4	10.7				10.2	10.5	10.8	11.2			

L.S.D. 0.05 %

Character	A	B	A x B	C	A C	B C	ABC	A	B	A x B	C	A C	B C	ABC
1st season	3.63	3.83	6.64	2.15	6.45	4.30	N.S	N.S	N.S	N.S	0.20	N.S	N.S	N.S
2nd season	1.43	3.14	N.S	3.10	5.29	N.S	N.S	0.16	N.S	N.S	0.15	0.27	N.S	N.S

Baneh *et al.*, (2003) found that the effect of foliar application of (1%) $CaCl_2$ on apple fruit firmness was significant at 1% level. Similar results were obtained by Tabatabaie and Malakouti (1999) as they cleared that apple fruit firmness prior to storage significantly increased and with a maximum of (1.7 kg/cm^2) when 1% $CaCl_2$ was applied twice.

2. Fruit chemical changes during storage periods:

Data presented in Table (2) showed that, total soluble solid contents increased by prolonging the storage period with all treatments. Pre- and post-harvest treatments decreased the loss in T.S.S. compared with control in both seasons but had no significant effect. On the other hand data in Table (3) cleared that, the pre- harvest treatments increased total acidity at harvest, and it decreased significantly by extending the storage period. Post- harvest treatment had the same trend in both seasons. The interaction between pre- or post-harvest treatments and storage periods was significant.

Data in Table (3) showed that, the pre- harvest treatments with calcium of (0.25% & 0.50%) significantly increased fruit ascorbic acid contents at harvest while it decreased with extended storage at 10°C. Fruit of Ca 0.50% and dipped in 3% rice starch solution had a slow rate in Vit.C decreases during storage in both seasons.

The interaction of pre-harvest, post-harvest treatments and storage periods was highly significant in both seasons. Ca- treated fruits maintained its soluble solids content, acidity and ascorbic acid content during the storage period due to the role of Ca in regulating respiration and other metabolic processes (Raychaudhary *et al.*, 1992) on L-49 guava; (Shandra *et al.*, 1994) on Allahabad Safeda guava. These data were in line with those obtained by Mishra *et al.*, (2003) as they revealed that twice spraying of calcium nitrate 1% reduced ascorbic acid of fruits for more than 3 days at ambient storage temperature. They also reported that the treatment had no significant effect on fruit acidity of guava fruits. Baneh *et al.*, (2003) studied the effect of foliar application on apple trees; treated with 2, 4, and 6 foliar sprays of $CaCl_2$ at 0, 0.5, 1.0 and 1.5% in weekly. The foliar application of $CaCl_2$ decreased T.S.S. compared to control but did not affect the acidity content.

3. Respiration rate:

Data in Fig. (2) showed that foliar sprays of Ca reduced fruit respiration rate than control either at harvesting time or during storage. Singh *et al.*, (1993) reported that Ca- treated mangoes fruits (0.6 % Ca^{2+} as $CaCl_2$ foliar spray) had a lower respiration rate than control. Moon *et al.*, (1999) found that respiration rate was reduced in "Tsugaru" apple fruit when apple trees were sprayed with oyster calcium of foliar sprays.

4. Shelf life:

Fig. (3) showed that with prolonging storage periods, the decay percentage of guava fruits was increased and the shelf life was decreased. Moreover pre-harvest spray treatments enhanced shelf life of fruits, also post-harvest treatment (3 % rice starch) extended the shelf life of guava fruits. Mishra *et al.*, (2003) reported that preharvest application of calcium nitrate increased the

Table (3): Effect of some pre-and post-harvest treatments on fruit total acidity (%) and vitamin C (%) during storage at 10C in (2003 & 2004 seasons)

Character		Total acidity (T.A.) %													Vitamin C (%)												
Season		1st season							2nd season						1st season							2nd season						
Treatment		Storage periods (C)				Mean			Storage periods (C)				Mean		Storage periods (C)				Mean			Storage periods (C)				Mean		
Pre-harvest (A)	Post harvest (B)	0	7	14	21	A	B	A x B	0	7	14	21	A	B	A x B	0	7	14	21	A	B	A x B	0	7	14	21	A	B	A x B
Control	Without	0.43	0.35	0.36	0.25	0.34	0.34	0.33	0.42	0.39	0.32	0.26	0.35	0.36	0.35	234.0	185.0	151.0	147.0	175.8	220.9	179.3	252.0	199.0	168.0	157.0	190.8	235.2	194.0
	Coated	0.43	0.38	0.31	0.25		0.37	0.34	0.42	0.40	0.33	0.27		0.38	0.36	234.0	175.0	142.0	138.0		208.5	172.3	252.0	188.0	160.0	150.0		224.2	187.5
Ca 0.25	Without	0.41	0.36	0.30	0.25	0.36		0.33	0.42	0.32	0.34	0.28	0.35		0.34	262.0	252.0	196.0	164.0	211.5		218.5	270.0	266.0	210.0	182.0	226.5		232.0
	Coated	0.41	0.38	0.43	0.30			0.38	0.42	0.39	0.36	0.30			0.36	262.0	227.0	178.0	151.0			204.5	270.0	247.0	192.0	175.0			220.9
Ca 0.50	Without	0.47	0.39	0.33	0.26	0.37		0.37	0.50	0.40	0.36	0.27	0.40		0.39	336.0	290.0	245.0	189.0	256.9		265.0	350.0	303.0	262.0	203.0	271.9		279.5
	Coated	0.47	0.41	0.35	0.28			0.38	0.50	0.44	0.38	0.30			0.41	336.0	269.0	215.0	175.0			248.8	350.0	287.0	224.0	196.0			264.3
Mean (C)		0.44	0.38	0.34	0.27				0.45	0.40	0.35	0.28				277.3	233.0	187.8	160.7				290.7	248.3	202.7	177.2			
Table of means																													
A C		0.43	0.37	0.31	0.25				0.42	0.40	0.33	0.27				234.0	180.0	146.5	142.5				252.0	193.5	164.0	153.5			
		0.41	0.37	0.37	0.28				0.42	0.36	0.35	0.29				262.0	239.5	187.0	157.5				270.0	256.3	201.0	178.5			
		0.47	0.40	0.34	0.27				0.50	0.44	0.37	0.29				336.0	279.0	230.0	182.0				250.0	295.0	243.0	199.5			
B C		0.44	0.37	0.31	0.25				0.45	0.38	0.34	0.27				277.3	242.3	147.3	166.7				290.7	256.0	213.3	180.7			
		0.44	0.39	0.36	0.28				0.45	0.41	0.36	0.29				277.3	223.7	178.3	154.7				290.7	240.6	192.0	173.7			

L.S.D. 0.05 %

Character	A	B	A x B	C	A C	B C	ABC	A	B	A x B	C	A C	B C	ABC
1st season	0.01	0.02	N.S.	0.02	0.03	0.03	N.S.	2.89	1.32	2.28	2.22	3.84	3.14	5.44
2nd season	0.01	0.01	N.S.	0.02	0.03	N.S.	N.S.	1.55	2.43	4.21	2.20	3.82	3.12	5.40

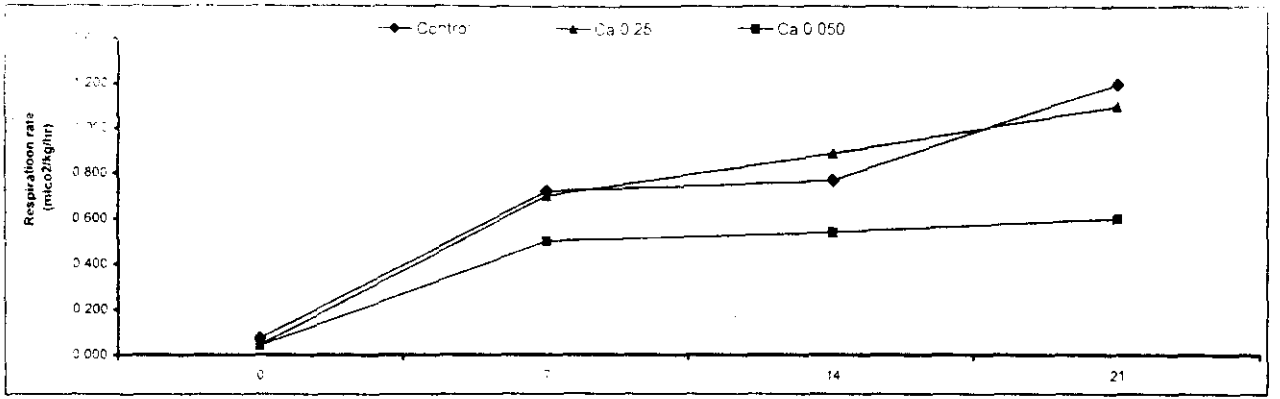

Fig. (2): Effect of foliar sprays with calcium on fruit respiration rate (ml Co2 kg/hr) during storage at 10 °C (average of both seasons).

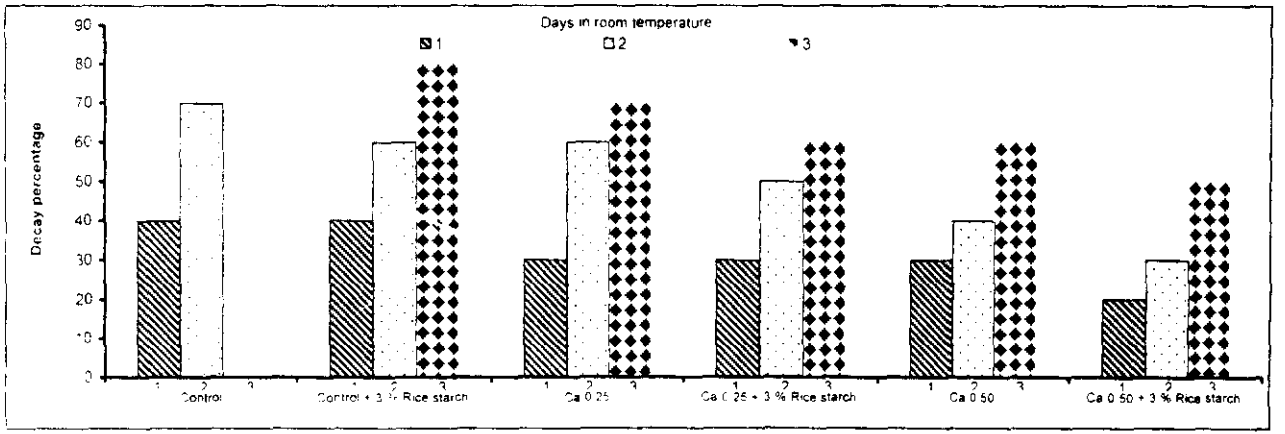

Fig. (3) Effect of pre-and post-harvest treatments on shelf life of guava fruits stored at at 10 °C (average of both seasons).

shelf life of guava fruits regardless of the application method used. Hisaw (1990) revealed that apple fruits having adequate tissue Ca concentrations could be stored for longer periods than untreated fruits. Singh and Mohammed (1997) reported that guava fruits were treated after harvest with 6 or 12 % wax emulsions or with 3 or 6 % rice starch and stored for up to 12 days at room temperature (16.5 – 22.5 °C). The fruits treated with either 3 % rice starch or with 12 % wax emulsion were found to retain good fruit quality. It is suggested that a 3 % rice starch treatment can be used as a substitute for wax emulsion treatments for extending the post-harvest shelf life of fully ripe guava fruits to up to 12 days.

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تأثير الرش بالكالسيوم وبعض معاملات بعد الحصاد على صفات الجودة والمقدرة التخزينية لثمار الجوافة

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اجريت هذه الدراسة على أشجار جوافة بلدى (صنف محلـــى) عمرهـــا ١٠ سنوات تم اكثارها بالسرطانات، متماثلة تقريبا فى نموها الخضرى ومنزرعة بـــارض طينية على مسافة ٥ × ٥ م وتروى غمرا وتنتج ثمارها شتاءا بطريقة التصويم وذلـــك بحديقة خاصة بمنطقة نوى محافظة القليوبية مصر.

تم رش الاشجار بالكالسيوم المخلبي بتركيـــزي (٠,٢٥ %، ٠,٥٠ %) بعـــد كتمال التزهير بثلاثة اسابيع وقبل الجمع بأربعة اسابيع خلال عامي٢٠٠٣ و٢٠٠٤ م.

تم جمع الثمار في الاسبوع الأول من شهر مارس ونقلت إلى المعمل حيث تم غسل وتجفيف وفرز الثمار وقسمت ثمار كل معاملة إلى قسمين: تم غمس ثمار القســـم الاول في محلول ٣% نشا الارز، وثمار القسم الثاني تركت بدون معاملة وتم تخـــزين كل المعاملات على درجة ١٠ °م ورطوبة نسبية (٨٥ - ٩٠ %) لمدة ٢١ يوم وأخـــذت العينات لتقدير صفات الجودة كل سبعة أيام.

اوضحت نتائج هذه الدراسة ان المعاملة بالكالسيوم المخلبي ادت إلى تحســـين صفات الجودة والمقدرة التخزينية وخاصة المعاملة بالكالسيوم (٠,٥ %) مع ٣% نشـــا الأرز (كمعاملة بعد الحصاد). والتى كانت اكثر المعاملات تأثيرا فى تقليل نسبة التالف والفقد فى الوزن