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EFFECT OF POSTHARVEST TREATMENTS ON STORAGE ABILITY AND KEEPING QUALITY OF AMAAR APRICOT FRUITS.

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ABSTRACT

In 2003, 2004 seasons, Amaar apricot fruits were picked at maturity stage and subjected to six treatments; dipping in $CaCl_2$, potassium permanganate solutions at 1 %, potassium permanganate bags placed inside the boxes and dipping the fruits in hot water at 40°C & 45°C for three minutes, beside the untreated fruits considered as control. Fruits of each treatment were stored for four weeks at either 0°C and 5°C, 85 - 90 % relative humidity. Quality measurements included weight loss, decay %, firmness, calcium content, carotene content, T.S.S. % and acidity %, then shelf life (after cold storage at 0°C and 5°C for 15 days and removal to 10°C and ambient temperature 23°C). It appeared from data that fruits treated by $CaCl_2$ at 3 %, potassium permanganate at 1 %, followed by placing potassium permanganate bags inside the boxes, were the best treatments for prolonging the storage life (lowest values of weight loss, decay percentages and acidity % than other treatments and untreated fruits). So it is as well as decreasing in flesh texture, the lowest in calcium and carotene contents, and the highest contents of total soluble solids % during storage at 0°C and or 5°C in both seasons, respectively The better results were obtained from fruits stored at 0°C than 5°C. On the other hand, treating the fruits with $CaCl_2$ at 3 %, potassium permanganate at 1 % and / or bags placed inside the boxes, increased the shelf-life for 7 days and maintained fruit quality as a lowest weight loss, decay percentages and highest values of total soluble solids % after removal from cold storage at 0°C or 5°C for 15 days to 10°C than ambient temperature at 23°C.

INTRODUCTION

Amaar apricot belong to the climacteric fruits, and after being picked in the proper maturity stage, quality suffers, due to the quick softening in ambient conditions (Luh *et al.*, 1974, Jeffery *et al.*, 1982). Fruits become more prone to postharvest decay organisms, causing damaging which is stimulated by bruises and injuries incurred to fruit, during rough handling, especially in prevailing high temperatures of summer (Snowdon, 1990 and Kader *et al.*, 1992). Some important measures are adapted to control market diseases and limit losses and quality deterioration. Among which are, careful and speed handling along with fruits exposure to low temperatures starting immediately after harvest (Mitchel, 1986) Most susceptible cultivars show greatest problem at temperature between 2°C and 7°C (Mitchel 1992). In this concern, postharvest calcium application has

been found to play an important role in maintaining fruit quality and prolonging storage life and extend shelf-life of many fruits through its effect on maintaining their cell wall structure and firmness, and reducing respiration rates, ethylene production and decay processes (Bangerth *et al.*, 1997; Poovaiah, 1998; Singh *et al.*, 1993; Hussein *et al.*, 1993 and El Dengawy 2004). So postharvest potassium permanganate application extended the shelf-life of Avocado and the potential to retard tissue softening and improved the fruit marketability of Zaghloul dates Scott *et al.*, 1970; Farag, 1998.

Ahlwat *et al.*, (1980) and Samia El-Oraby (1991), found that potassium permanganate in muslin bags placed inside the polyethylene covers reduced storage losses and prolonged storage life.

Hot water treatments can be effective in limiting pathological diseases but only if the temperature and time of immersion is closely controlled. However, this method usually results in weight losses causing several physical changes in the fruit appearance (Presumably the result of observed removal of trochees). "Philips and Austin, 1982".

The aim of this experiment was planned to investigate the effect of different postharvest treatments calcium chloride, potassium permanganate solutions or potassium permanganate bags placed inside boxes lined with Polyethylene and hot water application on storage ability and extended shelf-life and to obtain higher quality of Amaar Apricot fruits, after storage and during marketing (shelf-life).

MATERIALS AND METHODS

This study was carried out two in successive seasons 2002 & 2003 to investigate the effect of postharvest calcium chloride, potassium permanganate and hot water on storage ability and keeping quality of Amaar apricot fruits stored at 0°C and 5°C.

Fruits used in this study were picked at maturity stage from seedy trees grown at El Amaar district, Kaliobia Governorate. Selected fruits were firm, with green color covering ½ to ¾ of the skin. Thereafter, fruits were divided into six lots and exposed to the following treatments:

1- Control (untreated).
2- Dipping the fruits in 1 % calcium chloride solutions for three minutes.
3- Dipping the fruits in 3 % calcium chloride solutions for three minutes.
4- Dipping the fruits in 1 % potassium permanganate ($KMnO_4$) solution for three minutes.
5- Potassium permanganate ($KMnO_4$) bags (gm/100gm) placed inside the boxes.
6- Dipping the fruits in hot water at 40°C for three minutes.
7- Dipping the fruits in hot water at 45°C for three minutes.

Fruits were air dried and packed in carton boxes lined by polyethylene sheets (30 microns). Each box contained 3 kg of fruits and considered as one replicate. Each treatment was presented by three replicates. Then, fruits were stored at 0°C or 5°C with relative humidity 85 - 90 % in the storage chambers.

Evaluation of the tested treatments was carried out through the following quality criteria at weekly intervals during cold storage (4 weeks). At each sampling date ten, fruits were taken from each stored box.

Quality Measurements:

Different measurements were carried out from the beginning of storage until the percentage of fruit decay reached about 25 %.

Physical properties:

Percentage of weight loss: Fruits were weighed at weekly intervals in each sample during storage and the loss in fruit weight was recorded and calculated as a percentage from the initial weight.

Decay percentage: was determined according to McCornack and Brown (1973).

Fruit firmness: was recorded by Magness – Taylor type pressure tester has a standard 7/16 of inch^2 plunger, was used to determine fruit firmness and recorded in Lb/Inch^2.

Chemical properties:

Total soluble solids percentage (T.S.S.): was determined by using a hand referactometer.

Titratable acidity of the fruit juice: was expressed as percentage of Malic acid according to A.O.A.C. (1990).

Total calcium content: was Flame photometrically determined in fruit using the method of Brown and Lilleland (1946).

Carotene content: was determined according to Saric *et al* (1967).

Shelf-life: A sample consisted of 10 fruits was taken out after storage at 0°C and 5°C from each replicate, after 15 days, and left at 10°C and ambient temperature (23°C) to simulate the marketing environments in Egypt. The days after which fruit decay percentage reached about (20 – 35 %) were considered a shelf-life

Statistical Analysis:

Means were compared as the L.S.D values at 5% level, using Excel micro software. The obtained data were subjected to analysis of variance for split plot design as in (Snedecor and Cochran, 1990).

RESULTS AND DISCUSSION

Weight loss percentages:

Data presented in table (1) showed that the percent of Amaar apricot fruits weight loss increased with increasing the cold storage period (0°C and 5°C) for all treatments and untreated fruits. The obtained data appeared that the rate of loss in weight was the highest in the untreated fruits as well as those treated by dipping in hot water at 40°C & 45°C either stored at 0°C or at 5°C (1.53 &10.75

& 9.81) in the 1st season. On the other hand, fruits treated with $CaCl_2$ 3 % resulted in the lowest values of weight loss percentage followed by KMn O_4 at 1 % or bags placed inside the boxes (6.09 & 6.18 & 6.24) & (3.23 & 3.89 & 3.21) in both seasons, respectively.

These findings as mentioned above confirm the results of Maini *et al.*, (1983) found that dipping Red Delicious apple fruits in 4 % $CaCl_2$ for 15 min, reduced the physiological weight loss.

In addition, Nwufo *et al.*, (1994), concluded that potassium permanganate (KMn O_4) application extended the shelf-life of the fruits because it is quite effective in reducing ethylene levels. Also, Scott *et al.*, (1970) on banana fruits, found that potassium permanganate (KMn O_4) as an ethylene absorbent in polyethylene bags delayed ripening during storage.

Ahlawat *et al.*, (1980) and Samia El-Oraby (1991) on Guava, illustrated that potassium permanganate (KMn O_4) bags placed inside the boxes covered by polyethylene, reduced the storage losses and prolonged the storage life

Decay percentage:

Table (2) cleared that decay percentage was increased with increasing the cold storage period (at 0°C and 5°C) in all treatments, as well as, untreated fruits in both seasons. The least decay percentages was noticed in fruits dipped in 1 % potassium permanganate (KMn O_4) or bags placed inside the boxes followed by fruits treated with $CaCl_2$ at 3 % during storage at 0°C and 5°C in both seasons. Fruits treated with dipping in hot water at 40°C and 45°C showed the highest values in percentage of decay during storage at 0°C and 5°C followed by the untreated fruits (34.67 & 24.15 & 28.20) & (37.56 & 35.43 & 32.85) in both seasons.

Similar results were reported by Nwufo *et al.*, (1994) with Avocado fruits. They concluded that potassium permanganate application extended the shelf-life of climacteric fruits such as Avocado, because it is quite effective in reducing ethylene levels (Scott *et al.*, 1970). In addition, postharvest applying of (KMn O_4) had the potential to retard tissue softening of Zaghloul dates, which resulted in less electrolyte leakage, and improved fruit marketability (Farag, 1988). Such results agree with those of Blanpied, (1981) on McIntosh apples, who revealed that postharvest dipping in 4 % $CaCl_2$ delayed fruit senescence.

Fruit firmness:

Data in the table (3) showed that there was a significant difference between all treatments and control in fruit firmness during storage at 0°C and 5°C in both seasons. The highest fruit firmness resulted from 3 % $CaCl_2$ and 1 & 3 % KMn O_4 treatments which were significantly higher than other treatments and control. The same trend was found in fruits stored at 0°C during all period of storage till 4 weeks in the first season, while there is no significant difference between all treatments in fruit firmness during storage at 0°C and 5°C in 2nd season. On the other hand, untreated fruits showed the lowest values in fruit firmness during storage at 0°C and 5°C in both seasons.

Table (1): Effect of postharvest treatments and storage temperature on weight loss % of "Amaar" Apricot fruits during cold storage.

Temp. (A)	Treatments (C)	Storage periods in weeks (B) 1	2	3	4	A.V. of Temp.	A.V. of Treat.
1st season							
0°C	Control	6.62	7.72	14.54	16.53	11.36	11.53
5°C		7.02	8.10	14.99	17.04	11.79	
0°C	$CaCl_2$ 1 %	4.70	6.55	8.65	9.55	7.36	7.64
5°C		5.14	5.99	8.75	11.83	7.93	
0°C	$CaCl_2$ 3 %	3.39	4.45	6.20	7.80	5.46	6.09
5°C		4.93	6.76	6.52	8.62	6.81	
0°C	K Mn O_4 1 %	3.41	4.56	6.33	7.91	5.55	6.18
5°C		4.96	6.89	6.75	8.65	6.81	
0°C	K Mn O_4 1 % (bags)	3.43	4.65	6.50	7.95	5.63	6.24
5°C		4.95	6.92	6.80	8.70	6.84	
0°C	Hot water 40°C	6.82	7.22	12.51	14.61	10.29	10.75
5°C		6.96	8.88	12.71	16.29	11.21	
0°C	Hot water 45°C	5.60	6.75	11.15	13.67	9.29	9.81
5°C		6.35	8.51	11.44	15.00	10.32	
Average of storage period		6.19	7.83	9.56	11.73	7.85	
						8.82	
L.S.D. at 5 % level		A	B	C	A×B	A×C	B×C	A×B×C
		0.287	0.371	0.437	N.S	2.07	N.S	N.S
2nd season							
0°C	Control	2.13	6.10	8.49	11.09	6.95	7.27
5°C		2.45	6.26	8.87	12.76	7.58	
0°C	$CaCl_2$ 1 %	2.08	3.64	6.86	8.92	5.38	5.71
5°C		2.07	4.47	7.11	10.17	5.95	
0°C	$CaCl_2$ 3 %	1.39	2.08	2.92	5.96	3.09	3.23
5°C		1.55	2.24	3.15	6.58	3.38	
0°C	K Mn O_4 1 %	1.26	2.75	4.61	6.72	3.84	3.89
5°C		1.49	3.44	4.90	5.98	4.12	
0°C	K Mn O_4 1 % (bags)	1.78	2.20	3.25	5.16	3.10	3.21
5°C		1.87	2.31	3.46	5.67	3.33	
0°C	Hot water 40°C	3.45	4.67	5.13	6.82	4.01	4.16
5°C		3.67	4.99	5.87	7.03	4.31	
0°C	Hot water 45°C	1.78	3.21	6.04	7.93	4.74	4.86
5°C		1.90	3.37	6.48	8.14	4.97	
Average of storage period		2.06	3.70	5.51	7.78	4.44	
						4.81	
L.S.D. at 5 % level		A	B	C	A×B	A×C	B×C	A×B×C
		0.26	0.52	0.34	N.S	0.695	N.S	N.S

Table (2): Effect of postharvest treatments and storage temperature on Decay % of "Amaar" apricot fruits during cold storage.

Temp. (A)	Treatments (C)	Storage periods in weeks (B)				A.V. of Temp.	A.V. of Treat.
		1	2	3	4		
1st season							
0°C	Control	12.95	20.24	25.91	28.20	21.83	21.91
5°C		13.73	19.94	27.47	32.85	23.50	
0°C	$CaCl_2$ 1 %	0.99	1.83	3.35	9.91	3.94	4.43
5°C		1.52	2.68	4.34	10.83	4.84	
0°C	$CaCl_2$ 3 %	0.00	0.97	2.14	7.99	2.78	3.01
5°C		0.00	1.29	2.71	8.96	3.24	
0°C	K Mn O_4 1 %	0.00	1.00	2.67	7.99	2.33	2.48
5°C		0.00	1.35	2.80	8.99	2.63	
0°C	K Mn O_4 1 % (bags)	0.00	1.13	2.70	8.13	2.39	2.50
5°C		0.00	1.05	2.85	9.10	2.60	
0°C	Hot water 40°C	9.31	23.40	30.30	34.67	24.42	25.46
5°C		10.06	22.47	35.89	37.56	26.50	
0°C	Hot water 45°C	7.90	15.98	20.73	24.15	17.20	18.97
5°C		8.58	15.55	23.40	35.43	20.74	
Average of storage period		4.65	9.13	13.38	18.91	10.70	
						12.01	
L.S.D. at 5 % level		A	B	C	A×B	A×C	B×C	A×B×C
		1.38	1.54	1.72	N.S	3.44	N.S	N.S
2nd season							
0°C	Control	6.38	12.21	20.09	31.82	17.62	18.61
5°C		7.83	15.24	22.09	33.20	19.59	
0°C	$CaCl_2$ 1 %	0.49	1.66	3.28	6.38	2.95	3.56
5°C		0.54	2.00	5.35	8.82	4.18	
0°C	$CaCl_2$ 3 %	0.00	0.79	1.61	6.79	2.29	2.69
5°C		0.00	1.40	2.56	8.43	3.10	
0°C	K Mn O_4 1 %	0.00	0.67	1.13	4.28	1.22	1.48
5°C		0.00	1.31	2.00	5.35	1.73	
0°C	K Mn O_4 1 % (bags)	0.00	0.80	1.31	5.00	1.42	1.63
5°C		0.00	1.43	2.50	5.28	1.84	
0°C	Hot water 40°C	6.62	13.10	24.28	29.59	18.54	19.37
5°C		7.62	15.09	26.48	31.98	20.29	
0°C	Hot water 45°C	5.18	9.38	17.98	25.28	14.46	15.81
5°C		5.83	10.73	22.97	29.09	17.15	
Average of storage period		2.89	6.13	10.97	16.52	8.36	
						9.70	
L.S.D. at 5 % level		A	B	C	A×B	A×C	B×C	A×B×C
		0.40	1.06	0.94	0.80	1.88	N.S	N.S

Table (3): Effect of postharvest treatments and storage temperature on Firmness /inch^2 of "Amaar" Apricot fruits during cold storage.

Temp. (A)	Treatments (C)	Storage periods in weeks (B)					A.V. of Temp.	A.V. of Treat.
		0	1	2	3	4		
1st season								
0°C	Control	10.33	9.50	8.00	6.83	6.25	8.18	7.25
5°C		10.33	6.83	6.00	4.83	3.58	6.32	
0°C	$CaCl_2$ 1 %	10.33	10.17	8.58	7.58	6.50	8.63	8.10
5°C		10.33	8.50	7.00	6.33	5.67	7.57	
0°C	$CaCl_2$ 3 %	10.33	10.20	9.42	8.33	7.50	9.22	8.59
5°C		10.33	9.17	7.67	6.67	6.00	7.97	
0°C	K Mn O_4 1 %	10.33	10.20	9.80	8.93	7.79	9.41	9.32
5°C		10.33	9.70	9.20	9.00	7.87	9.22	
0°C	K Mn O_4 1 % (bags)	10.33	10.00	9.60	8.80	7.67	9.28	9.04
5°C		10.33	9.50	9.00	8.20	7.00	8.81	
0°C	Hot water 40°C	10.33	9.67	8.25	7.08	6.33	8.33	7.89
5°C		10.33	9.67	7.50	5.42	4.33	7.45	
0°C	Hot water 45°C	10.33	7.83	7.42	6.92	6.08	7.71	7.41
5°C		10.33	7.33	6.83	6.00	5.00	7.10	
Average of storage period		10.33	9.16	8.16	7.21	6.26	8.39	
							7.78	
L.S.D. at 5 % level		A	B	C	A×B	A×C	B×C	A×B×C
		0.20	0.56	0.26	0.45	0.59	0.37	N.S
2nd season								
0°C	Control	11.00	8.00	7.50	6.70	6.00	7.84	7.80
5°C		11.00	7.90	7.46	6.50	5.90	7.75	
0°C	$CaCl_2$ 1 %	11.00	9.50	8.00	7.50	6.92	8.58	8.51
5°C		11.00	9.42	8.33	7.17	5.92	8.37	
0°C	$CaCl_2$ 3 %	11.00	9.83	9.08	8.37	7.67	9.33	8.73
5°C		11.00	9.25	7.50	7.08	6.50	8.26	
0°C	K Mn O_4 1 %	11.00	10.17	8.67	8.33	7.67	9.17	8.86
5°C		11.00	9.70	8.42	7.25	6.42	8.56	
0°C	K Mn O_4 1 % (bags)	11.00	10.00	8.83	8.33	7.83	9.20	8.76
5°C		11.00	9.30	7.58	7.08	6.58	8.31	
0°C	Hot water 40°C	11.00	9.70	8.00	7.50	6.67	8.57	8.46
5°C		11.00	9.50	7.70	7.10	6.40	8.34	
0°C	Hot water 45°C	11.00	9.60	8.25	7.33	6.83	8.60	8.36
5°C		11.00	10.08	7.33	6.50	5.67	8.18	
Average of storage period		11.00	9.43	7.76	7.34	6.64	8.76	
							8.25	
L.S.D. at 5 % level		A	B	C	A×B	A×C	B×C	A×B×C
		0.13	0.81	0.24	N.S	N.S	0.34	0.75

These findings are somewhat in harmony with those obtained by Sams. and Conway (1984) who postulated that firmness of Golden "Delicious" apple fruits was correlated positively to Calcium concentration of the fruit both before and after storage at 0°C. On the other hand, results are not in agreement with the findings of Chopra *et al.*, (1986) on Plums cv Santarosa dipped in 4 % $CaCl_2$ for 2 minutes who found that the lowest firmness loss when held at 21 – 26°C . In addition, postharvest applying KMn O_4 had the potential to retard tissue softening of Zaghloul dates, resulted in less electrolyte leakage, and improved the fruit marketability (Farag, 1988).

T.S.S %:

Data shown in table (4) for cold storage (0°C and 5°C) at both seasons, showed a gradual increase in T.S.S. % during storage of Amaar Apricot. Differences in T.S.S. % among treatments and control were significant. The highest percentage of T.S.S. resulted from fruits dipped in 1 % KMn O_4 followed by 3 % KMn O_4 and 3 % $CaCl_2$ during storage at 0°C than 5°C in both seasons.

Untreated fruits showed the lowest values in T.S.S. % than other treatments in both seasons.

These results are in agreement with those of Chopra *et al*, (1986) on Plums cv Santa Rosa dipped in $CaCl_2$ 4 % for 2 minutes who found that the highest T.S.S. after 12 days holding.

Ahlawat *et al.*, (1980) and Samia El-Oraby (1991) on Guava, found that potassium permanganate bags placed inside boxes lined with polyethylene were the best treatments in prolonging the storage life of the fruits.

Titratable acidity %:

Data in table (5) showed a gradual decrease in acidity during storage of Amaar apricot fruits. However, there was a significant difference between various treatments and control in the changes of fruit acidity during storage. Fruits treated with 1 % KMn O_4 or bags, followed by $CaCl_2$ at 3 % were the most effective in reducing fruit acidity comparing with other treatments and control during storage at 0°C and 5°C in both seasons.

Untreated fruits showed the highest values in fruit acidity than those of other treatments in both seasons. These results are in agreement with those of Chopra *et al.*, (1986) on Plums cv Santa Rosa dipped in $CaCl_2$ at 4 % for 2 minutes who found that, contents of Titratable acidity declined during storage.

Also, Ahlawat *et al.*, (1980) and Samia El-Oraby (1991) on many fruits as (Guava), illustrated that potassium permanganate bags placed inside boxes lined by polyethylene gave the best treatments and prolonged the storage life, because it is quite effective in reducing ethylene levels (Nwufo *et al.*, 1994).

Table (4): Effect of postharvest treatments and storage temperature on T.S.S % of "Amaar" Apricot fruits during cold storage.

Temp. (A)	Treatments (C)	Storage periods in weeks (B)					A.V. of Temp.	A.V. of Treat.
		0	1	2	3	4		
1st season								
0°C	Control	12.00	12.13	12.60	12.90	13.20	12.57	12.55
5°C		12.00	12.13	12.50	12.85	13.10	12.52	
0°C	$CaCl_2$ 1 %	12.00	12.47	12.83	13.30	13.67	12.85	12.77
5°C		12.00	12.67	12.90	12.90	13.00	12.69	
0°C	$CaCl_2$ 3 %	12.00	12.53	12.90	13.40	13.77	13.75	12.82
5°C		12.00	12.20	12.65	12.75	14.00	12.72	
0°C	K Mn O_4 1 %	12.00	12.90	13.13	13.70	14.00	13.15	13.06
5°C		12.00	12.75	12.80	13.23	14.10	12.91	
0°C	K Mn O_4 1 % (bags)	12.00	12.70	13.25	13.35	13.83	13.03	12.90
5°C		12.00	12.33	12.70	13.20	13.60	12.77	
0°C	Hot water 40°C	12.00	12.50	12.90	13.46	13.80	12.93	12.91
5°C		12.00	12.45	12.86	13.40	13.75	12.89	
0°C	Hot water 45°C	12.00	12.43	12.80	13.30	13.73	12.85	12.59
5°C		12.00	12.25	12.33	12.33	12.75	12.33	
Average of storage period		12.00	12.46	12.80	13.15	13.59	13.02	
							12.69	
L.S.D. at 5 % level		A	B	C	A×B	A×C	B×C	A×B×C
		0.07	0.15	0.07	0.15	0.16	0.10	0.23
2nd season								
0°C	Control	12.50	13.10	13.80	14.10	14.70	13.64	13.55
5°C		12.50	13.00	13.67	14.00	14.10	13.45	
0°C	$CaCl_2$ 1 %	12.50	13.60	14.67	14.90	15.00	14.13	13.99
5°C		12.50	13.25	14.00	14.50	15.00	13.85	
0°C	$CaCl_2$ 3 %	12.50	14.40	16.17	16.50	17.00	15.31	14.46
5°C		12.50	12.75	13.50	14.25	15.00	13.60	
0°C	K Mn O_4 1 %	12.50	14.20	15.67	16.83	19.00	15.64	14.62
5°C		12.50	12.87	13.90	14.25	14.50	13.60	
0°C	K Mn O_4 1 % (bags)	12.50	13.20	13.92	16.33	18.50	14.89	14.50
5°C		12.50	13.45	14.42	14.90	15.25	14.10	
0°C	Hot water 40°C	12.50	13.36	13.90	15.30	18.00	14.60	14.18
5°C		12.50	13.20	14.00	14.10	15.00	13.76	
0°C	Hot water 45°C	12.50	13.38	14.25	14.50	15.00	13.93	13.59
5°C		12.50	12.67	12.72	13.58	14.75	13.24	
Average of storage period		12.50	13.31	14.19	14.86	15.77	14.59	
							13.66	
L.S.D. at 5 % level		A	B	C	A×B	A×C	B×C	A×B×C
		0.14	0.65	0.21	0.31	0.48	0.30	0.67

Table (5): Effect of postharvest treatments and storage temperature on Acidity % of "Amaar" apricot fruits during cold storage.

Temp. (A)	Treatments (C)	Storage periods in weeks (B)					A.V. of Temp.	A.V. of Treat.
		0	1	2	3	4		
1st season								
0°C	Control	2.54	2.40	2.10	2.00	1.70	2.15	2.17
5°C		2.54	2.43	2.13	2.10	1.73	2.19	
0°C	$CaCl_2$ 1 %	2.54	2.83	2.01	1.73	1.58	2.05	2.06
5°C		2.54	2.39	2.06	1.77	1.59	2.07	
0°C	$CaCl_2$ 3 %	2.54	2.10	2.03	1.70	1.30	1.93	1.95
5°C		2.54	2.15	2.04	1.75	1.36	1.97	
0°C	K Mn O_4 1 %	2.54	2.21	2.04	1.86	1.45	2.01	2.03
5°C		2.54	2.23	2.08	1.89	1.47	2.04	
0°C	K Mn O_4 1 % (bags)	2.54	2.25	2.10	1.82	1.52	2.05	2.05
5°C		2.54	2.27	2.11	1.86	1.53	2.06	
0°C	Hot water 40°C	2.54	2.45	1.90	1.91	1.60	2.08	2.09
5°C		2.54	2.46	1.93	1.93	1.63	2.10	
0°C	Hot water 45°C	2.54	2.39	2.01	1.92	1.55	2.08	2.09
5°C		2.54	2.41	2.06	1.93	1.58	2.10	
Average of storage period		2.54	2.32	2.04	1.87	1.54	2.05	
							2.08	
L.S.D. at 5 % level		A	B	C	A×B	A×C	B×C	A×B×C
		0.01	0.05	0.02	0.02	0.05	N.S	N.S
2nd season								
0°C	Control	2.17	1.96	1.80	1.70	1.60	1.85	1.88
5°C		2.17	2.00	1.90	1.80	1.70	1.91	
0°C	$CaCl_2$ 1 %	2.17	1.70	1.60	1.43	1.28	1.64	1.76
5°C		2.17	1.95	1.80	1.78	1.75	1.89	
0°C	$CaCl_2$ 3 %	2.17	1.53	1.30	1.10	0.92	1.40	1.57
5°C		2.17	1.83	1.77	1.50	1.40	1.73	
0°C	K Mn O_4 1 %	2.17	1.60	1.50	1.30	1.20	1.55	1.60
5°C		2.17	1.70	1.60	1.55	1.20	1.64	
0°C	K Mn O_4 1 % (bags)	2.17	1.62	1.55	1.35	1.30	1.60	1.65
5°C		2.17	1.75	1.65	1.60	1.30	1.69	
0°C	Hot water 40°C	2.17	1.97	1.63	1.60	1.17	1.71	1.79
5°C		2.17	1.96	1.80	1.78	1.70	1.88	
0°C	Hot water 45°C	2.17	1.80	1.70	1.60	1.45	1.74	1.78
5°C		2.17	1.94	1.79	1.70	1.45	1.81	
Average of storage period		2.17	1.81	1.67	1.56	1.46	1.64	
							1.79	
L.S.D. at 5 % level		A	B	C	A×B	A×C	B×C	A×B×C
		0.04	0.08	0.03	0.06	0.04	0.06	0.09

Calcium content (mg/gm):

Data in table (6) showed a gradual decrease in calcium content during storage of Amaar apricot at cold storage (0°C & 5°C) in both seasons. The untreated fruits as well as those treated with hot water 40°C and 45°C followed by $CaCl_2$ 1 % contained the lowest values of calcium content compared with other treatments. Moreover, these findings were true at the two storage temperatures (0°C and 5°C) and at the two seasons of the study. On the other hand, fruits treated with 3 % $CaCl_2$ contained the highest values of calcium content (0.638 & 0.618) & (0.603 & 0.590) during storage at 0°C and 5°C in both seasons, respectively.

These results are in accordance with those obtained by (Hardenburg and Anderson .,1979; and Drake et al ., 1966) who claimed that fruit decay of Stayman apple fruits was delayed by dipping them in $CaCl_2$ at 4 % and stored at 0°C. This present a negative relationship between Ca concentration in the peel and the incidence of fruit decay .

Carotene content (mg/gm):

Data in table (7) showed a gradual increase in total carotene content during storage at cold rooms (0°C & 5°C). The untreated fruits, as well as, those treated with hot water 40°C & 45°C contained the lowest values of carotene comparing with other treatments. More over, these findings were true at the two storage temperatures (0°C and 5°C) and at the two seasons of study. On the other hand, fruits treated with 3 % $CaCl_2$ and 1 % $KMn\ O_4$ or bags gave the highest values of carotene content (1.68 & 1.61 & 1.59) & (2.00 & 1.93 & 1.93) mg/gm fresh weight during storage at 0°C and 5°C in both seasons, respectively.

These results are in agreement with those of Chopra et al., (1986) on plums cv Santa Rosa dipped in 4 % $CaCl_2$ for 2 minutes who found that the highest color development when held at 21 – 26°C. Also, Ahlawat *et al.*, (1980) and Samia El-Oraby (1991) on guava and many fruits, illustrated that potassium permanganate bags placed inside boxes lined with polyethylene, were the best treatments and prolonged storage life, because it was quite effective in reducing ethylene levels (Nwufo *et al.*, 1994).

Shelf-life:

The effect of postharvest treatments of $CaCl_2$, potassium permanganate and hot water applied to Amaar apricot fruits on characters after removal from cold storage at 0°C or 5°C for two weeks to 10°C and ambient temperature (23°C) during both seasons are shown in tables (8 & 9 & 10 and 11) illustrating that the highest weight loss and decay % and decreased shelf-life was in untreated fruits followed by fruits dipped in hot water 40°C or 45°C, as fruit marketing was (1 – 2 days) after removal from cold storage to ambient temperature and (3 – 4 days) at 10°C.

Table (6): Effect of postharvest treatments and storage temperature on Calcium content (mg/gm) of "Amaar" apricot fruits during cold storage.

Temp. (A)	Treatments (C)	Storage periods in weeks (B)					A.V. of Temp.	A.V. of Treat.
		0	1	2	3	4		
1st season								
0°C	Control	0.773	0.400	0.290	0.187	0.155	0.361	0.357
5°C		0.773	0.390	0.287	0.170	0.146	0.353	
0°C	$CaCl_2$ 1 %	0.773	0.423	0.307	0.192	0.171	0.375	0.364
5°C		0.773	0.391	0.293	0.163	0.146	0.358	
0°C	$CaCl_2$ 3 %	0.773	0.717	0.653	0.537	0.496	0.638	0.128
5°C		0.773	0.691	0.611	0.511	0.486	0.618	
0°C	K Mn O_4 1 %	0.773	0.623	0.530	0.217	0.200	0.470	0.460
5°C		0.773	0.597	0.509	0.197	0.175	0.456	
0°C	K Mn O_4 1 % (bags)	0.773	0.560	0.500	0.335	0.250	0.484	0.476
5°C		0.773	0.540	0.480	0.300	0.243	0.467	
0°C	Hot water 40°C	0.773	0.517	0.370	0.240	0.213	0.425	0.415
5°C		0.773	0.503	0.348	0.214	0.197	0.410	
0°C	Hot water 45°C	0.773	0.533	0.323	0.135	0.121	0.378	0.373
5°C		0.773	0.518	0.310	0.128	0.109	0.370	
Average of storage period		0.773	0.529	0.415	0.252	0.222	0.447	
							0.433	
L.S.D. at 5 % level		A	B	C	A×B	A×C	B×C	A×B×C
		0.023	0.003	0.009	0.006	0.017	N.S	N.S
2nd season								
0°C	Control	0.846	0.410	0.310	0.146	0.127	0.368	0.364
5°C		0.846	0.400	0.300	0.131	0.120	0.359	
0°C	$CaCl_2$ 1 %	0.846	0.429	0.230	0.157	0.142	0.361	0.407
5°C		0.846	0.399	0.213	0.142	0.138	0.347	
0°C	$CaCl_2$ 3 %	0.846	0.729	0.627	0.419	0.393	0.603	0.649
5°C		0.846	0.711	0.614	0.399	0.367	0.590	
0°C	K Mn O_4 1 %	0.846	0.626	0.517	0.329	0.308	0.525	0.572
5°C		0.846	0.611	0.503	0.299	0.300	0.512	
0°C	K Mn O_4 1 % (bags)	0.846	0.600	0.503	0.307	0.295	0.510	0.507
5°C		0.846	0.590	0.500	0.295	0.290	0.504	
0°C	Hot water 40°C	0.846	0.535	0.366	0.203	0.168	0.424	0.481
5°C		0.846	0.510	0.353	0.189	0.163	0.412	
0°C	Hot water 45°C	0.846	0.540	0.335	0.151	0.135	0.402	0.463
5°C		0.846	0.512	0.328	0.148	0.131	0.393	
Average of storage period		0.846	0.543	0.407	0.239	0.220	0.456	
							0.445	
L.S.D. at 5 % level		A	B	C	A×B	A×C	B×C	A×B×C
		0.006	0.046	0.013	0.010	0.027	N.S	N.S

Table (7): Effect of postharvest treatments and storage temperature on Carotene content (mg/gm) of "Amaar" apricot fruits during cold storage.

Temp. (A)	Treatments (C)	Storage periods in weeks (B)					A.V. of Temp.	A.V. of Treat.
		0	1	2	3	4		
1st season								
0°C	Control	1.12	1.34	1.47	1.53	1.70	1.43	1.40
5°C		1.12	1.33	1.38	1.47	1.56	1.37	
0°C	$CaCl_2$ 1 %	1.12	1.40	1.52	1.55	1.77	1.47	1.46
5°C		1.12	1.39	1.50	1.52	1.70	1.45	
0°C	$CaCl_2$ 3 %	1.12	1.77	1.79	1.94	1.98	1.72	1.68
5°C		1.12	1.60	1.68	1.84	1.92	1.63	
0°C	K Mn O_4 1 %	1.12	1.54	1.73	1.81	1.96	1.63	1.61
5°C		1.12	1.55	1.64	1.75	1.84	1.58	
0°C	K Mn O_4 1 % (bags)	1.12	1.62	1.72	1.78	1.83	1.61	1.59
5°C		1.12	1.56	1.63	1.74	1.79	1.57	
0°C	Hot water 40°C	1.12	1.55	1.65	1.72	1.82	1.57	1.56
5°C		1.12	1.54	1.60	1.70	1.77	1.55	
0°C	Hot water 45°C	1.12	1.62	1.65	1.65	1.68	1.55	1.52
5°C		1.12	1.51	1.57	1.59	1.69	1.50	
Average of storage period		1.12	1.52	1.61	1.69	1.79	1.57	
							1.52	
L.S.D. at 5 % level		A	B	C	A×B	A×C	B×C	A×B×C
		N.S	0.125	0.067	N.S	N.S	N.S	N.S
2nd season								
0°C	Control	1.62	1.70	1.89	2.00	2.13	1.87	1.84
5°C		1.62	1.67	1.84	1.95	2.00	1.82	
0°C	$CaCl_2$ 1 %	1.62	1.78	1.93	2.07	2.27	1.93	1.88
5°C		1.62	1.74	1.84	1.96	2.02	1.84	
0°C	$CaCl_2$ 3 %	1.62	1.92	2.06	2.16	2.30	2.01	2.00
5°C		1.62	1.74	1.99	2.23	2.36	1.99	
0°C	K Mn O_4 1 %	1.62	1.75	1.99	2.10	2.26	1.95	1.93
5°C		1.62	1.74	1.91	2.05	2.17	1.90	
0°C	K Mn O_4 1 % (bags)	1.62	1.76	1.94	2.10	2.25	1.94	1.93
5°C		1.62	1.78	1.93	2.05	2.15	1.91	
0°C	Hot water 40°C	1.62	1.78	1.89	2.09	2.18	1.91	1.90
5°C		1.62	1.76	1.93	2.03	2.11	1.89	
0°C	Hot water 45°C	1.62	1.74	1.90	2.02	2.19	1.90	1.89
5°C		1.62	1.75	1.93	2.02	2.14	1.89	
Average of storage period		1.62	1.76	1.93	2.06	2.18	1.93	
							1.89	
L.S.D. at 5 % level		A	B	C	A×B	A×C	B×C	A×B×C
		0.016	0.103	0.037	0.035	N.S	0.052	N.S

Table (8): Fruit quality of Amaar Apricot cultivar after removal from 2 weeks of Storage at 0°C to Ambient temperature.

Treatments	Loss of Weight%		Decay%		Appearance		Fruit Marketing		T.S.S.%		Acidity%	
Prop.	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Control	11.09	11.53	24.42	26.50	Fair	Fair	1	1	12.60	13.70	1.80	1.70
$CaCl_2$ 1 %	9.67	9.04	17.20	20.74	Fair	Fair	2	2	13.20	14.80	1.78	1.60
$CaCl_2$ 3 %	5.96	7.80	4.20	4.38	Good	Good	4	4	13.70	16.10	1.20	1.30
K Mn O_4 %	6.72	7.93	5.93	6.70	Good	Good	4	4	13.50	15.90	1.35	1.45
K Mn O_4 % (bags)	8.92	9.55	8.14	8.51	Good	Good	4	4	13.30	14.15	1.50	1.55
Hot water 40°C	9.30	10.30	22.11	23.70	Fair	Fair	1	1	13.00	13.90	1.69	1.60
Hot water 45°C	10.29	10.32	21.83	23.05	Fair	Fair	1	1	13.10	14.25	1.60	1.56
L.S.D at 5%	0.81	2.38	4.65	3.96	-	-	-	-	0.76	0.63	0.11	0.09

Table (9): Fruit quality of Amaar Apricot cultivar after removal from 2 weeks of Storage at 5°C to Ambient temperature.

Treatments	Loss of Weight%		Decay%		Appearance		Fruit Marketing		T.S.S.%		Acidity%	
Prop.	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Control	12.36	12.79	39.60	35.67	Fair	Fair	1	1	12.65	13.75	1.70	1.60
$CaCl_2$ 1 %	9.76	9.95	18.20	19.67	Fair	Fair	2	2	13.30	14.80	1.65	1.55
$CaCl_2$ 3 %	6.70	8.00	4.90	4.85	Good	Good	4	4	13.80	16.10	1.15	1.20
K Mn O_4 %	7.13	8.12	6.15	6.88	Good	Good	4	4	13.60	15.95	1.30	1.40
K Mn O_4 % (bags)	9.07	10.00	8.90	9.00	Good	Good	4	4	13.40	14.20	1.45	1.50
Hot water 40°C	15.42	16.16	24.50	24.58	Fair	Fair	1	1	13.10	13.95	1.60	1.50
Hot water 45°C	13.67	14.61	23.40	23.00	Fair	Fair	2	2	13.25	14.30	1.55	1.58
L.S.D at 5%	1.01	1.13	6.19	1.22	-	-	-	-	0.53	0.74	0.10	0.06

Table (10): Fruit quality of Amaar Apricot cultivar after removal from 2 weeks of Storage at 0°C to 10°C.

Treatments	Loss of Weight%		Decay%		Appearance		Fruit Marketing		T.S.S.%		Acidity%	
Prop.	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Control	7.95	8.92	20.13	23.10	Fair	Fair	3	3	12.50	13.60	1.87	1.67
$CaCl_2$ 1 %	5.00	5.12	14.46	20.29	Good	Good	4	4	12.90	14.70	1.80	1.55
$CaCl_2$ 3 %	3.09	3.38	2.29	3.10	V.Good	Good	7	7	13.60	16.50	1.60	1.02
K Mn O_4 %	3.84	4.12	2.95	4.18	V.Good	Good	7	7	13.40	15.90	1.65	1.15
K Mn O_4 % (bags)	4.74	4.97	4.38	5.12	V.Good	Good	6	6	13.20	14.00	1.70	1.20
Hot water 40°C	5.90	5.95	18.54	19.59	Fair	Fair	4	4	12.90	13.80	1.78	1.45
Hot water 45°C	5.38	5.43	17.62	17.15	Fair	Fair	4	4	13.00	14.00	1.76	1.50
L.S.D at 5%	1.06	0.44	1.49	1.32	-	-	-	-	0.30	0.43	0.05	0.05

Table (11): Fruit quality of Amaar Apricot cultivar after removal from 2 weeks of Storage at 5°C to 10°C.

Treatments	Loss of Weight%		Decay%		Appearance		Fruit Marketing		T.S.S.%		Acidity%	
Prop.	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Control	9.67	9.04	18.20	19.97	Fair	Fair	3	3	12.40	13.60	1.80	1.75
$CaCl_2$ 1 %	5.67	6.35	15.20	16.13	Good	Good	4	4	13.80	13.90	1.75	1.65
$CaCl_2$ 3 %	3.47	4.12	3.05	4.10	V.Good	Good	7	7	13.90	14.30	1.21	1.29
K Mn O_4 %	4.15	4.97	5.10	5.60	V.Good	Good	7	7	12.95	14.00	1.38	1.30
K Mn O_4 % (bags)	5.00	5.30	6.70	6.12	V.Good	Good	6	6	12.90	14.50	1.53	1.50
Hot water 40°C	6.27	6.15	15.50	14.12	Fair	Fair	4	4	12.76	13.90	1.63	1.59
Hot water 45°C	6.00	5.90	14.30	14.00	Fair	Fair	4	4	12.30	12.60	1.90	1.65
L.S.D at 5%	0.68	0.60	2.49	1.92	-	-	-	-	0.14	0.12	0.04	0.03

Fruits treated with $CaCl_2$ at 3 % and potassium permanganate 1 % solution or bags placed inside the boxes gave the lowest weight loss and decay %, increased T.S.S. % and shelf-life (4 days) after removal from cold storage at 0°C or 5°C for 15 days to ambient temperature and (7 days) after removal from cold storage at 0°C or 5°C for 15 days to 10°C in both seasons.

These results are in agreement with those of Nwufo *et al.*, (1994) on avocado fruits who found that potassium permanganate application extended the shelf-life because it was quite effective in reducing ethylene levels (Scott *et al.*, 1970). In addition, postharvest applying $KMn\ O_4$ had the potential to retard tissue softening of Zaghloul dates, resulted in less electrolyte leakage, and improved the fruit marketability (Farag, 1988). Also, Ahlawat *et al.*, (1980) and Samia El-Oraby (1991) on guava and many fruits whose indicated that potassium permanganate bags placed inside the boxes lined with polyethylene, were the best treatments on reducing storage losses and prolonging the storage life.

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تأثير معاملات مابعد الحصاد على القدرة التخزينيه والتسويقيه لثمار مشمش العمار

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أجريت الدراسة خلال عامى ٢٠٠٣ و ٢٠٠٤ على صنف مشمش عمار بهدف زيادة القدرة التخزينيه والتسويقيه وتحسين جودة الثمار، فقد تم قطف الثمار فى مرحلة إكتمال النمو عندما كانت الثمرة صلبه ومخوصه (٢/١ – ٤/٣ تلوين) وتم غمس الثمار فى محلول كلوريد كالسيوم ١ & ٣% لمدة ثلاث دقائق وأيضا الغمس فى محلول برمنجانات بوتاسيوم ١ % لمدة ثلاث دقائق ثم وضع مادة برمنجانات بوتاسيوم ١٠ جم / ١٠٠٠ جم ثمار فى كيس صغير داخل العبوة وأيضا غمر الثمار فى ماء ساخن على درجة ٤٠ م & ٤٥ م لمدة ثلاث دقائق بالإضافه إلى ثمار لم تتعرض لأى من المعاملات السابقة كمقارنه وتم وضع الثمار فى عبوات مبطنه ببولى إيثيلين ٣٠ ميكرون . وتم تخزين الثمار على درجة صفر م & ٥ م ورطوبه نسبية ٨٥ – ٩٠ % لمدة ٤ أسابيع . وتم قياس الصفات الطبيعية والكيميائية للثمار كل أسبوع من بدء التخزين البارد . وبعد أسبوعين من التخزين البارد وتم خروج الثمار تدريجيا إلى درجات ١٠ م & ٢٣ م ووجد أن ثمار المشمش المعامله بكلوريد الكالسيوم ٣ % برمنجانات البوتاسيوم ١ % لمدة ثلاث دقائق وأيضا وضع عبوة صغيرة من برمنجانات البوتاسيوم ١٠ جم / ١٠٠٠ جم ثمار قد تفوقت عن باقى المعاملات وأيضا الثمار الغير معامله فى تقليل النسبه المئويه للفقد فى الوزن والتالف للثمار وتقليل معدل طراوة الثمار وتقليل نسبة الحموضه وزيادة نسبة المواد الصلبه الذائبه والكاروتينات

والمحافظه على محتوى الثمار من الكالسيوم . وعلى العكس فقد أدى غمر الثمار فى الماء ٤٠ °م & ٤٥ °م لمدة ثلاث دقائق وأيضا الثمار الغير معامله إلى زيادة معدل النسبه المئويه للفقد فى الوزن وكرمشه واضحه بالثمار وزيادة نسبة التالف وتقليل نسبة المواد الصلبه الذائبه والكاروتينات والكالسيوم خلال التخزين البارد على صفر °م & ٥ °م فى الموسمين وكان تخزين الثمار على درجة صفر °م أفضل من ٥ °م فى المحافظه على جودة الثمار وقدرتها التخزينيه .

وبعد ١٥ يوم من التخزين البارد إستمرت الثمار المعامله بكلوريد الكالسيوم ٣ % وأيضا برمنجانات البوتاسيوم ١ % أو وضعها داخل العبوة فى عبوات صغيرة (١٠جم/١٠٠٠جم ثمار) لمدة أسبوع بصفات جودة عاليه . عندما نقلت الثمار من صفر °م إلى ١٠ °م وحوالى ٤ أيام عندما نقلت من ٥ °م – ١٠ °م ولم تبقى فى الجو العادى (٢٣ °م) أكثر من ٣ أيام .

يتضح أنه يمكن تسويق الثمار وشحنها بعد ١٥ يوم من التخزين البارد سواء على صفر °م أو ٥ °م بصفات جيدة أفضل من تركها بالثلاجه لمدة شهر حيث أنها فى الحاله الأخيرة لم تتحمل الشحن بل لابد من التسويق الفورى للثمار .