J. of Plant Production, Mansoura Univ., Vol. 11 (7):675-680, 2020

Journal of Plant Production

Journal homepage: www.jpp.mans.edu.eg
Available online at: www. jpp.journals.ekb.eg

Influence of Different Modified Atmosphere Packaging on Quality Characteristics of Wonderful Pomegranate Arils

Cross Mark

Eleryan, E. E.*

Fruit Crops Handling Research Department, Horticulture Research Institute, Agricultural Research Center, Giza, Egypt

ABSTRACT

Pomegranate (*Punica granatum* L.) is one of the most favorite fruits which consumed fresh or processed into juice due to its nutritional quality. Fresh cut pomegranate arils have become popular for their ease of eating, highest value, unique properties and health benefits. This study was conducted during the two successive seasons 2017 and 2018. Data revealed all packaging materials in combination with gelatin recorded high score of visual quality along the storage period, after 18 days at 5 ± 1 °C compared with the control. Coating arils in alginate at 3% with Packing in silver nano bag was the effective MPA bags in maintaining taste, aroma and overall acceptability. Also, it recorded the higher value of anthocyanin, vitamin C and antioxidant activity whereas decreased pectinase activity. On the other hand, coating arils in alginate at 3% with packing in Xtend bag (XT) was prefer ablein maintained brightness score and produced lower loss in weight % and oxygen levels inside the package. It could be concluded that coating arils of Wonderful pomegranate in alginate solution 3% then stored in silver nano bag (SN) technology was more effective method to extend storage life of fresh cut pomegranate aril during cold storage.

Keywords: pomegranate aril, alginate, modified atmosphere, MPA, Xtend® bag and silver nano bag.

INTRODUCTION

Pomegranate (*Punica granatum* L.) is an important fruit crop commercially cultivated in tropical and subtropical regions of the world and viewed as one of the promising exportation fruits products in Egypt in the most recent years Abd-elghany *et al*., (2012).Wonderful pomegranate is late cultivar with high yield, enormous fruit, rich red aril, high juice, rich source of bioactive compounds and good attractiveness Palou *et al*., (2007). Almost all parts of the fruit can be used. The edible part (aril) contains vitamin C, sugars, pectin, amino acids, minerals, fibers, phytoestrogens, flavonoids, phenolic acids Miguel, *et al.* , (2010). Physiological, physicochemical, phytochemical, mechanical, microbial and sensory qualities of pomegranate fruit are impacted by postharvest storage conditions such as temperature, packaging and relative humidity that could be utilized to keep up fruit quality to prolong storage periods Fawole and Opara, (2013).

The success of minimally processed products (fresh cut), favored by social and demographic trends in the world, is linked to the consumer's present demand for convenient products coupled with perception of freshness and natural taste. Consumer interest for minimally processed produce is growing rapidly, but maintaining product quality has been a significant difficult

Ma *et al*., (2010) Types of fresh produce vary widely from fruits, it is hard to protect fresh-cut produce for long storage periods in respiration, transpiration, enzymatic action of the living tissue and microbiological wellbeing. As a rule, the storage temperature particularly impacts the endogenous metabolism of the fruit and microbial decay. At room temperature the Pomegranate arils can be stored up to 2 days. The data on broadening its shelf life period is missing and thus it experiences a considerable post-harvest loss. Fresh-cut is more prone to microbial spoilage than whole fruits because of tissue harm; it contains high measures of moisture which lessens its shelf-life Arganosa *et al*.,(2008).

Edible coating is one of the most accepted strategies for prolonging the commercial shelf-life of fruits. The most important advantages of edible coatings are a decrease in the synthetic packaging waste and a contribution to food health and safety while meeting the environmental requirements Garcia *et al*., (2010). Edible coatings and films are applied on many products to control gas exchange, moisture transfer or oxidation processes. One major advantage of utilizing edible coatings and films is that several active ingredients can be incorporated into the polymer matrix and consumed with the food, thus upgrading safety or even nutritional and sensory attributes.

Alginate is a natural polysaccharide extracted from brown sea algae (Phaeophyceae), and it is made out of two uronic acids: β-D-mannuronic acid and α-L-guluronic acid. Sodium alginate is composed of block polymers of sodium poly (L-guluronate), sodium poly (D-mannuronate) also alternating sequences of both sugars. Alginate is known as a hydrophilic biopolymer that has a coating function of the fact that its well-studied unique colloidal characteristic, which contain its use for thickening, suspension forming, gel forming and emulsion stabilizing Acevedo *et al*.,(2012). It has several characteristic such as uniformity, transparency and fills in as a superb obstruction to dampness. Specifically, alginate has unique colloidal characteristic permitting its utilization as a thickening specialist and a settling material. It is widely utilized to improve the shelf life of many fruits and vegetables by controlling respiration, diminution dehydration and civilizing mechanical properties Koh *et al*., (2017).

Packaging play a significant role in keeping up the nutritional and microbial quality of fresh or fresh-cut produce. Packaging protects the food products, serves as an alternative measure for controlling diseases and provides structural support for convenient storage and transportation purposes. This play an

* **Corresponding author.**
E-mail address: d.emaneleryan@hotmail.com
DOI: 10.21608/jpp.2020.110592

important role in extending shelf life of food products and reduces the risk of food borne pathogens Opara and Mditshwa, (2013).

Modified atmosphere packaging (MAP) with low temperature storage or alone has been successfully used to prolong shelf life of fresh fruit moreover it's a simple and little price process to lessen these troubles, it can also keep the quality of pomegranate between 12-16 weeks after harvest. In a MAP technique, there is a change in the concentration of gases in the packaging headspace because of the dynamic interaction between the metabolic and biochemical processes of the packaged product. When fruits produce respire, O_2 and CO_2, ethylene, and water vapor are generated and transfer of all these gases through the packaging is regulated in MAP. The aim of the system is to balance these two processes to provide favorable conditions to preserve the product Fawole and Opara, (2013). Modified atmospheres are achieved by hermetically sealing fresh respiring produce in polymeric film and allowing the atmosphere within the package to be modified passively by the interplay of produce respiration rate (RR) and the film permeability properties, or actively by flushing the desired gas mixtures inside a package before sealing .Also, they slow down biochemical and physiological processes and retards senescence. MAP keep up arils pigments (anthocyanins) preferable than samples packed without MAP. Thereby maintaining packaged produce microbial safety and freshness, quality attributes. Failure to create this suitable atmosphere may result in a shortened shelf life. Xtend™ packaging passion fruit preserves quality and freshness during storage and shipment by Slowing down respiration and thereby preserving color, fresh taste and nutritional value for longer, Reducing shriveling and decay by removing excess moisture and providing an environment containing elevated CO_2 , Preserving color and glossy appearance and slowing down senescence Mahajan *et al*., (2014). The major difficulty in pomegranate aril export is limited shelf life and the only way to prolong the period of export is by increase the storage period of arils without affecting their quality.

The main objective of this study was to find the suitable method to extend storage life of fresh cut pomegranate aril through using proper packaging materials with alginate coating technique.

MATERIALS AND METHODS

Pomegranate fruits (*Punica granatum* L., cv. 'Wonderful') were reaped in 2017 & 2018 seasons from particular orchards at Cairo-Alexandria desert road, Egypt. The fruits were prepared for collect when total soluble solids (TSS) ranged 15 -17 ˚Brix and acidity below1.85% Kader *et al.,* (1984) and Martinez *et al., (*2006). Fruits were transported to the fruits research laboratory and washed with sterile water. Outer skins of healthy fruits uniform in size and manifestation were carefully cut at the equatorial zone with sharpened knife and the arils were manually separated. Arils, were divided into five gropes four of them dipped in 3 % alginate edible coating for 1 min dried for 30 min at 25°C,and the fifth one was the control treatment without any edible coating as follows:-

(T1) Coating arils alginate3%+Packed in polypropylene bag (PP)
(T2) Coating arils alginate3% + Packed in Xtend bag (XT)
(T3) Coating arils alginate3% + Packed in silver nano bag (SN)
(T4) Coating arils alginate3% + Packed in polyethylene bag (PE).
(T5) Control (Packed arils in polyethylene bag) (PE).

Preparation of edible coatings: Sodium alginate powder (Sigma-Aldrich) was dissolved in hot water (45°C) at 3% (w/v). After cooling, he add 10% glycerol and 2% (w/v) calcium chloride solution to the alginate solution as a firming agent Nair *et al*., (2018).

Table 1. Thickness, water vapor transmission rate (WVTR) and oxygen transmission rate (OTR) of selected films used for packaging of pomegranate arils

Packaging material	Thickness (µm)	WVTR (cm3/m2/24 hr)	OTR (cm3/m2/24 hr)
PP	40	5.6	63.13
XT	50	1.4	27.01
SN	90	2.5	35
PE	25	13.41	89.25

(PP) Polypropylene bag, (XT) Xtend bag, (SN) silver nano bag, (PE) polyethylene bag

Each treatment consists of three replicates, each contain 250g arils, 45 bags for all treatments. Pomegranate arils after packaged in different MAP bags as shown in table (1) Caleb *et al*., (2013), were stored alone with control for 18 days at 5±1ºC. Arils were examined at initial time and during storage every 6 days regarded the following parameters:

Visual appearance quality (score):

It was evaluated based on the whole visual general appearance in view of taste, aroma, overall acceptability, and brightness by a scale of 9-point rating Gorny *et al*., (2002) and Medina *et al*., (2012) as following:

9-8	excellent
7-6	good
5-4	(fair) limit of consumer acceptability
3-2	poor
1	(extremely poor) unacceptable

$$\text{Weight loss (\%)} = \frac{\text{Initial weight} - \text{weight at sampling date}}{\text{Initial fruit weight}} x100$$

Headspace gas analysis

Before packages were opened on testing date, the in-package atmosphere (O_2, CO_2) was calculated through storage with attracting up to 2 mL of air samples by using (Dual Trak model 902D gas analyzer; Quantek Instruments, USA) a headspace gas analyzer. At every sampling date, O_2 and CO_2 values were articulated as percentage.

-Total soluble solids (TSS %): Total soluble solids were calculated using drops of pomegranate arils juice using a Carl-Zeiss hand refractometer according to AOAC.,(2005)

-Titratable acidity (TA %): It was defined in fruit juice by titration 0.1 N sodium hydroxide (NaOH), using phenolphthalein as indicator and calculated as citric acid according to AOAC.,(2005)

- Anthocyanin (mg/100 ml juice): 1 ml of aril juice was blended with 95% ethyl alcohol and 1% HCl, after that it calculated on spectrophotometer (wave length 535^{mm}). It was calculated as next equations:

$$\text{Total anthocyanin (mg / 100 ml juice)} = \frac{\text{Total absorbance per 100 ml juice}}{98.2\ (E)}$$

Wheres: (E) value of 1% solution at 535 ^{nm} is equal to 98.2. So, the absorbance of a solution containing 1 ml is equal to 98.2 Ranganna., (1979)

- Vitamin C(mg/ 100 ml juice): the oxidation of ascorbic acid with 2, 6-dichlorophenolindophenol solution and 2% oxalic acid as a substrate then the results were recorded as mg ascorbic acid per 100 ml aril juice according to AOAC.,(2005)

- Total phenols (mg /100 gm fresh weight):

Total phenolics fixed by the Folin- Cicalteau method as Singleton *et al*., (1999) with modifications, based on colorimetric oxidation/reduction reaction of phenols. Gallic acid was used for calibration. Results were articulated as mg gallic acid100 g^{-1}FW.

- Pectinase activity:

0.5 ml arils samples of supernatant enzyme extraction was measured at wave length of 570 nm and expressed as 1 unit of pectinase activity 1 M mol D-galactouronic acid in milliliter/min Miller., (1959).

-Antioxidant activity:

It was carried out by free radical DPPH according to Bond and Michel., (1997) The antioxidant activity was determined using the next equation:

$$\text{Antioxidant activity \%} = [1 - (\text{Abs sample 517 nm/Abs control 517 nm})] \times 100$$

Statistical analysis: Data were analyzed using analysis of variance (ANOVA) according to Snedecor and Cochran (1982). Variation means were statistically parallel using Duncan's multiple tests at 0.05, using the CoStat V6.4 program.

RESULTS AND DISCUSSION

Visual appearance quality (score):

The adjustment of the fruit common appearance through the storage period were shown in Fig (1). Despite the treatments, a perceptible decrease was registered with the advancement of the storage period. Control fruits products endured over the top loss of visual quality and before long, became under the constraint of adequacy. As for MAP preserved fruits, in all packaging materials in combination with alginate data exposed high score of chart quality along the storage period, compared with the control. Although coating arils in alginate at 3% +Packed in silver nano bag was the effective MPA bags in maintaining taste, aroma and overall acceptability. While, coating arils in alginateat 3% + packed in Xtend bag (XT) was preferable in brightnessscore. This examination is in line with Mphahlele *et al.*, (2014) and Caleb *et al*., (2013) renowned that appearance of fruits chart was highly preserved in MAP packages throughout the whole storage period.

Weight loss (%):

Data in table (2) indicated a continuous increase in weight loss % with all treatments, in seasons 2017&2018. By comparing treatments of Packaging with the control through the storage periods, they appeared a significant variations. Control picked up the maximum percentage in loss of weight, whereas fruits packaged in MPA materials significantly showed lesser weight loss percentage relating to control. control maximum weight loss might be required to upper pace of transpiration and respiration which, thusly prompts propelled weight loss Mahajan *et al*., (2014). In the mean while, Xtend MAP gave significantly the lowest value of loss in weight percentage during the two seasons. In addition, it has confirmed to be an effective means of decreasing water loss through storage. Moreover, MAP of fruits confines water vapor dispersion, thus generating water vapor pressure and relative humidity inside packages control Selcuk and Erkan (2014).

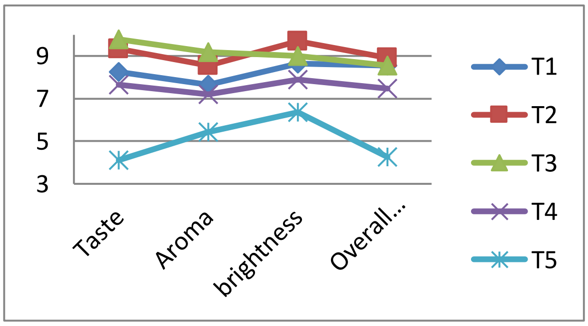

Fig. 1. Influence of MAP with alginate coating on visual appearance quality (Taste, Aroma, brightness and overall acceptability) of pomegranate arils during cold storage

(T1) Coating arils alginate3% + packed in polypropylene bag (PP) (T2) Coatingarils alginate3% + packed in Xtend bag (XT) (T3) Coatingarils alginate3% + packed in silver nano bag (SN) (T4) Coatingarils alginate3% + packed in polyethylene bag (PE) (T5) Control Packed arils in polyethylene bag (PE)

Table 2. Influence of MAP with alginate coating on weight loss %, respiration O_2%and CO_2% of pomegranate arils through cold storage

Treatments	Weight loss%				Respiration O_2%				Respiration CO_2%			
	Season 2017											
	Storage period (days)											
	Initial	6	12	18	Initial	6	12	18	Initial	6	12	18
(T1) Alginate 3% + (PP) bag	0.0 j	0.40i	1.20e	1.30d	10.02E	9.83f	9.51g	8.90i	5.00f	5.17e	5.40d	6.03a
(T2) Alginate 3% + (XT) bag	0.0j	0.0j	0.58h	0.91f	5.00M	5.13l	5.50k	5.92j	5.00f	4.80g	4.50h	4.06j
(T3) Alginate3% + (SN) bag	0.0j	0.45i	1.20e	0.95d	10.02E	9.49g	9.00h	9.00h	5.00f	5.46c	5.03f	5.88b
(T4) Alginate3% + (PE) bag	0.0j	0.00j	0.67g	1.31b	10.00E	10.90d	11.33c	11.91b	5.00f	4.42i	4.02j	3.92k
(T5)(PE) bag (control)	0.0j	1.92c	3.53b	4.34a	21.00A	21.00a	21.00a	21.00a	0.03l	0.03l	0.03l	0.03l
	Season 2018											
(T1) Alginate 3% + (PP) bag	0.0i	0.55h	1.41e	1.53d	10.02E	9.80f	9.50g	8.87k	5.00f	5.22e	5.69c	5.93a
(T2) Alginate 3% + (XT) bag	0.0i	0.0i	0.74g	1.11f	5.00O	5.20n	5.44m	5.90l	5.00f	4.85g	4.61h	4.13J
(T3) Alginate3% + (SN) bag	0.0i	1.13f	1.50d	1.55d	10.02E	9.40h	9.06i	8.93j	5.00f	5.53d	5.80b	5.97a
(T4) Alginate3% + (PE) bag	0.0i	0.0i	0.78g	1.61b	10.02E	11.00d	11.30c	11.90b	5.00f	4.48i	4.00k	3.80l
(T5)(PE) bag (control)	0.0i	2.05c	3.75b	4.81a	21.00A	21.00a	21.00a	21.00a	0.03m	0.03m	0.03m	0.03M

Gas analysis (CO_2 and O_2):

Changes in atmospheres headspace of packaged treatments are existed in Tables (2). In both seasons, it was showed a regular significant variations in O_2 level in all packaging materials used along with all over the storage period, comparing with the control, i.e. the normal circumstances of atmospheric gas composition (21% O_2).Silver nano bag (SN) and polypropylene bag (PP) appeared a steady lessening with the progress of the storage time, began with 10.2 % reaching the levels of (9.0 % - 8.90%) in season 2017 and (8.93% - 8.87) in season 2018.On the other hand , Xtend bag (XT) appeared the contrary pattern of O2 level inside the package, starting with 5% increasing to(5.92% - 5.90%) in both seasons. This result matches with the silver nano bag properties, representing that films is breathable polyethylene (PE) material that permits the correct trade of gases inside packages.

Carbon dioxide (CO_2) concentrations in headspace of all kinds of practical packages are exposed also in Table (2). A regular change all over the storage period with all treatments is evidently showed.Silver nano bag and polypropylene bag (PP) appeared a common increase in CO_2 percentage, related with time development. On the other side, CO_2 levels tend to decree into Xtend bag (XT) significantly in seasons 2017 & 2018. It is essential to note that, effect of MAP technologies neither silver nano bag (SN) nor Xtend bag (XT) does not count mostly on changing the levels of O_2 and CO_2 inside the package. Under these gas creations, both packaging materials had the option to confine weight loss and Keep up fruit quality traits. These results are in accordance with those accomplished by Laribi *et al.*, (2012) who affirm that, in MAP respiration pace of fruits, the vulnerability of the packaging films are the primarily huge significant parameter.

Total soluble solid (TSS) %:

TSS content of pomegranate arils in both seasons (Table 3) showed an expansion up to the furthest limit of storage period. Yet, the fruits of control presented a lesser advancement in TSS % regarding to packaged ones. Insignificant variations were seen among stuffed materials. A minor loss in TSS content was acquired in all treatment before the end of the storage period, producing larger in the control than in packaged fruits significantly. It very well may be assumed that the fruits of control utilized vitality for respiration, as recommended by Laribi *et al.*, (2012) on pomegranate.

Table 3. Influence of MAP with alginate coating on total soluble solids (TSS %) and titratable acidity (TA %) of pomegranate arils during cold storage

Treatments	Total soluble solids (TSS %)				Titratable acidity (TA %)			
	Season 2017							
	Storage period (days)							
	Initial	6	12	18	Initial	6	12	18
(T1)Alginate 3% + (PP) bag	15.60 h	15.70efgh	15.73 efg	15.90abcd	1.44a	1.40ab	1.39ab	1.30C
(T2) Alginate 3% + (XT) bag	15.60 h	15.60h	15.89abcd	16.00a	1.44a	1.40ab	1.37b	1.24D
(T3)Alginate3% + (SN) bag	15.60 h	15.63gh	15.82bcde	15.91abc	1.44a	1.39ab	1.38b	1.27Cd
(T4) Alginate3% +(PE) bag	15.60h	15.63gh	15.80cdef	15.93ab	1.44a	1.41ab	1.37b	1.32C
(T5)(PE) bag (control)	15.60h	15.69fgh	15.79def	15.30i	1.44a	1.40ab	1.40ab	1.29C
	Season 2018							
(T1)Alginate 3% + (PP) bag	15.90ab	15.94Ab	15.97ab	16.10ab	1.31a	1.29abc	1.26bcd	1.22Fg
(T2) Alginate 3% + (XT) bag	15.90ab	15.90Ab	15.95ab	16.23a	1.31a	1.29abc	1.23ef	1.12I
(T3)Alginate3% + (SN) bag	15.90ab	15.94Ab	16.14ab	16.19a	1.31a	1.29abc	1.22fg	1.16H
(T4) Alginate3% +(PE) bag	15.90ab	15.98Ab	16.12ab	15.36b	1.31a	1.30ab	1.26cde	1.21Fg
(T5)(PE) bag (control)	15.90ab	16.10ab	16.20A	15.71ab	1.31A	1.24def	1.19gh	1.05J

-Titratable acidity%:

Table (3) cleared that fruit titratable acidity % gradually decreased during the storage period. TA had a regular development through the storage period in all used treatments. A slight reduction in TA in packaged fruits appeared wich was less than control at the end of the storage period, yet variations were insignificant. Commonly, the watched decline in acidity with ripening may be accredited to an exhibit of variables, for example transformation of acids to new compounds and minimized capacity of fruits to synthesize acids by maturity. Artés *et al.*, (2000) found the same result on pomegranate with diverse modified atmosphere packaging. In general the changes in TSS in fruits is related with the hydrolytic enzymes for starch as the propelled action of enzymes is liable for the progressions of starch to sugars Laribi *et al., (*2012).

Anthocyanin content (mg100 ml^{-1}juice):

Table (4) presented a significant reduce by time on total anthocyanin content through seasons 2017, 2018 and regardless of the treatments. The control gave lesser anthocyanin content (11.03 and 11.29) than those of MAP treatments with significant variations in all treatments. While, silver nano bag (SN) packages recorded the higher value of anthocyanin content (12.74 and 13.01) in both seasons, correspondingly. This was in line with Gil *et al*., (1996), which notified that MAP preserved arils anthocyanins preferable in simile to fruits packed without MAP.

Table 4. Influence of MAP with alginate coating on anthocyanin (mg100 ml^{-1}juice) and vitamin C (mg100 ml^{-1}juice) of pomegranate arils through cold storage.

Treatments	Anthocyanin (mg 100 ml^{-1} juice)				Vitamin C (mg 100 ml^{-1} juice)			
	Season 2017							
	Storage period (days)							
	Initial	6	12	18	Initial	6	12	18
(T1)Alginate 3% + (PP) bag	13.06a	12.82cd	12.39E	12.22f	21.43A	20.81ab	19.65abc	18.80bcd
(T2) Alginate 3% + (XT) bag	13.06a	12.91bc	12.42E	12.51e	21.43A	17.55cd	19.73abc	18.81bcd
(T3) Alginate3% + (SN) bag	13.06a	12.95ab	12.81Cd	12.74d	21.43A	20.91ab	19.96abc	18.87abcd
(T4) Alginate3% +(PE) bag	13.06a	12.81cd	12.47E	12.16f	21.43A	20.94ab	19.96abc	18.13cd
(T5)(PE) bag (control)	13.06a	12.78cd	11.88G	11.03h	21.43A	19.93abc	18.51bcd	16.84d
	Season 2018							
(T1)Alginate 3% + (PP) bag	13.50a	13.28abc	13.17bcd	12.63f	20.18a	19.59ab	18.87ab	17.81abc
(T2) Alginate 3% + (XT) bag	13.50a	13.30abc	13.00De	12.67e	20.18a	19.70ab	15.76c	17.83abc
(T3) Alginate3% + (SN) bag	13.50a	13.40ab	13.20bcd	13.01d	20.18a	19.70ab	18.75ab	17.93abc
(T4) Alginate3% +(PE) bag	13.50a	13.07cde	12.64F	12.59f	20.18A	19.65ab	18.75ab	17.21bc
(T5)(PE) bag (control)	13.50a	12.97de	11.93G	11.29h	20.18a	19.34ab	17.73abc	15.93C

Vitamin C (mg100 ml^{-1}FW):

Significantly, all treatments overdue the losses of vitamin C comparing with the control as appeared in Table (4) at the end of cold storage. The amount of ascorbic acid decreased continuously with storage prolonged. Vitamin C contents in control treatments descend to 16.84 and 15.93mg 100 ml^{-1}FWafter 18 days at cold storage through both seasons. There were insignificant values between packaged treatments, although the higher amounts of vitamin C contents were obtained in silver nano bag (SN) through the whole storage period. In this treatment the contents of vitamin C were 18.87 and 17.93 mg 100 ml^{-1} FW at the end of cold storage period in both seasons, respectively. The decline in ascorbic acid in pomegranate at cold storage may be attributed to conversion of ascorbic acid into dehydroascorbic acid. The degradation in ascorbic acid during storage may be because of circuitous disintegration among polyphenol oxidase and peroxidase activity. Moreover, ascorbic acid is delicate to oxidative degradation lead to the arrangement of dehydroascorbic acid. Similar result also was observed by Fawole and Opara, (2013).

Total Pectinase Content (U/g pulp):

All packaged treatments in Table (5) succeeded with regards to expanding the pectinase content of pomegranate arils season 2017&2018. On the other hand, the difference between all MPA packaged treatments was insignificant. Also the data show that, the pectinase content of arils was gradually improved as the cold storage period increased from 0 to 18 days. In this search the lowest values of pectinase content was recorded by arils stored in silver nano bag (SN) treatment (2.11 and 2.26 U/g pulp) through both seasons. On the contrary, the control were recorded the maximum values of this parameter (3.80 and 4.03 U/g pulp). The previously mentioned outcomes are in line with Mahajan *et al*., (2014) they recorded that, the function of controlled atmosphere packing showed inhibitory effect on pectinase and cellulase enzymes and in delay in ripening. pectinase activity was increased and the lowest activity.

Table 5. Influence of MAP with alginate coating on pectinase activity and Antioxidant activity of pomegranate arils during cold storage.

Treatments	pectinase activity (U/g pulp)				Antioxidant activity (GAE µg mL^{-1})			
	Season 2017							
	Storage period (days)							
	Initial	6	12	18	Initial	6	12	18
(T1)Alginate 3% + (PP) bag	1.60ef	1.56f	1.91D	2.20c	20.15l	20.66k	21.57g	22.48C
(T2) Alginate 3% + (XT) bag	1.60ef	1.54f	1.85D	2.13c	20.15l	20.67k	21.44h	22.43Cd
(T3)Alginate3% + (SN) bag	1.60ef	1.51f	1.82D	2.11c	20.15l	20.93i	21.91e	23.54A
(T4) Alginate3% +(PE) bag	1.60ef	1.60a	1.91D	2.19c	20.15l	20.75j	21.69f	22.55b
(T5)(PE) bag (control)	1.60ef	1.70e	2.69B	3.80a	20.15l	20.70jk	21.43h	22.04D
	Season 2018							
(T1)Alginate 3% + (PP) bag	1.70j	1.70j	1.99F	2.41c	20.00k	20.57ij	21.29e	22.13b
(T2) Alginate 3% + (XT) bag	1.70j	1.68j	1.96Fg	2.33d	20.00k	20.61hi	21.28ef	22.00d
(T3)Alginate3% + (SN) bag	1.70j	1.65j	1.93gh	2.26E	20.00k	20.86g	22.03c	23.10a
(T4) Alginate3% +(PE) bag	1.70j	1.70j	1.90H	2.39c	20.00k	20.63h	21.39d	22.20b
(T5)(PE) bag (control)	1.70j	1.75i	3.05B	4.03a	20.00k	20.55j	21.24f	22.06c

Antioxidant activity (GAE µg mL^{-1}):

Table (5) presented that total antioxidant activity improved as storage advanced.There were an increment in antioxidant activity through all treatments compared with the control during both seasons. It also showed that silver nano bag (SN) resulted significant increment in antioxidant activity by DPPH assay approached with all treatments used or the control after 18 days of cold storage (23.54 and 23.10GAEµg mL^{-1}) in the season 2017 & 2018, respectively. Likewise, control treatment achieved the lowest significant contents of antioxidant activity in pomegranate arils compared with all treatments used (22.04 and 22.06 GAEµg mL^{-1}) in seasons2017 &2018. In this respect, Aloui,H. *et al*., (2014) found that alginate coating improve the AOA in coated fruits. The all out antioxidant activity movement is referred to the sizes of phenolic acids, ascorbic corrosive just as anthocyanin and as such the normal changes in all total antioxidant activity are assorted to those seen for the all out phenolic content. The size of antioxidant activity action is noteworthy quality thought in states of bioactivity and taste Mphahlele *et al.,* (2014).

CONCLUSION

It could be concluded that , commercial implementation of silver nano bag(SN) and Xtend bag (XT) technology are simple, cost effective and maintaining pomegranate arils quality for 18 days during cold storage at 5 ± 1°C.Moreover,these MAP maintaining visual appearance quality, anthocyanin content, vitamin C, pectinase content and antioxidant activity. By the by, extraordinary endeavor must be made to pack just new and ready natural fruits without decay, immature or over ripe. It is also important to lock the bags only after transferring the fruit to low temperatures in order to avert water condensation and undesirable gas compositions inside the bags. Application of agreed postharvest alginate was recommended to improve the performance of the packaging in forbidding loss of weight and for long-term storage in modified atmosphere packing.

REFERENCES

A.O.A.C., 2005. Official Methods of Analysis, 16th Ed., Association of Official Analytical Chemists, Washington DC. https://www.researchgate. net/ publication/ 292783651.

Abd-elghany,N.A., S.I. Nasr, and H.M. Korkar,2012. Effects of polyolefin film wrapping and calcium chloride treatments on posthravest quality of “Wonderful” pomegranate fruits. Journal of Horticultural ScienceandOrnamental Plants, 4(1), 7-17.

Acevedo, C.A., D.A. López, M.J. Tapia, J. Enrione, O. Skurtys, F. Pedreschi, D.I. Brown, W. Creixelland F. Osorio, 2012. Using RGB image processing for designating an alginate edible film. Food and Bioproc. Techno., 5(5):1511-1520.Doi: 10.1007/s 11947-010-0453y

Aloui,H., K. Khwaldia, L. S´anchez-Gonz´alez., 2014 “Alginate coatings containing grapefruit essential oil or grapefruit seed extract for grapes preservation,” *International* J. of Food Sci.and Techno., 49,(4):952–959.https://doi.org/ 10.1111 /ijfs. 12387

Arganosa, A.C.S., M.F.J.Raposo, P.C.Teixeira and A.M.Morais, 2008. Effect of cuttype on quality of minimally processed papaya. J. Sci. Food Agric. 88,2050–2060.https://www. tandfonline.com/ doi/ pdf/10.1080/10942912.2017.1293090

Artes, F., R.Villaescusa and J. A. Tudela, 2000. Modified atmosphere packaging of pomegranates. J. Food Sci. 65: 1112-1116.https : // doi.org / 10.1111/j.1365-2621. 2000. tb10248.x

Bond, S. and R. Michel, 1997. Antioxidant activity analysis in various fruit crops. J. Postharvest Biol. Technol., 52: 654-658. PMID: 25050243.

Caleb, O. J., U. L.Opara, V. M. Pramod, M. Manley, M.Rena, L. Mokwena and A. G. J. Tredouxe, 2013. Effect of modified atmosphere packaging and storage temperature on volatile composition and postharvest life of minimally processed pomegranate arils (cvs. ‘Acco’ and ‘Herskawitz’). Postharvest Biol. and Techno., 79: 54-61. https : // doi.org / 10. 1016/ j.postharvbio.2013.01.006

Fawole, O.A. and U.L.Opara, 2013 Effects of storage temperature and duration on physiological responses of pomegranate fruit. Ind. Crops and Prod., 47(1):300-309. https:// doi. org / 10.1016/ j.indcrop. 2013. 03.028

Garcia, L.C., L.M.Pereira, C.I.de Luca Sarantópoulos and M.D. Hubinger, 2010. Selection of an edible starch coating for minimally processed strawberry. Food and Bioproc. Techno., 3(6): 834-842.DOI: 10.1007/s11947-009-0313-9

Gil, M.I., F. Artes and F.A. Toma-Barberan, 1996. Minimal processing and modified atmospherepackaging effects on pigmentation of pomegranate seeds. J. of Food Sci., 61: 161-164. https://doi.org/10.1111/ j.1365-2621.1996. tb14749.x

Gorny, J. R., B. Hess-Pierce, R. A. Cifuentes and A. A. Kader, 2002. Quality changes in fresh-cut pearslices as affected by controlled atmospheres and. chemical preservatives. Postharvest Biol.Techno. 24(3):271-278.http://ucce. ucdavis.edu/files/datastore/234-153. pdf http://www. curresweb.com/ mejas/mejas/ 2017/ 289-298.pdf

Kader, A. A., A.Chordas and S.Elyatem, 1984. "Responses of Pomegranate to Ethylene Treatment andStorage Temperature." Archive California. Agri., 38: 14-15.https://pdfs.semanticscholar.org/1e86/a01642378f62d 1f38adda5ea09bc58a08dab.pdf

Koh,P. C., M. A. Noranizan, Z. A. Nur Hanani, R. Karim, and S. Z. Rosli, 2017. "Application of edible coatings and repetitive pulsed light for shelf life extension of fresh-cut cantaloupe (*Cucumis melo*L. *reticulatus*cv. Glamour)," Postharvest Biol. and Techno.,129: 64–78.DOI: 10.1016/j.postharvbio. 2017. 03.003

Laribi, A. I., L. Palou, V.Taberner and M. B.Pérez-Gago, 2012. Modified Atmosphere packaging toextend cold storage of pomegranate cv. "Mollar de Elche"., 1-6.Enghttp://www.academia.edu/2500799/.

Ma, Y., Q.Wang, G.Hong and M.Cantwell, 2010. Reassessment of treatments to retard browning of fresh-cut Russet potato with emphasis on controlled atmospheres and low concentrations of bisulphate. Int. J. Food Sci. Technol., 45, 1486–1494. DOI: 10.1111/j.1365-2621.2010.02294.x

Mahajan, P.V., O.J.Caleb, Z.Singh, C.B. Watkins, M.Geyer, 2014. Postharvest treatments of fresh produce. Philos. Trans. R. Soc., 372: 1471–2962. Doi: 10.1098/ rsta. 2013.0309

Martnez, J. J., P.Melgarejo, F. Hernandez, D. M. Salazar and R.Martnez, 2006. Seed characterization of five new pomegranates (*Punicagranatum*L.) varieties. Scientia Hort., 110: 241-246. DOI: 10.1016/j.scienta. 2006.07.018

Medina, M. S., J. A. Tudela, A. Marín, A. Allende and M. I. Gil, 2012. Short postharvest storage underlow relative humidity improves quality and shelf life of minimal processed baby spinach.Postharvest Biol. and Techno. 67: 1-9. DOI: 10.1016/j. postharvbio. 2011.12.002.

Miguel, M. G., M. A.Nevesa and M. D. Antunes, 2010. Pomegranate (Punicagranatum L.): A medicinal plant with myriad biological properties. J. of Med. Plants Res., 4, 2836–2847. https : // www. semanticscholar. org/paper/ Pomegranate-(Punica-granatum-L.)%3A-A-medicinal-plant-Miguel Neves/f3438e74c189e5c8f6430a816a67a963de5f5a6b

Miller, G.L., 1959. Use of dinitro salicylic for determination of reducing sugar. Analytical Chem., 31: 426-428. ttps://doi.org/10.1021/ac60147a030.

Mphahlele, R. R., O. A.Fawole, M. A. Stander and U. L. Opara, 2014. Preharvest and postharvestfactors influencing bioactive compounds in pomegranate (*Punicagranatum* L.): a review.Scientia Hort., 178: 114-123.https://doi.org/ 10.1016/j.scienta.2014. 08.010

Nair, M. S., A. Saxena, and C. Kaur,2018. "Effect of chitosan and alginate-based coatings enriched with pomegranate peel extract to extend the postharvest quality of guava (*Psidiumguajava*L.)," Food Chem., 240: 245–252.https://doi.org/10.1155/2019/8192964

Opara, U. L., and A.Mditshwa, 2013. A review on the role of packaging in securing food system: Adding value to food products and reducing losses and waste. Afr. J. of Agri. Res., 8: 2621–2630. DOI: 10.5897/ AJAR2013.6931

Palou, L., H.Carlos, G.Aguilar and G.David, 2007. Combination of postharvest antifungal chemical treatments and controlled atmosphere storage to control gray mold and improve storability of 'Wonderful' pomegranates. Postharvest Biol. Technol., 43, 133-142.https://crisosto. ucdavis. edu/ sites/ g/ files/ dgvnsk 6166/files/inline-files/109-07-Pomegranates-Combination-of-postharvest-antifungal-chemical-treatments-a.pdf

Ranganna,S., 1979.Manual of Analysis of fruit and vegetable products. 2nd end. Tata MC Graw Hill Publishing Company Limited, New Delhi, 634. http://agris.fao. org/agris-search/search.do?recordID= US201300540990

Selcuk, M. and M. Erkan, 2014. Changes in antioxidant activity and postharvest quality of sweetpomegranates cv. Hicrannar under modified atmosphere packing. Postharvest Biol. Technol., 92:29–36.https: //doi.org/ 10.1016/ j.postharvbio. 2014. 01.007

Singleton, V.L., R. Orthofer and R.S. LamuelaRaventós, 1999. Aalysis of total phenols and other oxidation substrates and antioxidants by means of Folin-Ciocalteau Reagent. Methods Enzymol., 299: 152-178. https://doi.org/10. 1016/S0076-6879(99)99017-1.

Snedecor, G. W. and W. G. Cochran, 1982. Statistical Methods. 7th Ed. The Iowa State Univ. Press,Ames Iowa, USA.https://www.jstor.org/stable/ 2530041? seq=1.

تأثير عبوات الجو الهوائى المعدل على خصائص الجودة لحبات الرمان الوندرفل

إيمان العريان*

قسم بحوث تداول محاصيل الفاكهة، معهد بحوث البساتين، مركز البحوث الزراعية

يعتبر الرمان (*Punica granatum L.*) من أكثر الفواكه المفضلة التي يتم استهلاكها طازجة أوبشكل عصير بسبب جودتها الغذائية ولقد أصبح فرط حبات الرمان مؤخرا أكثر شيوعا لسهولة تناولها ، وقيمتها المرتفعة، وفوائدها الغذائية. وهذه الدراسة تهدف إلى تقييم تأثير التغليف بإستخدام الألجينات على جودة حفظ حبات الرمان الطازجة بإستخدام ثلاث عبوات جو هوائى معدل مختلفة أثناء التخزين البارد. و قد أجريت الدراسة خلال الموسمين (2017 و2018) لفحص تأثير تغليف حبات الرمان الوندرفل بمحلول ألجينات 3٪ و التعبئة فى عبوات جو هوائى معدل (الكنترول عبوة من البولي إيثيلين , عبوة من البولي بروبيلين ، عبوة ®Xtend و عبوة نانو الفضية) على الخصائص الفيزيائية والكيميائية لحبات الرمان الوندرفل خلال التخزين البارد 5 ± 1م° لمدة 18 يومًا. وقد أوضحت النتائج أن التعبئة فى كل أنواع العبوات المختبرة مع التغليف بالألجينات أدت إلى إرتفاع الجودة المظهرية طول فترة التخزين مقارنة بالكنترول و أن تغليف الحبات بالألجينات(تركيز 3 ٪) مع التعبئة في عبوات نانو الفضية، كانت أكثرعبوات الجو الهوائى معدل (MPA) فاعلية فى الحفاظ على الطعم والرائحة المقبولة وكل صفات الجودة , كما أظهرت أعلى قيمة للأنثوسيانين وفيتامين ج وزيادة كبيرة في نشاط مضادات الأكسدة وأدنى قيم لإنزيم البكتينيز. .في حين كان تغليف الحبات بالألجينات(تركيز 3 ٪) مع التعبئة في عبوات ®(Xtend XT) أفضل من حيث درجة النضارة التي تم الحصول عليها ، وأقل نسبة مئوية في الفقد فى وزن الحبات مع انخفاض مستويات الأكسجين داخل العبوة. و قد أوضحت الدراسة أن تغليف حبات الرمان الوندرفل بمحلول ألجينات(3٪) ثم التعبئة فى عبوات نانو الفضية (SN) كانت أكثر فاعلية لإطالة العمر التخزينى لحبات الرمان الطازجة أثناء التخزين البارد.