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BIOCHEMICAL PROPERTIES AND FRUIT QUALITY OF "JAHANGIRI" (*PRUNUS ARMENIACA* L.) APRICOT FRUIT UNDER CALCIUM CHLORIDE TREATMENT

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ABSTRACT. Worldwide, the nutritional value and health benefit of apricot fruit (*Prunus armeniaca* L., Rosaceae) has been known. The present study was therefore undertaken to assess the effects of $CaCl_2$ pre harvest treatment on some of the biochemical properties and fruit quality of "Jahangiri" (*Prunus armeniaca* L.) apricot at harvest time and during four weeks cold storage at $0^{\circ}C$. The combined analysis of variances indicated that year had a significant influence on all studied parameters of "Jahangiri" cultivar. $CaCl_2$ pre harvest treatments also affected significantly the most of studied parameters. The interaction between year and Ca treatment was also significant. Results of these tests showed that pre-harvest application of Ca foliar spray increased some of biochemical properties (protein, free amino acid and non protein) and fruit quality (fruit density) of apricot cultivar "Jahangiri". In addition, the contents of fruit-Ca, -Mg, -N, and vitamin C were higher than those in the control at harvest time and after four weeks storage at $0^{\circ}C$. The characteristics that correlated best with the fruit Ca content included fruit pH, fruit density, vitamin C of fruit and fruit Mg. The results also showed that the most effective pre-harvest $CaCl_2$ application for apricot "Jahangiri " was found to be 0.5 % $Ca\ Cl_2$ in 46 days after full bloom.

Key words: "Jahangiri"; Calcium chloride treatment; Biochemical properties; Fruit quality.

INTRODUCTION

Apricot has an important place in terms of human health. Apricot is rich in mineral content, such as potassium, copper manganese, magnesium, and phosphorous. Apricots are also a very good source of dietary fiber, like most fruits. The impressive health benefits of apricots are due to the content of vitamins, including vitamins A, C, K, E, and niacin in significant amounts, as well as a number of other essential

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vitamins in trace amounts (less than 5% of daily requirement), as well as their mineral content, Apricot has an important place in terms of human health (Hacıseferoğulları *et al*., 2007).

Statistical data for apricot trees in Iran are as follows: annual production amounts to 460000 tones, an area harvested of 50500 ha is under apricot cultivation and average annual yield is 91089 hg/ha (FAO, 2012). In Iran, the most widely produced type of apricot is "Jahangiri". The biochemical properties and fruit quality of this type of apricot is important for post-harvesting technology transporting, storing, and processing it into different food.

It has been reported that Ca often influences various senescence characteristics, such as ripening of fruit (Paliyath *et al.,* 1984; Richardson and Al-Alani, 1982; Eaks, 1985; Robson *et al.,* 1989) and fruit firmness (Knee, 1974) and calcium content in fruit (Tzoutzoukou and Bouranis, 1997) and also biochemical composition (Sartaj, 2013). Many studies have reported on the apricot crop in Iran (Jannatizadeh *et al.,* 2008; Filsoof, 1976; Ghasemnezhad, 2010). But to our knowledge, little information is available concerning biochemical properties and fruit quality of "Jahangiri", an Iranian apricot, a fruit that has potential nutritional, medical and commercial values.

This study was conducted to examine the effect of pre-harvest calcium foliar application on biochemical properties and fruit quality in "Jahangiri"(*Prunus armeniaca* L.) apricot fruit at harvest time and after four weeks cold storage at $0^{\circ}C$.

MATERIAL AND METHOD

The study was conducted to examine the effects of $CaCl_2$ pre-harvest treatment on biochemical properties and fruit quality in "Jahangiri"(*Prunus armeniaca* L.) apricot fruit at harvest time and after four weeks cold storage at $0^{\circ}C$, which were grown at the experimental orchard of horticultural research station of Kamalabad in province of Alborz, Iran).

The samples of the fruits were determined at harvest time and during four weeks storage at $0^{\circ}C$. The study was carried out in two experimental years, 2010-2011. Calcium was applied 30, 38, and 46 days after full bloom at the concentrations of 0.5% and 1% calcium chloride. Mature, full bearing of studied apricot trees (all trees were 4 years old, 3 meters spacing and stocks were apricot seeds) were used for obtaining the fruit in all the tests. Date of full bloom in the first year of experiment were 18 March 2010 and for the second year of experiment on 2 April 2011**.** The fruits were collected on 18 July in 2010 and 2 June in 2011.

Mineral content{Ca (%), Mg (%), N (%), K (%) and P (%)}, total non protein nitrogen, free amino acid content, crude potential, fruit flesh dry and wet weight (g), flesh fruit firmness (kg m^{-3}) and fruit density (cm^3), soluble solids content, soluble solids content, fruit density, vitamin C{Ascorbic acid (AA)} contents, pectin content (%) of studied apricot variety were determined in individual fruits (three replicates per treatment) and analyzed at harvest time and during four weeks storage at $0^{\circ}C$.

Soluble solids content (Brix) was determined by hand digital refract meter and **pH** by a 510 pH meter. Soluble solids content was measured with an effigy pressure tester using an 8-mm tip on the two opposite sites of each fruit, the test results expressed as $kg.m^{-3}$. **Fruit density** was determined by the water displacement method (Dutta *et al.,* 1988). Randomly selected apricot fruits were weighed on a digital balance with 0.01 g accuracy. The fruits were lowered with a metal sponge sinker into measuring cylinder containing water such that the fruits did not float during immersion in water; weight of water displaced by the fruit was recorded. **Nitrogen** was determined by micro-Kjeldahl method (AOAC 1980) and **calcium, magnesium** were determined by atomic absorption spectophotometry (AOAC 1980). **P** was analyzed by the molibdovanadate method using a Jenway 6305UV–VIS spectrophotometer. **K** was analyzed by flame photometry using a Jenway PFP7 flame photometer (Jenway, Essex, UK).

To determine the amount of **non-protein nitrogen**, trichloroacetic acid (TCA, 10% w/v), which precipitates protein, was added to 2 g portions of dry pulp. Enough TCA was added to allow the sample to be homogenized, poured into a centrifuge tube, and centrifuged. The protein-free supernatant was collected and analyzed with the micro-Kjeldahl method to determine **total non-protein nitrogen** (Woyewoda *et al.,* 1986) and with the ninhydrin method (Kates, 1986) to determine **free amino acid** content. To determine **protein nitrogen**, the amount of non-protein nitrogen was subtracted from total nitrogen. To determine **crude potential**, the amount of total multiplied by 6.25 sources (Douglas *et al.,* 2000).

To determine extract and analyze of **vitamin C**, ascorbic acid (AA) contents were determined as described by Zapata and Dufour (1992). Pear flesh (10 g) was homogenized in 10 ml of methanol/water (5:95 v/v) plus citric acid and EDTA (0.5 g l^{-1}) in an Ultraturrax T-25 (Jauke and Kunkel IKA, dabortechnik, Staufen, Germany) for 3 min. Then pH was adjusted to 2.2 - 2.4 and the extract was adsorbed onto a C18 Sep-Pak cartridge (Waters Associates, Milford, MA, USA). The resultant solution was made with 1, 2- phenylenediamine dihydrochloride (OPDA) (Fluka Chemika, Neu-Ulm, Switzerland) for 37 min prior to analysis by HPLC. AA content was expressed as mg 100 g^{-1} fresh weight. Fruit flesh was analyzed for 10 fruit in three replications. Standard solutions, column conditioning and production procedures were made according to the method cited in Ferreres *et al.* (1991). Ascorbate determinations were made for fruit flesh in triplicate.

To determine **pectin content (%)**, the procedure described by Onwuka (2005) was used to determine pectin content. A two gram sample was heated in 95% alcohol for 10 min at 70°C to inactivate the pectin enzymes. Fruit were ground using an electric blender and the ground material was placed in a beaker and covered with a solution of 2% sodium EDTA, pH was adjusted to 6.0 and the mixture was heated to 95°C. The clear solution was filtered with a white cloth and pectin was precipitated from the solution using acidified alcohol. The precipitate was centrifuged and washed repeatedly using 70% alcohol. The pectin was dried in a hot air oven at 50°C for 4 h and then weighed.

$$\% \text{ Pectin} = \frac{\text{weight of pectin} \times 100}{\text{weight of sample}}$$

To determine **mineral content,** about 0.5 g dried tissue was digested using the wet ashing method (Yıldız, 1994). The digested matter was filtered, transferred into a 50 ml volumetric flask, and the volume was adjusted with distilled deionized water Concentration of Ca, Na, K, Mg, Mn, Fe, Cu and Zn were measured using atomic absorption spectrophotometer model (Model Analyst 300, Perkin Elmer). Phosphorus content was determined according to the method of Watanabe and Olsen (1965).

The experiment was conducted in a randomized complete block design with three replications. The statistical evaluation was done by using analysis of variance (ANOVA). This paper would use SAS statistic computer system to calculate the surveyed data and means were evaluated using Duncan's multiple range test at p=0.05. The relationships between studied parameters were evaluated by Pearson's correlation coefficients at $p \leq 0.05$.

RESULTS

The combined analysis of variances indicated that year had a significant influence on all studied parameters of "Jahangiri" cultivar. $CaCl_2$ pre-harvest treatments also affected significantly all of studied parameters, except for evaluation of free amino acid, at harvest time and during four weeks storage at 0°C. The interaction between year and Ca treatment was also significant (*Table 1*).

Results of these tests showed that pre-harvest application of Ca foliar spray increased some of biochemical properties and fruit quality of apricot cultivar "Jahangiri. with the intention that, the contents of fruit-Ca, -Mg, -N, -protein and vitamin C content were higher than those in the control at harvest time and after four weeks storage at 0°C. The highest Ca and Mg content and vitamin C of "Jahangiri fruit were recorded for the application of 0.5% $CaCl_2$ at 46 days after full bloom (0.54% for fruit Ca, 0.12% for fruit Mg and 8.23% for vitamin C) in the first week of storage at 0°C. Moreover, the highest fruit N content was proofed for the application of 0.5% $CaCl_2$ at 30 days after full bloom (3.3%) in the second week of storage at 0°C. The highest mean of fruit protein (11.95%) was observed by application of 1% $CaCl_2$ in 30 days after full bloom in the third week of storage at 0°C. In addition, at the third week of storage (0°C), the highest mean of fruit K (3.23%), fruit pH (5.78), fruit density (182.23 cm^2), fruit free amino acid (2.78) and fruit non-protein (2.09%) were observed by application of 0.5% $CaCl_2$ in 38 days after full bloom for fruit K; 1% $CaCl_2$ in 38 days after full bloom for fruit pH and 0.5% $CaCl_2$ in 46 days after full bloom for fruit density, fruit free amino acid and fruit non-protein. During the last week of storage at 0°C, Ca-untreated fruits (control) exhibited lower mean of all studied parameters, except of fruit-Mg-K and-P than the other treatments (*Table 2*).

Table 1 - Analysis of variances and probability values of studied parameters in fruit of "Jahangiri" as affected by pre-harvest Ca treatment and year (2012-2013) and their interactions

S.O.V.	DF	Flesh wet weight	Flesh dry weight	Total soluble solids	pH	Density	Flesh fruit firmness	Ca	Mg	N	P	K	Nonprotein N	Free amino acid	Crude potential	Pectin	Mineral content	Vitamin C
		(g)		(%)		(cm^3)	kg/m^3			% DW						(%)		
Year	1	486.83**	28.44**	244.40**	3.73**	3070.22*	5.80**	1.20**	0.27**	27.5**	0.02*	61.88**	7.94**	14.09**	833.7**	94.50**	46.30**	239.89**
Block (year)	4	28.40*	1.74**	86.75**	2.57**	1645.53*	0.19^{ns}	0.01^{ns}	0.003^{ns}	2.17*	0.001^{ns}	0.06^{ns}	0.09^{ns}	0.15^{ns}	1.53^{ns}	0.31**	0.15**	0.81**
Treatment	34	63.9**	1.20**	45.15**	4.47**	1964.62**	8.35**	0.04**	0.005**	1.74**	0.03**	0.95**	0.65**	0.15^{ns}	67.94**	17.41**	8.53**	11.59**
Year* Treatment	34	35.96**	1.00**	27.17**	1.09**	1903.89**	0.44^{ns}	0.04**	0.004**	1.14^{ns}	0.04**	0.96**	0.35**	0.63**	37.25**	10.71**	5.25**	9.24**
CV (%)		11.94	12.02	25.76	14.31	15.58	27.43	35.98	53.43	43.21	20.87	11.76	18.42	18.00	18.42	2.11	2.11	0.40

*significant at Ps- 0.05; **significant at Ps- 0.01; ns- not significant

Table 2 - Average values of studied parameters in fruit of "Jahangiri" as affected by pre-harvest Ca treatment during two years experimental trials (2012-2013)

Pre-harvest Ca treatment		Harvest time						
		Fruits (control)	0.5% 30 days after full bloom	1% 30 days after full bloom	0.5% 38 days after full bloom	1% 38 days after full bloom	0.5% 46 days after full bloom	1% 46 days after full bloom
Vitamin C	(%)	2.77	5.39	4.23	4.01	4.54	6.69	4.77
Mineral content		4.74	5.46	5.95	8.24	5.58	4.54	5.1
Pectin		6.77	7.81	8.5	11.77	7.98	6.48	7.28
Non-protein		0.81	0.91	1.43	1.05	1.71	1.52	1.42
Free amino acid		1.07	1.21	1.91	1.39	2.26	2.02	1.91
Protein		0.52	0.58	0.92	0.67	1.08	0.97	0.91
Density		148.11	165.22	129.56	148.61	154.57	151.37	141.74
pH		4.25	5.03	3.49	4.46	4.4	4.54	3.75
Total soluble acid	(%)	10.83	12.48	13.61	18.83	12.76	10.37	11.65
Flesh dry weight	(g)	6.23	6.42	5.51	5.78	5.74	5.41	5.3
Flesh wet weight		36.31	36.88	33.31	25.94	34.51	29.31	33.09
P	% DW	0.32	0.23	0.33	0.26	0.25	0.41	0.29
K		1.73	2.43	2.43	2.86	2.12	2.31	2.22
N		1.32	1.49	2.58	1.72	2.64	2.24	2.07
Mg		0.04	0.09	0.05	0.06	0.06	0.05	0.08
Ca		0.18	0.35	0.275	0.26	0.31	0.44	0.31

Table 2 (continuation)

Pre-harvest Ca treatment		First week of storage						
		Fruits (control)	0.5% 30 days after full bloom	1% 30 days after full bloom	0.5% 38 days after full bloom	1% 38 days after full bloom	0.5% 46 days after full bloom	1% 46 days after full bloom
Vitamin C	(%)	2.39	5.31	3.23	4.15	5	8.23	3.23
Mineral content		6.09	4.76	6.31	6.43	5.76	4.94	6.01
Pectin		8.7	6.81	9.01	9.19	8.23	7.05	8.57
Non-protein		1.34	1.34	1.07	1.41	0.81	1.63	1.15
Free amino acid		1.78	1.78	1.43	1.87	1.08	2.17	1.53
Protein		0.85	0.85	0.69	0.91	0.52	1.04	0.74
Density		133.17	168.73	125.61	142.16	151.68	170.62	128.48
pH		3.55	4.16	2.95	3.66	3.76	4.25	3.03
Total soluble acid	(%)	13.92	10.89	14.39	14.71	13.16	11.28	13.71
Flesh dry weight	(g)	5.55	6.55	4.67	6.16	6.05	6.25	4.61
Flesh wet weight		33.18	34.17	32.21	32.68	32.32	31.41	27.31
P	% DW	0.31	0.31	0.27	0.27	0.58	0.44	0.32
K		2.25	1.74	2.02	2.3	2.08	2.22	2.67
N		2.02	2.19	1.94	2.42	1.36	2.33	1.76
Mg		0.05	0.09	0.07	0.08	0.09	0.12	0.07
Ca		0.16	0.35	0.21	0.27	0.33	0.535	0.21

Table 2 (continuation)

Pre-harvest Ca treatment		Second week of storage						
		Fruits (control)	0.5% 30 days after full bloom	1% 30 days after full bloom	0.5% 38 days after full bloom	1% 38 days after full bloom	0.5% 46 days after full bloom	1% 46 days after full bloom
Vitamin C	(%)	1.85	5.31	3.85	4.85	4.62	5.62	2.31
Mineral content		4.12	5.67	8.36	5.92	5.99	4.51	5.98
Pectin		5.89	8.1	11.95	8.46	8.55	6.44	8.54
Non-protein		0.88	0.91	1.28	1.21	1.35	1.81	1.94
Free amino acid		1.17	1.22	1.71	1.61	1.81	2.41	2.58
Protein		0.56	0.58	0.82	0.77	0.87	1.15	1.24
Density		130.05	158.32	115.64	149.48	151.37	175.55	133.95
pH		2.83	4.83	3.11	4.18	3.97	4.87	4.12
Total soluble acid	(%)	9.41	12.96	19.12	13.53	13.69	10.31	13.67
Flesh dry weight	(g)	5.75	5.85	5.31	5.99	5.54	5.13	4.94
Flesh wet weight		31.8	32.87	28.78	32.77	31.86	29.57	28.59
P	% DW	0.37	0.27	0.32	0.26	0.25	0.34	0.31
K		2.77	1.72	2.26	2.21	1.9	1.81	2.25
N		1.44	3.3	2.09	1.97	2.22	2.95	3.18
Mg		0.03	0.12	0.09	0.09	0.09	0.05	0.04
Ca		0.12	0.35	0.25	0.315	0.3	0.37	0.15

Table 2 (continuation)

Pre-harvest Ca treatment		Third week of storage						
		Fruits (control)	0.5% 30 days after full bloom	1% 30 days after full bloom	0.5% 38 days after full bloom	1% 38 days after full bloom	0.5% 46 days after full bloom	1% 46 days after full bloom
Vitamin C	(%)	2.39	4.46	5.08	4.23	4.92	5.62	4.31
Mineral content	(%)	4.01	6.195	5.83	7.22	5.48	5.05	5.65
Pectin	(%)	5.73	8.85	8.32	10.32	7.83	7.22	8.08
Non-protein	(%)	0.97	1.46	1.48	1.18	1.01	2.09	1.72
Free amino acid	(%)	1.29	1.94	1.98	1.57	1.33	2.78	2.29
Protein	(%)	0.62	0.93	0.95	0.75	0.64	1.33	1.11
Density	(%)	126.39	149.6	126.62	133.91	152.25	182.23	137.48
pH		2.61	4.57	3.02	4.56	5.78	4.67	4.85
Total soluble acid	(%)	9.17	14.16	13.32	16.51	12.54	11.55	12.92
Flesh dry weight	(g)	5.68	4.97	6.05	5.235	5.84	5.21	5.31
Flesh wet weight	(g)	29.41	31.38	30.44	27.71	32.42	28.12	28.51
P	% DW	0.39	0.29	0.215	0.29	0.25	0.23	0.21
K	% DW	2.86	2.97	2.61	3.23	1.94	2.95	2.91
N	% DW	1.59	2.39	2.77	1.94	1.63	3.09	2.82
Mg	% DW	0.04	0.12	0.11	0.12	0.11	0.11	0.06
Ca	% DW	0.16	0.29	0.33	0.28	0.32	0.37	0.28

Table 2 (continuation)

Pre-harvest Ca treatment		Forth week of storage						
		Fruits (control)	0.5% 30 days after full bloom	1% 30 days after full bloom	0.5% 38 days after full bloom	1% 38 days after full bloom	0.5% 46 days after full bloom	1% 46 days after full bloom
Vitamin C	(%)	2.39	2.39	3.01	2.92	5.23	2.87	4.08
Mineral content		3.78	6.42	8.32	8.09	6.46	5.29	7.41
Pectin		5.41	9.18	11.89	11.55	9.2	7.56	10.59
Non-protein		0.88	1.19	1.51	1.12	1.072	1.48	0.95
Free amino acid		1.17	1.59	2.015	1.49	1.43	1.97	1.26
Protein		0.56	0.76	0.97	0.72	0.68	0.94	0.61
Density		104.77	151.17	109.81	126.58	134.08	168.57	125.48
pH		1.7	5.09	3.79	4.68	4.88	5.28	4.27
Total soluble acid	(%)	8.64	14.68	19.03	18.48	14.76	12.11	16.95
Flesh dry weight	(g)	5.09	6.35	4.97	5.41	5.26	5.46	5.27
Flesh wet weight		23.17	29.19	25.73	25.53	26.65	25.96	25.95
P	% DW	0.39	0.27	0.31	0.32	0.25	0.31	0.29
K		2.855	2.65	2.31	2.29	2.91	2.28	2.59
N		1.44	1.79	2.48	2.17	1.76	2.42	1.55
Mg		0.05	0.06	0.04	0.06	0.11	0.04	0.06
Ca		0.16	0.16	0.21	0.19	0.34	0.19	0.27

Table 3 - Correlation matrix among the studied variables

	Ca	Mg	N	K	P	Fruit flesh wet weight	Fruit flesh dry weight	Fruit total soluble solid	pH	Fruit density	Protein	Free amino acid	Non-protein	Pectin	Mineral content	Vitamin C
Ca	1															
Mg	.641**	1														
N	0.294	0.152	1													
K	-0.196	0.056	-0.154	1												
P	0.046	-0.212	-0.319	-0.129	1											
Fruit flesh wet weight	0.235	0.145	-0.094	-.426*	-0.114	1										
Fruit flesh dry weight	0.266	0.179	-0.202	-0.305	0.053	.590**	1									
Fruit total soluble solid	-0.142	0.128	0.032	0.135	-0.277	-0.154	-0.211	1								
pH	.392*	0.284	0.245	-0.156	-.337*	0.138	0.228	0.162	1							
Fruit density	.592**	0.322	0.287	-0.32	-0.058	.422*	.437**	-.358*	.657**	1						
Protein	0.301	0.012	.799**	0.021	-0.232	-0.151	-0.259	-0.033	0.21	0.321	1					
Free amino acid	0.305	0.017	.800**	0.02	-0.231	-0.151	-0.257	-0.039	0.213	0.329	1.000**	1				
Non-protein	0.304	0.015	.798**	0.02	-0.231	-0.149	-0.255	-0.041	0.217	0.332	0.998**	0.998**	1			
Pectin	-0.143	0.127	0.031	0.135	-0.277	-0.153	-0.211	1.000**	0.161	-.358*	-0.034	-0.04	-0.041	1		
Mineral	-0.142	0.128	0.031	0.134	-0.276	-0.154	-0.212	1.000**	0.161	-.359*	-0.034	-0.04	-0.042	0.998**	1	
Vitamin C	.999**	.649**	0.286	-0.192	0.04	0.244	0.268	-0.143	.391*	.591**	0.293	0.297	0.296	-0.144	-0.143	1

** Correlation is significant at the 0.01 level; * Correlation is significant at the 0.05 level.

The characteristics that correlated best with the fruit Ca content included fruit pH (at the 0.05 level), fruit density (at the 0.01 level), vitamin C of fruit (at the 0.01 level) and fruit Mg (at the 0.01 level). Also, positive significant correlations were found between other studied properties of apricot cultivar "Jahangiri" (*Table 3*).

DISCUSSION

Apricot trees grow well in the five of the world's continents and production level exceeds 2 tons. Australia, France, Hungary, Iran, Italy, Morocco, Spain, Tunisia, Turkey are considered as the most important apricot producing countries in the world (FAO, 2012).

Ca-treated fruit may produce fruit that is better suited to undergo prolonged shipment and longer periods of cold storage, thus increasing marketability (Tzoutzoukou and Bouranis, 1997). The report suggested that a pre harvest Ca foliar applied spray results in firmer fruit, lower soluble polyuronide content, and higher Ca content. It has also been reported that calcium application pre and post harvest delays processes of softening by retarding disintegration of cell walls in fruit tissue (Roy *et al.* 1994).

In the present work all of studied parameters of "Jahangiri" cultivar at harvest time and during four weeks storage at 0°C was affected by $CaCl_2$ pre harvest treatments in 2 experimental years, 2010 and 2011 (*Tabs. 1 and 2*).

Owais (2007) reported that fruit calcium of different apricot cultivars (Bulgari Cafona Mistikawi) significantly correlated with fruit weight. Also we found significantly and positively correlation between fruit calcium content with fruit pH, and flesh fruit density, fruit-Mg and fruit vitamin C. Tzoutzoukou and Bouranis (1997) found that Ca sprays had slightly induced Mg content of apricot flesh but did not affect the K content. Ca deficiency increases permeability of cell membranes that permits ions to escape and leads to the breakdown of intercellular compartmentalization.

Research has shown that processes of ripening and softening are accelerated when cell wall enzymes such as polygalactunase and pectin methyl esterase escape (Deytieux-Belleau *et al.,* 2008). Results of tests in this study demonstrated that Ca-treated fruit of apricot cultivar "Jahangiri" was firmer, had higher evaluations for Ca, Mg, N and K contents, fruit flesh dry and wet weight, fruit density, fruit total soluble solids, fruit protein and fruit vitamin C compared to untreated fruit during cold storage at 0°C.

CONCLUSION

In summary, the benefits of pre harvest Ca foliar application spray compared to non-application increased essential biochemical properties and fruit quality of

"Jahangiri". Based on fruit quality (fruit density) and mineral content in fruit (fruit-Ca and fruit-Mg,), and also biochemical properties (protein, free amino acid and non-protein), the most effective pre-harvest $CaCl_2$ application for apricot (cv. "Jahangiri") was found to be 0.5 % $CaCl_2$ in 46 days after full bloom. This study suggests that biochemical properties and fruit quality of "Jahangiri" apricot cultivar can be improved under horticultural practices such as pre-harvest Ca foliar application.

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