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KEEPING QUALITY OF POMEGRANATE FRUIT (CV. MAHDAWI) BY PACKING, WRAPPING WITH ALOE VERA AND PUTRESCINE DURING COLD STORAGE

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ABSTRACT

This study was carried out in the refrigerated stores unit of the central laboratory, College of Agricultural Engineering Sciences, University of Duhok, in which local pomegranate fruits were obtained in one of the private orchards located in the village of Armasht (fifty-three kilometers from the city of Duhok). Dohuk Governorate, Kurdistan Region/Iraq, to study the effect of packing type (non-packing and packing) and dipped fruits for 7 min in different concentration of (0, 15, 30% AV gel, and 1.5 and 3 mM PUT) on fruit quality of pomegranate during (0, 2, 3 month) cold storage at 6+1℃ with 85-90% RH. The fruits packed in closed polyethylene bags were significantly superior to the non-packed fruits, in total soluble solids%, total acidity% and vitamin C, while they gave the lowest weight loss % during the cold storage period. As for the effect of AVgel and PUT solution results explained that dipped fruit in 30% AV gel Significantly reduce the fruit weight loss% and caused increase total soluble solids%, vitamin C, and juice density, and total acidity % compared to the other value. When storage progressed, a significant decrease was observed in TSS, titratable acidity, vitamin C and juice density in juice of all treated and untreated pomegranate fruits. The interaction of packing, storage period and dip treatments had significantly a positive effect on the quality pomegranate fruits.

KEYWORDS: *packing, Aloe Vera, putrescine, pomegranate fruits and storage*

INTRODUCTION

The pomegranate, (*Punica granatum* L.), is an ancient, mystical, and highly distinctive fruit in the *Punicaceae* family, Punica genus. The pomegranate is native to the Himalayas in northern India and Iran, but it has long been cultivated and naturalized throughout the Mediterranean region. It can also be found in India, as well as more arid areas of Southeast Asia, the East Indies, and tropical Africa. From Anatolia to Persia, India, Israel, China, Egypt, Greece, Tunisia, Spain, Mexico, Indonesia, South America, and, more recently, the United States, the pomegranate spread (Ward, 2003). The mature fruit has many seeds (arils) separated by white, membranous membranes, and each seed is surrounded by small amounts of tart, red juice (Morton, 1987and Jurenka, 2008). Due to its low respiration and ethylene production restarter harvest, pomegranate is classified as a non-climacteric fruit. Despite its non-climatic nature, the fruit suffers both quantitative and qualitative losses as a result of postharvest handling processes that cause weight loss, husk scald, chilling injuries, and decay (Kader *et al*., 1984).

Pomegranate cultivation in Iraq is thriving due to favorable environmental conditions, but there is a need to protect the fruits from sunburn during the season summer (Al-Jumaili and Abo Elsaad, 1989). In Iraq, more than 23 pomegranate cultivars are grown (Nasir, 1991), with fruit produced in the Diyala, Karbla, Hillah, Kirkuk, Sulaimania, and Duhok governorates (Inma Agribusiness Program, 2008). Arils, the fruit's edible part, contain about 80-85 percentage juice and 15-20% seed and are mostly eaten fresh (Al-Maiman and Ahmad, 2002 and Levin, 2006). Pomegranate fruit is high in antioxidants (Gil *et al*., 2000), such as anthocyanins, phenolic acids, and flavonoids (Zaouay *et al*., 2012). In addition, it is rich in the usual nutrients such as minerals and vitamins (Fawole and Opara ,2013).The economic importance of pomegranate fruits appears through along period that displays in the market since the start of fruit ripening in late summer to mid-winter in the time when most deciduous fruit types have disappeared, the fruit is

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distinguished by its ability to be transported over long distances and stored using a variety of methods (Al-Jumaili and Al-Dujaili, 1989). Edible coating is general method for extending the commercial shelf life of fruits. (ÖZ and Eker, 2017). Aloe Vera is known for its amazing medicinal properties, as AV gel has proven to be one of the best edible and safe coatings for a variety of foods due to its film-forming properties, antimicrobial properties, as well as its biodegradability and biodegradability, biochemical Properties, it consists primarily of polysaccharides and acts as a natural barrier to control moisture and oxygen, decrease respiration and maturity growth in pomegranate, increase storage and shelf life, delay oxidative browning, and reduce the proliferation of microorganisms in arils of pomegranate (Martínez-Romero *et al*., 2013 and Misir *et al.*,2014). Edible Aloe Vera coatings have been shown to reduce microorganisms, prevent moisture loss, and maintain firmness (Martinez-Romero *et al.*,2006 and Ahmed *et al*.,2009). Hasan *et al*., (2021) reported that cherries coated with 4% AV gel remained fresh and lowest decay of fruits for up to 12 days in cold storage. Also**,** Khan *et al*., (2022) showed that peach fruit Indian blood cv. when stored at ambient temperatures (25˚C ± 2) for nine days, and was coated with various AV gel treatments to assess post-harvest shelf-life extension and changes in physiological and biochemical attributes. When compared to the control treatment on the end of storage, peach fruits treated with AV gel ($100ml.l^{-1}$) maintained a good status of total soluble solids concentrations while maintaining a high level of titratable acidity. Hassan *e al*., (2022) when they 20% and 40% AV gel were used as edible coatings for strawberries in this study. The strawberries were then stored for 16 days at a temperature of 5 ± 1 °C. The results show that AV gel decrease deterioration and had the highest shelf life of the fruit. It also resulted in the least weight loss, retained firmness and acidity, but increased TSS and total anthocyanins when compared to uncoated fruits. Putrescin, spermidine, and spermine are the main polyamines found in plant tissues (Valero and Serrano, 2010). Compounds like Polyamines, can delay fruit ripening, extending the shelf life and improving the quality of a different climacteric fruits (Valero *et al.,* 2002). Polyamines are ubiquitous biogenic amines that are known to play advance roles in biological processes such as cell growth, division, proliferation, apoptosis/senescence, embryogenesis, and organ development (Mattoo and Handa, 2008).Increased endogenous PUT levels are linked to delayed fruit ripening. When applied exogenously, it inhibits ethylene production, postponing the rise in malondialdehyde content and membrane permeability, as well as the occurrence of chilling injury (Zhang et al. 2000). Aly *et al.*, (2019) study the effect of pre-harvest foliar application with PUT, (200, 400, 600) mg. l^{-1} and control on fruit quality and storability of "Anna" apple, then the fruits were stored for 60 days at 2°C and assessed at harvest time and every 20 days to determine how fruit quality characteristics change during cold storage. Results showed that, TSS, total sugars, vitamin C, firmness and anthocyanin contents were significantly increased while, weight loss, physiological damage and, acidity significantly decreased by pre-harvest foliar application with PUT. Hosseini farahi *et al*., (2020) Effects were assessed of PUT treatments on apricot quality after 40 days of storage, and 2.0 mM PUT treatments resulted in the least fruit weight loss, brown rot incidence, and firmness loss. But on other hand apricots treated PUT had the greatest titratable acidity fruit TSS increased during storage. The physiological and chemical quality of fruit during storage was improved by modified atmosphere packaging (Tefera *et al.*, 2007). Modified atmosphere packaging is an efficient method for preserving the quality of fresh fruits during postharvest storage (Beaudry, 1999). This method involves sealing a specific number of fruits in plastic bags with predetermined gas permeability, as the fruit respires, the concentration of O2 reduced and the concentration of CO2 raise inside the bags, which is determined by the commodity's respiration rate, storage temperature, and the type of film used, i.e. its thickness and permeability to oxygen, carbon dioxide, and water vapor (Kader *et al.*, 1989). Khan and Alam, (2021) the purpose of this post-harvest investigation was to determine how the interaction of wrapping materials and storage requirements affected the storage life and chemical fruit quality of the 'Khirsapat' mango. Wrapping 'Khirsapat' mango in LDPE 5% perforation + CFB Box 5% ventilation at 12±1°C revealed that the most successful treatment approach showed a more progressive maintain in TSS and total sugar than other treatments up to the 12 day. Aslanturk *et al.*,

(2021) they clarify, the effects of MAP applications on the mechanical and physical properties of the apricot variety 'Precocede Thyrinthe' during 20 days of cold storage. Apricot physical properties such as geometric mean diameter, sphericity, surface area, bulk and fruit densities were determined, as well as mechanical properties such as puncture compression forces and friction coefficient. When comparing MAP application to non-MAP application, the effect on the puncture force on three axes showed a lower tendency to decrease in the MAP application than in the harvest period.

The aim of the experiment was to study some qualitative characteristics of pomegranate fruits during cold storage, also to study the role of the postharvest treatments like packing and edible coating to prolong storability and proved fruit quality of pomegranate fruit during cold storage.

MATERIALS AND METHODS

Fully mature ripe, medium sized pomegranate fruits were harvested randomly from chosen trees of 8-year old in 15 October, were directly transferred to the central laboratory of Agriculture engineering science, sound fruits were kept in cold room to remove field heat.

After choose homogenize pomegranate fruits, fruits were divided into three groups, the first group of fruits was immersed in distilled water for 7 minutes. According to the second group, the fruits were immersed in 15 and 30% of Aloe Vera gel (AVgel) for 7 minutes. The third group of fruits were immersed with Putrescine (PUT) 1.5mM and 3mM for 7 minutes. After dipping, fruits were furnished on a thick piece of cloth and left to air-dry, then fruits of these groups was divided into two groups, the first group: were packed in polyethylene plastic bag tightly. The second group was without filling nylon fruits (6 fruits for each replicate), then stored in cold storage at (6+1 °C) and 85- 90%RH.

The experiment laid out in factorial experiment, by Complete Blocks Design (RCBD) including three factors (2 packing ×5 AV gel, and PUT × 3 storage period), with three replicates and 6 fruits for each replicate, (Al-Rawi and Khalafalla, 2000). Statistically analyzed between various treatments means were tested with Duncan Multiple Range test at 5% level. The parameters that were taken during the experiment as given below:

1- Fruit Weight Loss%: The percentage of fruit weight loss for each storage period for each treatment was calculated in relation to its original weight and the average weight loss% (El- Badawy, 2007).

2- Total Soluble Solid TSS%: Total soluble solid was determined using a hand refractometer (A.O.A.C., 1994).

3-Titratable acidity (TA %): The total acidity was determined using the method of (Srivastava and Kumar, 1993) by juice titrated with (0.1N NaOH) phenolphthalein used as indicator.

4-Vitamin C (mg. 100 ml-1 juice): Vitamin C in pomegranate fruit juice was determined with the titration, depending on procedure describe by (Pearson, 1976).

5- Juice (%): Juice present was calculated by (Karomi, 2001).

6- Juice Density: When calculating the juice density of pomegranate fruit juice, we relied on the method used (Otopeanu *et* al., 1967).

RESULTS AND DISCUSSION:

Fruit Weight Loss (%)

The results of fruit weight loss (%) presented in Table (1) indicated that fruit weight loss (%) of packing fruit was less significantly than fruit of non-packing.

Same table (1) illustrated that fruit weight loss increased significantly when storage period prolonged from 2 month to 3 months.

About the effect of dipping fruits in different concentration of AVgel on PUT. The result explained that all concentration (15, 30% AV gel and 1.5, 3 mM PUT) lowered the fruit weight loss % significantly in compration with untreated fruits.

About the triple interactions (packing, storage period and treatment) the results showed that fruit of packing , stored for 2 month and treated with 30% AV gel was significantly less fruit weight loss% comparted with the highest fruit weight loss% interaction of non-packing fruit , 3 month storage and untreated fruit (Table 1)

Table (1): Effect of packaging, AV gel (%), PUT (mM) , storage period and their interactions on Fruit Weight Loss (%) of pomegranate fruit during cold storage

Packing	Storage period (month)	Treatments					Packing*Sp.	Effect of Packing
		0	AloeVera (%)		putrescin(mM)			
			15	30	1.5	3		
Packing	**2**	0.91 d	0.56 d	0.45 d	0.45 d	0.39 d	0.53 c	0.82 b
	3	1.65 d	1.38 d	0.93 d	0.81 d	0.79 d	1.11 c	
Non-packing	**2**	3.89 c	3.77 c	3.49 c	3.83 c	3.53 c	3.70 b	7.82 a
	3	17.39 a	10.25 b	10.17 b	10.04 b	10.85 b	11.94 a	
Packing*Treat.	**Packing**	1.28 c	0.97 c	0.69 c	0.58 c	0.59 c	**Effect of Storage period**	
	Non-packing	10.64 a	7.01 b	6.83 b	7.43 b	7.19 b		
SP*Treat.	**2**	2.41 c	2.17 c	1.97 c	2.09 c	1.96 c	2.12 b	
	3	9.52 a	5.93 b	5.55 b	5.93 b	5.82 b	6.53 a	
Effect of Treatments		5.96 a	3.99 b	3.76 b	4.01 b	3.89 b		

Means followed by the same letters did not differ significantly according to Duncan's test at 0.05 level

Total soluble solids TSS (%):

The obtained results in table (2) appeared that packing pomegranate fruit proved a significant increase in TSS (%) as compared with the non-packing fruit.

From the same table, we noticed that the TSS (%) decreased significantly when storage period prolonged to 3 months.

The different treatments used in the investigation showed no significant differences among the results of all treatment in TSS (%).

About the triple interactions (packing, storage period and treatment) the results showed that fruit of packing, stored for 2months and treated with 30% AV gel or 1.5mM PUT had higher TSS (%) respectively, these values were significantly different with the values of some interactions. On other hand the lowest TSS (%) was from fruit of without packing, 2 months, and control.

Table (2): Effect of packaging, AV gel (%), PUT (mM) dip, storage period and their interactions on total soluble solid (%) of pomegranate fruit at cold storage.

Packing	Storage period (month)	Treatments					Packing*Sp.	Effect of Packing
		0	AloeVera (%)		putrescin(mM)			
			15	30	1.5	3		
Packing	**0**	15.6 a-e	15.6 a-e	15.6 a-e	15.6 a-e	15.60 a-e	15.60 ab	15.64 a
	2	15.80 a-d	15.03 efg	16.13 a	16.27 a	15.4 b-f	15.73 a	
	3	15.63 ae	16.10 ab	15.10 d-g	15.90 abc	15.17 d-g	15.58 ab	
Non-packing	**0**	15.6 a-e	15.6 a-e	15.6 a-e	15.6 a-e	15.6 a-e	15.60 ab	15.35 b
	2	14.63 g	15.6 a-e	15.90 abc	15.57 a-e	15.17 d-g	15.37 b	
	3	15.03	15.10	15.3	14.77	15.17	15.07	

		efg	d-g	c-g	fg	d-g	c
Packing*Treat.	**Packing**	15.68 ab	15.58 ab	15.61 ab	15.92 a	15.39 bc	**Effect of Storage period**
	Non-packing	15.09 c	15.43 bc	15.60 ab	15.31 bc	15.31 bc	
SP*Treat.	**0**	15.6 ab	15.6 ab	15.6 ab	15.6 ab	15.6 ab	15.60 a
	2	15.22 b	15.32 b	16.02 a	15.92 a	15.28 b	15.55 a
	3	15.33 b	15.6 ab	15.2 b	15.33 b	15.17 b	15.33 b
Effect of Treatments		15.38 a	15.51 a	15.61 a	15.62 a	15.35 a	

Means followed by the same letters did not differ significantly according to Duncan's test at 0.05 level

Titratable acidity (%)

Data table (3) showed that there were no significant different between the packing and non-packing pomegranate fruit in titratable acidity (%) content.

The data of titratable acidity (%) presented in Table (3) showed decrease in titratable acidity (%) significantly, when storage period prolonged to 3 months.

About titratable acidity (%) no significant differences among the results of all treatment showed the higher titratable acidity (%) recorded from treatment 15% AVgel and 3mM PUT.

The interaction of the three studied factors, the results showed that fruit of packing or non-packing 0 month storage and dipped in all concentration of AV gel and PUT mM gave the highest titratable acidity (%) these values were significantly different with the values of all interactions among the three factors. While the minimum value of titratable acidity (%) was from without packing and 3month storage treated 1.5 mM PUT.

Table(3): Effect of packaging, AV gel (%) ,PUT (mM) dip, storage period and their interactions on titratable acidity (%) of pomegranate fruit at cold storage .

Packing	**Storage period (month)**	**Treatments**					**Packing*Sp.**	**Effect of Packing**
		0	**AloeVera (%)**		**putrescin(mM)**			
			15	**30**	**1.5**	**3**		
Packing	**0**	0.57 a	0.57 a	0.57 a	0.57 a	0.57 a	0.57 a	0.39 a
	2	0.33 bcd	0.30 b-f	0.31 b-f	0.39 b	0.26 def	0.32 b	
	3	0.25 efd	0.23 ef	0.30 b-f	0.25 def	0.30 b-f	0.26 c	
Non-packing	**0**	0.57 a	0.57 a	0.57 a	0.57 a	0.57 a	0.57 a	0.38 a
	2	0.32 b-e	0.26 def	0.31 b-f	0.31 b-f	0.36 bc	0.31 b	
	3	0.26 def	0.23 ef	0.28 c-f	0.22 f	0.30 b-f	0.25 c	
Packing*Treat.	**Packing**	0.39 ab	0.37 ab	0.39 ab	0.41 ab	0.37 ab	**Effect of Storage period**	
	Non-packing	0.38 ab	0.36 b	0.39 ab	0.37 ab	0.41 a		
SP*Treat.	**0**	0.57 a	0.57 a	0.57 a	0.57 a	0.57 a	0.57 a	
	2	0.33 bc	0.28 cde	0.31 bcd	0.35 b	0.31 bcd	0.32 b	
	3	0.25 ed	0.23 e	0.29 b-e	0.24 e	0.29 b-e	0.26 c	
Effect of Treatments		0.38 a	0.36 a	0.39 a	0.38 a	0.39 a		

Means followed by the same letters did not differ significantly according to Duncan's test at 0.05 level.

Vitamin C (mg.100ml^{-1} juice):

Table (4) results for vitamin C were suggestive that packing pomegranate fruits proved a significant increase in vitamin C as compared with the non-packing fruit.

We noticed from the results of the same table that the amount of vitamin C decreases significantly as the fruits advance storage period from to 0 months.

No significant differences showed among the results of all dip treatment (15,30% AV gel and 1.5, 3mM PUT) in vitamin C, 30% AVgel have highest vitamin C , and fruit of control have the lowest vitamin C.

About the interactions of (packing, storage period and dip treatment) the data showed that fruit of packing and non-packing 0 storage and all dipping treatments yielded the maximum value vitamin C, these values were significantly different with the values of all interactions. Minimum value was from without packing, 3 months storage and 15% AV gel.

Table(4) : Effect of packaging, AV gel (%) ,PUT (mM) dip, storage period and their interactions on vitamin C (mg.100ml^{-1} juice) of pomegranate fruit at cold storage .

Packing	Storage period (month)	Treatments					Packing*Sp.	Effect of Packing
		0	AloeVera (%)		putrescin(mM)			
			15	30	1.5	3		
Packing	0	22.46 a	22.46 a	22.46 a	22.46 a	22.46 a	22.46 a	12.35 a
	2	9.94 b	10.22 b	11.45 b	9.86 b	10.66 b	10.43 b	
	3	4.39 d	4.32 d	3.74 d	4.46 d	3.89 d	4.16 d	
Non-packing	0	22.46 a	22.46 a	22.46 a	22.46 a	22.46 a	22.46 a	11.39 b
	2	6.98 c	7.13 c	7.99 c	7.19 c	7.48 c	7.34 c	
	3	4.10 d	4.03 d	4.54 d	4.25 d	4.86 d	4.36 d	
Packing*Treat.	Packing	12.26 ab	12.33 ab	12.55 a	12.26 ab	12.33 ab	Effect of Storage period	
	Non-packing	11.18 b	11.21 b	11.66 ab	11.28 b	11.60 ab		
SP*Treat.	0	22.46 a	22.46 a	22.46 a	22.46 a	22.46 a	22.46 a	
	2	8.46 b	8.68 b	9.72 b	8.50 b	9.07 b	8.88 b	
	3	4.25 c	4.18 c	4.14 c	4.36 c	4.37 c	4.26 c	
Effect of Treatments		11.72 a	11.77 a	12.11 a	11.77 a	11.97 a		

Means followed by the same letters did not differ significantly according to Duncan's test at 0.05 level

Juice (%):

Appeared from the results in table (5) that non-packing pomegranate fruit proved a significant increase in juice (%) as compared with the packing fruit.

Showed increase significantly in fruit juice (%) when storage period prolonged to 3 month.

No significant difference was observed in juice (%) of fruits between fruits at harvest and stored fruit for 2 months.

About the triple interactions the higher juice (%) came from non-packing, 3month storage and treated with 30% AV gel followed by packing fruits, 2month storage and 15% AVgel these interactions were significantly different from most other interactions. In addition, the lowest juice% was founded from fruit of packing, 2 months and control.

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Table(5) : Effect of packaging, AV gel (%) ,PUT (mM) dip, storage period and their interactions on juice (%) of pomegranate fruit at cold storage

Packing	Storage period (month)	Treatments					Packing*Sp.	Effect of Packing
		0	AloeVera (%)		putrescin(mM)			
			15	30	1.5	3		
Packing	0	52.95 cde	52.95 cde	52.95 cde	52.95 cde	52.95 cde	52.95 b	51.97 b
	2	41.83 g	58.47 a	47.41 f	52.24 cde	51.44 def	50.28 c	
	3	52.05 cde	55.49 a-e	53.08 cde	52.22 cde	50.55 ef	52.68 b	
Non-packing	0	52.95 cde	52.95 cde	52.95 cde	52.95 cde	52.95 cde	52.95 b	54.50 a
	2	52.79 cde	53.60 b-e	53.04 cde	53.32 b-e	55.09 a-e	53.57 b	
	3	56.0 a-d	57.90 ab	58.56 a	55.53 a-d	56.99 abc	56.99 a	
Packing*Treat.	Packing	48.94 e	55.64 a	51.15 de	52.47 bcd	51.64 cd	Effect of Storage period	
	Non-packing	53.91 abc	55.01 ab	54.85 ab	53.93 abc	55.01 ab		
SP*Treat.	0	52.95 bc	52.95 bc	52.95 bc	52.95 bc	52.95 bc	52.95 b	
	2	47.31 d	56.03 ab	50.22 c	52.78 bc	53.26 bc	51.92 b	
	3	54.03 ab	56.69 a	55.82 ab	53.88 ab	53.77 ab	54.83 a	
Effect of Treatments		51.43 c	55.23 a	52.99 bc	53.20 b	53.33 b		

Means followed by the same letters did not differ significantly according to Duncan's test at 0.05 level

Juice Density

Results in table (6) that there were no significant different between the packing and non- packing pomegranate fruit in juice density.

From the same table, we noticed that the juice density decreased significantly when storage period prolonged to 3 months.

Also, no significant differences showed among the results of all treatment (0, 15, 30% A V gel 1.5, and 3mM PUT) in juice density.

Storage period observed from the results that fruit of packing, 0 month storage period and treated with distil water had higher juice density , these values were significantly different with the values of some interactions. On other hand the lowest juice density was from fruit of non-packing, 2 months and control, 3 months and15% AV gel.

Table(6) : Effect of packaging, AV gel (%) ,PUT (mM) dip, storage period and their interactions on juice density of pomegranate fruit at cold storage

Packing	Storage period (month)	Treatments					Packing*Sp.	Effect of Packing
		0	AloeVera (%)		putrescin(mM)			
			15	30	1.5	3		
Packing	0	1.067 a-e	1.067 a-e	1.067 a-e	1.067 a-e	1.067 a-e	1.067 ab	1.066 a
	2	1.076 a	1.062 cde	1.062 cde	1.074 ab	1.065 a-e	1.068 a	
	3	1.059 e	1.063 b-e	1.071 a-d	1.061 cde	1.061 cde	1.063 bc	
Non-packing	0	1.067 a-e	1.067 a-e	1.067 a-e	1.067 a-e	1.067 a-e	1.067 ab	1.063 a
	2	1.057 e	1.058 e	1.072 abc	1.060 de	1.061 cde	1.061 c	
	3	1.066 a-e	1.057 e	1.059 e	1.060 cde	1.066 a-e	1.061 c	

Packing*Treat.	**Packing**	1.067 ab	1.064 ab	1.067 ab	1.067 a	1.064 ab	**Effect of Storage period**
	Non-packing	1.063 ab	1.060 b	1.066 ab	1.062 ab	1.064 ab	
SP*Treat.	**0**	1.067 a	1.067 a	1.067 a	1.067 a	1.067 a	1.067 a
	2	1.066 a	1.060 a	1.067 a	1.067 a	1.063 a	1.065 ab
	3	1.063 a	1.060 a	1.065 a	1.061 a	1.063 a	1.062 b
Effect of Treatments		1.065 a	1.062 a	1.066 a	1.065 a	1.064 a	

Means followed by the same letters did not differ significantly according to Duncan's test at 0.05 level.

Depending on the results obtained from this study, we can discuss the positive or negative effect of the studied factors (Packing, storage period and AV gel and PUT) on some qualitative characteristics of pomegranate fruits under cold storage conditions.

As for the effect of the packaging method, the content of the juice of the fruits packed in polyethylene bags dissolved that total soluble solids%, acidity%, vitamin C, and juice density was significantly higher, while fruits of packing gave the lowest significant in fruit weight loss Table (1,2,3,5,6) on the contrary, the non-packing fruits gave the highest percentage of juice% in pomegranate fruits compared to packing fruits. As it is known and as indicated in the studies, the fruits when packed in closed polyethylene bags create modified atmosphere packing (MAP) for the fruits and reduce gas exchange between the inside and outside of the bags. MAP changes the air composition around the fruit in the package low O2 and high CO2, which reduces respiratory activity and ethylene production, as well as delays ripening and softening**,** (Nurten and Mustafa, 2014). Weight loss is one of the most important physiological disorders influencing fruit shelf life (Serrano *et al.,* 2006). Kader *et al.,* (1989) reported that the primary function of packaging was to reduce the respiration rate of fruits and vegetables by delaying their metabolic activities. Decrease respiration also delays softening and slows various compositional changes associated with ripening, such as total soluble solids. Who reported a sustained and delayed increase in total soluble solids in polythene-packed fruits (Singh *et al.*,1967). Cua, (1989) the increase was also attributed to polysaccharide hydrolysis, which converts starch to sugar. The amount of vitamin C increased over time in different packaging becouse of different pore and non-porous coatings. The cause of increased ascorbic acid activation of ascorbate peroxidase in peach fruit has been expressed (Wang *et al*.,2006).

However, the preservation of acidity in polythene packaged fruits during storage could be attributed to decreased hydrolysis of organic acids and subsequent accumulation of organic acids that were oxidized slowly due to decreased respiration (Venkatesha and Reddy, 1994).

According to the information or the mean numbers in the tables which numbers are (1,2,3,4,5,6), the effect of immersing the fruits in different concentrations of AV gel and PUT solutions, on the quality of the pomegranate fruits were clear through the following terms (TSS, TA, VC, juice%, Juice density and weight loss).

The obtained results show that AV gel concentrations had a positive effect on the physical and chemical properties of stored pomegranate fruits.

AV gel contains polysaccharides and acts as a natural barrier to moisture and oxygen, both of which are major causes of fruit and vegetable wilting (Misir *et al.,* 2014). Physiological loss in weight was significantly less in fruits coated with different 30% AVgel, compared to control (untreated) fruits. However, the mechanism of these beneficial effects of AV gel edible coatings on fruit physiological weight loss is based on their hygroscopic properties, which allow the formation of a barrier to water diffusion between fruit and external environment, preventing its external transference (Morillon *et al.,* 2002).

The increase in TSS% of fruit juice when dipped in 15%AV gel one possible explanation for this phenomenon is the solubilization of polyuronides and hemicelluloses in the cell wall, additionally, water loss due to transpiration may contribute to the raise in total soluble solid (Hernández- Muñoz *et al.,* 2008).

The fruits dipped in 30% AV gel or 3mM PUT, on the other hand, had the highest acidity but did not reach a significant level. When fruit was treated with AV gel coating, the internal atmosphere of coated fruits was changed (Valverde *et al.,* 2005), resulting by a reduction

in the respiratory process (Serrano *et al.,* 2005), through the use of a barrier coating to reduce the use of organic acid in respiration (Nabifarkhani *et al.*, 2015).

Also Vitamin C (mg/100g) juice was recorded the height value when fruit coated by 30%AV gel but not significantly as compared to other treatments, the low oxygen permeability of the coating slowed the deteriorative oxidation reaction of the ascorbic acid content (Ayranci and Tunc,2003), because oxidative is the primary cause of ascorbic acid degradation in fruits (Castillo *et al.*,2010)

CONCLUSION

From the results can be concluded that pomegranate fruit packed with polyethylene and treated with an edible coating of AV gel and PUT each alone or in combination can reduce fruit weight loss%, delay in ripening in term of retention in (total soluble solids, tit-ratable acidity, vitamin C and juice%) of pomegranate fruit compared to non-packing or non-dipped fruits during 2 to 3 months cold storage. The event Finally, it was observed, the use of coating AV gel, PUT and packaging fruits under (6+1 °C) and 85- 90 RH is a suitable method for pomegranate fruit storage to maintain the fruit quality.

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