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Influence of Treatment with *Aloe vera* Extract, Honey Solution and Salicylic Acid on Quality Maintenance of 'Wonderful' Pomegranate Fruits during Cold Storage.

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Abstract: The effect of immersing 'Wonderful' pomegranate fruits in 17% *Aloe vera* extract, 20% honey solution, 0.5g/l salicylic acid and mixture solution (*Aloe vera* extract+honey solution+salicylic acid) was studied throughout two successive seasons (2013 and 2014) to evaluate the effectiveness of these safe materials as postharvest treatments on maintaining quality attributes (decay incidence (%), severity, weight loss(%), firmness of fruit and arils, color of fruit and arils, juice content (%), total soluble solids (%), acidity (%), total soluble solids/acidity ratio, anthocyanins content) of 'Wonderful' pomegranate fruits during cold storage (5±1ºC, with 85-90% RH) for 90 days compared with control fruits (untreated).

The attained results revealed that, after 90 days of cold storage the majority of assessed attributes were statistically equal in control and adopted treatments. This was untrue for treatments with *Aloe vera* and salicylic acid, since *Aloe vera* treatment in both seasons maintained significant higher fruits firmness and hue angle value of arils color (H^o) in relation to control treatment. In addition, this treatment in the 1st season decreased weight loss (%) and exhibited higher content juice when comparing with control treatment. Also, in the 2nd season, *Aloe vera* treatment significantly decreased decay incidence (%), severity and exhibited higher aril firmness and fruits hue angle color (H^o) than that control treatment. Also, treated fruits with salicylic acid had significantly higher juice content (%) in the 2nd season in compared to control treatment.

Yet, after 60 days the majority of assessed attributes were positively affected by *Aloe vera* treatment, which in both seasons of the study, significantly decreased decay incidence (%) and severity to the lowest values and had the lowest significant decline in fruits and arils firmness in comparison with control treatment. Furthermore, in the 2nd season, *Aloe vera* treatment significantly increased hue angle value of fruit and arils color (H^o), juice content (%) and acidity content (%) than that control treatment, which had highest total soluble solids/acidity ratio after 60 days. Meanwhile, salicylic acid achieved significant highest value of hue angle of arils color (H^o) when compared with control treatment.

Decay incidence and severity, weight loss (%) and TSS/acidity ratio were increased as cold storage prolonged. In addition, arils juice (%) as well as total soluble solids and anthocyanins content were slightly increased with slight fluctuations throughout cold storage durations in comparison with that at zero time during the 1st and 2nd seasons with various significant differences. On the contrary, throughout both seasons, the values of firmness and Hue angle of fruits and arils as well as acidity content percentage decreased with the advancing of the storage duration.

Finally, from the above results, it could be concluded that, treatment with *Aloe vera* extract at 17% as natural and safe material followed by 0.5g/l salicylic acid treatment can be recommended to be used effectively in maintaining quality of 'Wonderful' pomegranate fruits during cold storage (5ºC) for short time (60-90 days) (representing the conditions of transport, handling, shipment export, market of the fruits) in comparison with remaining treatments.

Key words*:* Wonderful pomegranate, *Aloe vera*, Honey solution, Salicylic acid, Cold storage.

Introduction

Pomegranate (*Punica granatum* L.) is one of the preferred fruits in the world, which is known as a highly nutritional fruit, a rich source of antioxidants, sugars, vitamins, polysaccharides, minerals and has long been valued for its flavourful and juicy edible parts (aril)[1-4]. Suitable storage temperature for 'Wonderful' pomegranate fruits is 5 ^{o}C for 2 months and cannot be stored for longer than 2 months due to chilling injury, susceptibility to decay and browning of the fruit's rind and arils, so these defects make the injured fruit unfitting for fresh marketing and consumption[5-7].

Aloe Vera is a stemless or very short-stemmed perennial succulent plant, which belongs to family Liliaceae[8, 9]. The two major liquid sources of *A. Vera* are a yellow latex (exudates) and a clear gel (mucilage), which proceeds from the large leaf parenchymatic cells[10]. *Aloe Vera* gel has biological activities such as promotion of wound healing, antifungal activity and contains many active compounds including phenols, aloin, anthraquinones, sugars, vitamins, enzymes, minerals and amino acids[11-13]. As post-harvest treatments an edible coating based on *Aloe Vera* gel has been used by the several researchers to maintain fruits quality and safety of various fruits such as Apples, Valencia Orange, fresh-cut Kiwifruit and Grapes[14-18].

Salicylic acid is an essential endogenous signal molecule that plays a constitutive role in many processes including disease resistance, seed germination, inhibiting ethylene biosynthesis, delaying ripening, enhancing chilling tolerance and reducing fungal decay of Mango, Banana, Sweet cherry and Peach fruits[19-26].

Honey is a natural product, which is produced by bees and it has a powerful antibacterial, antifungal activity and antioxidant properties[27-29]. Honey ingredients are differ according to geographic origin and floral source, since honey is consisting of fructose, glucose, sucrose, phenols, flavonoids, protein and minerals such as N, P and K[30]. Honey solution has been used as postharvest treatment to maintain quality attributes of fresh-cut persimmon cubes, grapes cv. Razaki and guava fruits[31-33].

As far as we know from the literature, this is the first time *Aloe vera* extract as alone or as a combined treatment with honey solution and salicylic acid is being used as an edible coating for whole 'Wonderful' pomegranate fruits which would be an innovative and interesting means for commercial postharvest application. The objectives of this work were to assess the impact effect of *Aloe vera*, honey, salicylic acid alone or mixed as an edible coating on quality attributes of 'Wonderful' pomegranate fruits during cold storage.

Materials and Methods

Pomegranate 'Wonderful' fruits were obtained from 10 year old trees grown at Hegazy orchard at 74 Km Cairo-Alexandria Desert Road, during 2013 and 2014 seasons. Mature fruits were harvested when the average juice TSS content reached 17.32% according to[34]. Fruits were immediately transferred to the laboratory of the Agricultural Development System (ADS) project, Faculty of Agriculture, Cairo University. Fruits were uniform in size, appearance and either free from visible physical and pathological defects. They were thoroughly washed with tap water and lead to dry in the air. Fruits samples were dipped in the following treatments for 15 minutes (1) aqueous extract containing 17% (v/v) *Aloe vera* gel. (2) honey solution at 20% (w/v) (3) salicylic acid at 0.5g/l (4) mixed solution of *Aloe vera* extract, honey solution and salicylic acid. (5) control (water only).

Aloe vera fleshy leaves (1 kilogram) were obtained from Ornamental Department orchard, Faculty of Agriculture, Cairo University. Then two margins of leaves were removed and the remains was cut to pieces and blended in a blender. The blend was removed in a gauzemesh and pressed powerfully and the juice was obtained in a glass beaker and directly used[35]. Aloe vera gel ingredients are shown in Table (1) as mentioned by[36]. Honey solution (Pure honey bee produced by El-Fardows beehives for bee breeding and honey production, El-Minia, Egypt, which contains groups of polysaccharides, vitamins, enzymes, mineral elements and proteins) was prepared by completely dissolving 20 g of pure honey bee in 100 ml water. Salicylic acid at 0.5g/l (produced by El-Nasr pharmaceutical chemicals Company, Egypt) was prepared by completely dissolving 2.5 g of salicylic acid powder in 50 ml absolute Ethyl alcohol then solution was completed to 5 liters.

Treated fruits air dried and packed inside carton boxes with dimensions of 30x40x20cm and stored at 5±1ºC at 85-90% RH for 90 days. Each treatment comprised 3 replicates each replicate was made of 2 boxes (6

fruits/box), one box to determinate weight loss (%) and decay incidence (%) and severity, and the other was used to obtain interval samples for analysis of physical and chemical properties every 30 days. The impact of different treatments on Wonderful pomegranate fruits was evaluated throughout the following determinations:

Decay incidence (%) and severity (Score): Decay incidence (DI) (%) data was presented as the percentage of defected fruits ascribed to total number of fruits in each treatment, while decay severity (DS) were evaluated using scale of 1–5 where 1=0 % of the fruit surface rottened, 2= 1–25 %, 3= 26–50 %, 4= 51–75 % and 5=76–100%[37].

Weight loss%: Was calculated according to the following equation as mentioned by[38]**:**

$$\text{Weight loss\%} = \frac{\text{Fruits weight at the beginning} - \text{Fruits weight at the sampling time}}{\text{Fruits weight at the beginning of the storage}} \times 100$$

Firmness (g/cm²): Peel and arils firmness were measured using Lefra Texture Analyser **(Mod.TA1000).**

Color (H^o): a Konica Minolta Colorimeter **(Chroma meter CR-400, Minolta, Japan)** was used to measure the hue angle of peel and arils surface and expressed as degrees (H^o).

Juice content (%): 100g of arils were hand pressed using muslin cloth, the extracted juice was weighted and presented as percentage.

Total soluble solids (TSS %): Fresh arils juice was used to measure total soluble solids (TSS) by using digital hand refractometer (**Model Palette, PR-32, ATAGO**).

Total acidity (%): was determined as described by[39] and expressed as citric acid (%).

Total soluble solids/ Total acidity ratio. It was calculated by dividing TSS % by total acidity %.

Anthocyanins content (mg.100g^{-1}F.W): Total anthocyanins content in treated and untreated arils juice was determined by the method described by[40].

Statistical analysis: This experiment had two factors i.e. treatments and sampling data was designed as completely randomize. The means were compared by the least significant difference (LSD) at 5% level according to[41].

Table 1. Aloe *vera* gel ingredients

Class	Compounds
Anthraquinones	Aloin/Barb-aloin, Isobarba-aloin, Aloe-emodin, Emodin, Aloetic acid, Ester of cinnamic acid, Anthranol, Chrysophanic acid, Resistannol Anthracene, Ethereal oil.
Vitamins	B1, B2, B6, A-Tocopherol, β–Carotene,Choline, Vitamins, Folic acid and ascorbic acid.
Enzymes	Cyclo-oxygenase, Oxidase, Amylase, Catalase, Lipase, Alkaline-phospahatase and Carboxy-peptidase.
Miscellaneous	Cholesterol, Steroids, Tricylglycerides, β–Sitosterol, Lignins, Uric Acid, Gibberellin, Lectin like substances, Salicylic Acid and Arachidonic Acid.
Saccharides	Mannose, Glucose, L-Rhamnose, Aldo-pentose
Carbohydrates	Cellulose, acetylated mannan, Arabinogalactan, Xylan, Pure mannan, pectic substance, glucomannan, Glucogalc-tomannan and Galactan.
Inorganic Compounds	Ca, Na,Cl,Mn,Zn,Cu Mg and Fe
Non-essential Amino acids	Histidine, Arginine, Hydroxyproline, Aspartic Acid, Glutamic Acid, Proline, Glycine and Alanine.
Essential Amino acids	Lysine, Threonine, Valine, Leucine, Iso-leucine,Phenyl-alanine and Methionine.

Results and Discussion

Decay incidence and severity:

Concerning the average of different postharvest treatments as presented in Table (2), it was notice that, Wonderful pomegranate fruits treated with 17% *Aloe vera* extract during both seasons exhibited the lowest significant incidence (%) and severity of decay in comparison with the control treatment under the study.

Prolonging storage duration resulted in an increase in decay incidence and severity in both seasons, and significant differences were observed in the 2st season among storage periods for both incidence (%) and severity of decay.

The interaction between treatments and storage duration showed increasing trend in both incidence (%) and severity of decay during the storage. In this respect, at 60 days, the lowest significant incidence (%) of decay was observed with fruits treated with *Aloe vera* extract as well as salicylic acid (5.56%) during the 1st season, and fruits treated with *Aloe vera* extract (11.11%) throughout the 2nd season compared with control fruits (44.44%, 38.89% during the 1st and 2nd seasons, respectively). Moreover, *Aloe vera* treatment exhibited the lowest significant value of decay severity (1.33) at 60 days throughout both seasons in comparison with control fruits (2.67).

The present results are in harmony with results obtained by[42]. They reported that, *Aloe vera* extracts at 2% resulted in a complete reduction of DI and DS of *Penicillum digitatum* for Navel Oranges during 60 days of storage temperature (18-23°C). In addition, [26]on mango**,** [32]on grape cv. Razaki, [43]on peach and [44]on strawberry fruits. They noticed that, 20% honey solution for grape and salicylic acid treatments for remaining fruits markedly decreased decay incidence compared with control.

The antifungal activity of *Aloe vera* gel from several species including *Botrytis cinerea, Alternaria alternate* and *Penicillum digitatum* has been correlated with their content of phenolic compounds such as aloin[13, 45, 46]. Moreover, [47] indicated that salicylic acid has direct antifungal effects on fungus development or it increases the production of H_2O_2 in plants, which acts as a signaling molecule, activates the plant resistance against pathogens, antioxidant defense responses and stimulates either the synthesis of antioxidant enzymes or PPO and PAL activity[48-50].

Weight loss (%):

Data in Table (2) cleared that, fruits treated with *Aloe vera* had the least weight loss (%) on the average that reached the values of 4.27 and 5.13% during the 1st and 2nd seasons, respectively which was significantly lower from control but insignificant from other treatments. Weight loss (%) was significantly increased as cold storage prolonged.

Concerning the effect of the interaction is clear from the present results, it can be reported that, during the 1st season at 90days of storage, the least significant decrease of pomegranate fruits weight was recorded by the mixture solution (8.75%) followed by *Aloe vera* treatment (9.08%) compared control fruits (12.10%). Meanwhile, in the 2nd season honey solution and *Aloe vera* had insignificant lowest weight loss (%) (9.22 and 10.73%, respectively) for 90days of cold storage duration in comparing with control treatment (11.34%).

Aloe vera gel coating has also been effective in controlling water loss from other commodities, including, Sweet cherry, Granny smith and Red chief apples and table grape[14, 18, 51]. Furthermore, weight loss of grape cv. Razaki significantly decreased by postharvest treatment 20% honey solely or combined with MAP treatments compared to the control[32].

The reduction of moisture loss might be due to that *Aloe vera* gel is mostly composed of polysaccharides which had hygroscopic properties and act as barrier to water and O_2 between the fruit and the surrounding environment. Consequently, preventing its external transferences and leading to a modified atmosphere inside fruit tissue which enhances its safety[10, 52, 53].

Table 2. Influence of aloe vera extract, honey solution, salicylic acid and mixture treatments on decay incidence (%), severity (score) and weight loss(%) of Wonderful fruits for 90 days storage in 5±1°C during 2013 and 2014 seasons.

Treatments (A)	Decay incidence (%)**									
	2013 Season					2014 Season				
	Storage period (days) (B)					Storage period (days) (B)				
	0	30	60	90	Mean (A)	0	30	60	90	Mean (A)
17% Aloe Vera	0.00	5.56	5.56	50.00	**15.28**	0.00	5.56	11.11	38.89	**13.89**
20% Honey solution	0.00	16.67	22.22	33.33	**18.06**	0.00	11.11	22.22	61.11	**23.61**
0.5g/l Salicylic acid	0.00	5.56	5.56	66.67	**19.45**	0.00	11.11	16.67	55.56	**20.83**
Mixture solution*	0.00	11.11	22.22	61.11	**23.61**	0.00	5.56	33.33	66.67	**26.39**
Control (water only)	0.00	22.22	44.44	72.22	**34.72**	0.00	16.67	38.89	66.67	**30.56**
Mean (B)	**0.00**	**12.22**	**20.00**	**56.67**	-	**0.00**	**10.00**	**24.44**	**57.78**	-
LSD at 5%	A=13.24 B=11.84 AB=26.48					A=12.16 B=10.88 AB=24.33				
	Decay severity (score)* **									
17% Aloe Vera	1.00	1.33	1.33	2.33	**1.50**	1.00	1.33	1.33	3.00	**1.67**
20% Honey solution	1.00	1.67	2.00	2.33	**1.75**	1.00	1.67	1.67	3.00	**1.83**
0.5g/l Salicylic acid	1.00	1.33	1.67	3.33	**1.83**	1.00	1.33	1.67	3.00	**1.75**
Mixture solution*	1.00	1.33	2.33	3.00	**1.92**	1.00	1.33	2.67	3.33	**2.08**
Control (water only)	1.00	2.00	2.67	3.33	**2.25**	1.00	2.33	2.67	4.00	**2.50**
Mean (B)	**1.00**	**1.53**	**2.00**	**2.87**	-	**1.00**	**1.60**	**2.00**	**3.27**	-
LSD at 5%	A=0.639 B=0.571 AB=1.28					A=0.481 B=0.430 AB=0.962				
	Weight loss (%)									
17% Aloe Vera	0.00	2.70	5.31	9.08	**4.27**	0.00	3.75	6.04	10.73	**5.13**
20% Honey solution	0.00	3.27	6.00	10.24	**4.88**	0.00	3.66	8.16	9.22	**5.26**
0.5g/l Salicylic acid	0.00	4.04	5.68	9.27	**4.75**	0.00	3.97	5.74	13.64	**5.84**
Mixture solution*	0.00	4.17	6.64	8.75	**4.89**	0.00	4.07	8.62	13.74	**6.61**
Control (water only)	0.00	4.25	6.40	12.10	**5.69**	0.00	4.49	6.24	11.34	**5.51**
Mean (B)	**0.00**	**3.68**	**6.01**	**9.89**	-	**0.00**	**3.99**	**6.96**	**11.73**	-
LSD at 5%	A=0.895 B=0.800 AB=1.79					A=N.S. B=1.46 AB=3.25				

* Mixture solution= 17% *Aloe vera* + 20% honey solution + 0.5g/l salicylic acid.
**DI=Decay incidence (%) ***DS=Disease severity (score) was scored following the scale (1=0 % of fruit surface rottened; 2=1– 25 %; 3=26–50 %; 4=51–75 % and 5=76–100 % rottened[37].

Firmness (g/cm²):

Results of fruit firmness during the two successive seasons are shown in Table (3), it could be mentioned that, in the 2013 season and regardless effects of storage time, all treatments except those treated with the mixture solution led to maintaining the fruits a firmness that was insignificant from each other and that was significantly higher from control fruits. In the 2014 season, fruits treated with *Aloe vera* followed by honey solution were significantly firmer (370.50 and 352.33g/cm^2, respectively) than control (309.75 g/cm^2). In addition, similarly trend was noticed with arils firmness in both seasons as shown in Table (3), since arils of fruits treated with all treatments were firmer than control arils, and arils of treated fruits with *Aloe vera* exhibited higher values of firmness.

Concerning the storage duration, the results indicated that, in both seasons the values of fruits and arils firmness significantly decreased with the advancing of the storage duration, however the difference between values of arils firmness at 0 days and 30 days in the 2nd season only did not attain a statistical level.

Interaction data revealed that, during 2013 season at 60 days, the lowest significant decline in fruits firmness was obtained with fruits treated with honey solution (284.67g/cm^2) and *Aloe vera* treatments (282.33 g/cm^2) in relative to control fruits (224.33 g/cm^2). Meanwhile, at 90 days *Aloe vera* treatment was more effective in maintaining higher fruit firmness (231.33 g/cm^2) with significant differences in comparison with control treatment (172.67 g/cm^2). However, throughout the 2014 season at 60 and 90 days, respectively fruits

treated with *Aloe vera* treatment were significantly firmer (349.0 and 252.33 g/cm^2) than control (234.67 and 154.0 g/cm^2). Similar trend was noticed with arils firmness in both seasons of this study at 60 and 90 days, where *Aloe vera* treatment followed by honey and salicylic acid treatments exhibited higher arils firmness than mixture solution and control treatments, and significant differences occurred among different interactions.

The present results are accordance with obtained by[16] on kiwifruit slices and [54]on papaya fruits. They concluded that, *Aloe vera* treatment significantly reduced the firmness losses of fruits (15% *Aloe vera* for kiwifruit slices and *Aloe vera* gel (100%) or papaya leaf extract with *Aloe vera* gel (PLEAG; 1:1) for papaya fruits). On the other side, the obtained results were in harmony with those obtained by[31] on fresh-cuts of persimmon cubes and [32]on grape cv. Razaki. They mentioned that, honey solution dips delayed firmness loss. Moreover, salicylic acid reduced fruit softening rate of peach, kiwi and kitt mango fruits during cold storage[42, 55, 56].

The explanation for the positive effect due to *Aloe vera* treatment on maintenance of peel and arils firmness in the present study could be related to the lower weight losses as well as lower incidence of decay. In addition, changes in cell wall structure due to the combined action of enzymes including hydrolases, particularly polygalacturonase (PG), pectinestarage (PE), β- Galactosidase (β-Gal), pectate lyase (PL) and cellulose (Cel) and *Aloe vera* gel has a role in the reduction of activity of (PG), (PE) and β-Gal enzymes responsible for fruit softening[57-59]. The maintain in fruits and arils firmness due to salicylic acid treatment in comparing with control might be due to polyphenolic metabolism during cold storage as previously reported in loquat fruit[60].

Table 3. Influence of aloe vera extract, honey solution, salicylic acid and mixture treatments on firmness (g/cm^2) of Wonderful fruits and arils for 90 days storage in 5±1ºC during 2013 and 2014 seasons.

Treatments (A)	Fruit firmness (g/cm^2)									
	2013 Season					2014 Season				
	Storage period (days) (B)					Storage period (days) (B)				
	0	30	60	90	Mean (A)	0	30	60	90	Mean (A)
17% Aloe Vera	415.00	356.00	282.33	231.33	**321.17**	461.33	419.33	349.00	252.33	**370.50**
20% Honey solution	415.00	362.33	284.67	218.00	**320.00**	461.33	391.00	306.00	251.00	**352.33**
0.5g/l Salicylic acid	415.00	352.67	275.67	211.33	**313.67**	461.33	363.33	309.00	230.00	**340.92**
Mixture solution*	415.00	336.33	201.67	132.00	**271.25**	461.33	368.00	257.00	196.00	**320.58**
Control (water only)	415.00	325.67	224.33	172.67	**284.42**	461.33	389.00	234.67	154.00	**309.75**
Mean (B)	**415.00**	**346.60**	**253.73**	**193.07**	-	**461.33**	**386.13**	**291.13**	**216.67**	-
LSD at 5%	A=25.90 B=23.17 AB=51.81					A=26.83 B=24.00 AB=53.66				
Treatments (A)	Arils firmness (g/cm^2)									
17% Aloe Vera	10.33	10.00	9.33	8.00	**9.42**	11.00	10.67	10.00	9.67	**10.33**
20% Honey solution	10.33	9.67	8.67	7.67	**9.08**	11.00	10.67	9.33	8.00	**9.75**
0.5g/l Salicylic acid	10.33	9.33	7.67	6.33	**8.42**	11.00	10.00	8.67	7.67	**9.33**
Mixture solution*	10.33	9.00	7.33	6.33	**8.25**	11.00	10.00	8.33	7.33	**9.17**
Control (water only)	10.33	8.00	7.00	6.00	**7.83**	11.00	10.00	6.67	5.33	**8.25**
Mean (B)	**10.33**	**9.20**	**8.00**	**6.87**	-	**11.00**	**10.27**	**8.60**	**7.60**	-
LSD at 5%	A=1.007 B=0.900 AB=2.014					A=1.000 B=0.894 AB=2.000				

* Mixture solution= 17% *Aloe vera* + 20% honey solution + 0.5g/l salicylic acid.

Color (H^o):

Results presented in Table (4) exhibited the effects of different postharvest treatments on pomegranate fruit color (H^o) on the average throughout both seasons, it was clear that, control treatment in the 1st season and mixture solution in the 2nd season recorded a lower value in comparing to remaining treatments, and significant differences were differ among different treatments including control. Furthermore, arils color (H^o) of fruits treated with *Aloe vera* exhibited a significant higher hue angle of arils (31.32 and 28.57) than in control arils (27.27 and 25.22) in both seasons.

The results regarding the effect of storage period revealed that, hue angle of fruits and arils significantly decreased gradually with the increasing cold storage period in both seasons. The differences between values of fruit and arils color (H^o) at 0 days and other periods attained significant levels in both seasons, excepted value of fruit color (H^o) at 90 days was insignificant in comparison with 0 days in the 1st season only.

Concerning the interaction between postharvest treatments and storage duration, data clear that in both seasons at 90days of storage, *Aloe vera* treatment maintained highest insignificant value of fruit hue angle in relation to control treatment. While, the results of arils color (H^o) indicated that, in the two seasons at 90days of storage, *Aloe vera* treatment maintained highest significant value in relative to control ones.

The aforementioned results are in accordance with the findings of [61]on table grapes and [14]on apples. They revealed that, skin color of fruits showed lower losses in *Aloe vera* treated than in control (untreated) fruits at cold storage (1-2°C, 95% RH). In addition, [62]reported that, salicylic acid delayed discoloration with the inhibition of browning for fresh–cut in Chinese water chestnut.

Juice content (%):

With respect to the effect of different postharvest treatments on arils juice (%) (Table 4) on the average, it was clear that, fruits treated with 17% *Aloe vera* extract in both seasons had significantly the highest juice arils content (76.03 and 79.68%) followed by 0.5g/l salicylic acid in the 1st season or 20% honey solution in the 2nd than that obtained from control arils (73.38 and 76.78%), and significant differences did not attain between *Aloe vera* extract and either salicylic acid in the 1st season or 20% honey solution in the 2nd season.

The present results clearly indicate that, the storage duration effect on the arils juice (%) was insignificant in most cases during both seasons, and arils juice (%) at the end of storage period was slightly increased compared to with arils juice (%) at 0 days throughout the 1st and 2nd season. Data pertaining the effect of the interactions, at 90 days, showed that fruits treated with 17% *Aloe vera* in the 1st season and 0.5g/l salicylic acid in the 2nd significantly increased the juice content (%) than that control treatment. [6]reported that, juice content of Wonderful arils decreased at cold storage 5°C in comparison with fruits that at harvest time.

Total soluble solids (%):

Concerning the average of different postharvest treatments as presented in Table (5), during the first season, it was noticed that, treatment of 17% *Aloe vera* maintained lower TSS in compared to other treatments with insignificant differences expect 20% honey treatment, where a significant difference was scored. However, in the second season, it was observed that treatments of 20% honey and 0.5g/l salicylic acid significantly exhibited lower TSS content in relative to control treatment. In this concern, these results are in harmony with those attained by[24] who cleared that, 'Hayward' kiwifruit fruits treated with methyl salicylate vapor maintained TSS content lower than control fruits content during cold storage at 0.5°C and 90% RH for 5 months, and this might be due to that methyl salicylate acid reduced ethylene production and may have resulted in decreasing sucrose-phosphate synthase (SPS) enzyme activity leading to decrease sucrose synthesis[25].

The computed data (Table 5) give an indication that during both seasons total soluble solids content was slightly increased by prolonging cold storage duration at 5°C with slight fluctuations, and significant differences were observed at 30 and 90 days in the 1st season and at 30days during the 2nd season in comparison with the initial value of TSS% at 0 days.

The observed changes in TSS values during storage are in agreement with[63], who reported a significant increase in TSS for 'Shlefy' pomegranate when stored at 5°C for 4 months. Also, [6]mentioned After 2 months, no

significant increases in TSS of Wonderful were observed at 5°C; however, after 4 months, there were further marked increases in TSS in fruits.

The results pertaining the effect of interaction between different treatments and storage periods cleared that, fruit's soluble solids content at 90 days was significantly decreased by 0.5g/l salicylic acid (17.77%) throughout the 1st season and by 17% *Aloe vera* treatments (17.13%) during 2nd season when comparing with control treatments (18.37 and 17.77% for the 1st and 2nd seasons, respectively).

Table 4. Influence of aloe vera extract, honey solution, salicylic acid and mixture treatments on hue angle (H°) of Wonderful fruits, arils and juice content of 100g arils (%) for 90 days storage in 5±1°C during 2013 and 2014 seasons.

Treatments (A)	Fruits (H°)									
	2013 Season					2014 Season				
	Storage period (days) (B)					Storage period (days) (B)				
	0	30	60	90	Mean (A)	0	30	60	90	Mean (A)
17% Aloe Vera	20.91	23.66	20.65	20.59	**21.45**	26.44	25.79	23.94	21.70	**24.47**
20% Honey solution	20.91	24.64	23.92	20.25	**22.43**	26.44	24.57	22.76	20.41	**23.55**
0.5g/l Salicylic acid	20.91	24.45	23.99	19.94	**22.32**	26.44	24.62	21.70	20.62	**23.34**
Mixture solution*	20.91	24.78	22.51	19.97	**22.04**	26.44	20.82	19.43	17.35	**21.01**
Control (water only)	20.91	21.93	19.62	18.77	**20.31**	26.44	22.05	20.33	19.11	**21.98**
Mean (B)	**20.91**	**23.89**	**22.14**	**19.90**	-	**26.44**	**23.57**	**21.63**	**19.84**	-
LSD at 5%		A=1.22		B=1.09	AB=2.43			A=1.25	B=1.11	AB=2.49
Treatments (A)	Arils (H°)									
17% Aloe Vera	37.69	33.36	29.53	24.70	**31.32**	34.01	31.32	27.11	21.84	**28.57**
20% Honey solution	37.69	30.02	23.88	20.46	**28.01**	34.01	30.62	24.42	19.74	**27.20**
0.5g/l Salicylic acid	37.69	34.63	28.45	21.21	**30.50**	34.01	29.27	24.25	20.98	**27.13**
Mixture solution*	37.69	27.25	20.80	18.60	**26.09**	34.01	28.30	21.59	19.22	**25.78**
Control (water only)	37.69	30.21	22.93	18.27	**27.27**	34.01	28.98	20.74	17.16	**25.22**
Mean (B)	**37.69**	**31.10**	**25.12**	**20.65**	-	**34.01**	**29.70**	**23.62**	**19.79**	-
LSD at 5%		A=2.16		B=1.93	AB=4.32			A=1.84	B=1.65	AB=3.68
Treatments (A)	Juice content of 100g arils (%)									
17% Aloe Vera	73.65	74.56	76.00	79.91	**76.03**	76.13	86.11	78.72	77.75	**79.68**
20% Honey solution	73.65	78.03	74.97	73.00	**74.91**	76.13	87.01	78.00	74.73	**78.97**
0.5g/l Salicylic acid	73.65	74.58	75.33	79.20	**75.69**	76.13	74.35	77.33	79.10	**76.73**
Mixture solution*	73.65	74.67	76.47	74.54	**74.83**	76.13	82.10	77.57	77.83	**78.41**
Control (water only)	73.65	72.52	74.00	73.33	**73.38**	76.13	82.52	74.00	74.47	**76.78**
Mean (B)	**73.65**	**74.87**	**75.35**	**76.00**	-	**76.13**	**82.42**	**77.12**	**76.78**	-
LSD at 5%		A=2.07		B=1.85	AB=4.13			A=1.87	B=1.67	AB=3.74

* Mixture solution= 17% *Aloe vera* + 20% honey solution + 0.5g/l salicylic acid.

Acidity content (%):

On the average as shown in Table (5), the data clear that, an insignificant higher content of acidity was scored with salicylic acid in 2013 season and *Aloe vera* as well as mixture solution treatments during 2014 season in relation to control fruits. Acidity content (%) significantly declined over storage time regardless of the postharvest treatments used during 1st season and significant differences occurred among different periods in

the 2nd season. Dipping Wonderful fruits in 17% *Aloe vera* at 60days during both seasons exhibited the lowest reduction in acidity content (%) (1.14 and 1.13 % in the 1st and 2nd seasons, respectively) in relative to remaining treatments and significant differences occurred among different interactions.

Our findings are in agreement with[61], they mentioned that coated berries with *Aloe vera* had a higher content of titrable acidity compared with control. Also, the current results are in conformed with the finding of [64]on winter pineapple fruits, [65]on peach fruits cv. 'Flordaking' and [55]on 'Kitt' mango. They mentioned that different concentrations of salicylic acid treatments exhibited higher titrable acidity contents compared with control fruits during cold storage.

In the current investigation, *Aloe vera* led to greater titrable acidity retention of treated Wonderful fruits, it could be due to that *Aloe vera* extract decreased respiration rate and delayed the utilization of organic acids, which are the primary substrates for respiration[14, 66, 67.] In addition, the reduction of acid contents might be due to that transformation of acids into sugars[68].

Table 5. Influence of aloe vera extract, honey solution, salicylic acid and mixture treatments on TSS (%), acidity(%) and TSS/acidity ratio of Wonderful fruits for 90 days storage in 5±1ºC during 2013 and 2014 seasons.

Treatments (A)	Total soluble solids (TSS %)									
	2013 Season					2014 Season				
	Storage period (days) (B)					Storage period (days) (B)				
	0	30	60	90	Mean (A)	0	30	60	90	Mean (A)
17% Aloe Vera	17.03	17.13	16.90	17.80	**17.22**	17.60	17.43	17.90	17.13	**17.52**
20% Honey solution	17.03	17.20	18.07	18.27	**17.64**	17.60	17.20	17.05	17.57	**17.35**
0.5g/l Salicylic acid	17.03	17.93	17.00	17.77	**17.43**	17.60	17.10	17.13	17.83	**17.42**
Mixture solution*	17.03	17.20	16.77	18.07	**17.27**	17.60	17.30	17.20	17.97	**17.52**
Control (water only)	17.03	17.20	17.17	18.37	**17.44**	17.60	17.50	17.86	17.77	**17.68**
Mean (B)	**17.03**	**17.33**	**17.18**	**18.05**	**-**	**17.60**	**17.31**	**17.43**	**17.65**	**-**
LSD at 5%	A=0.228 B=0.204 AB=0.456					A=0.289 B=0.258 AB=0.577				
Treatments (A)	**Acidity (%)**									
17% Aloe Vera	1.17	0.95	1.14	0.81	**1.02**	1.08	0.92	1.13	1.00	**1.03**
20% Honey solution	1.17	0.96	1.03	0.77	**0.98**	1.08	0.99	1.06	0.96	**1.02**
0.5g/l Salicylic acid	1.17	1.09	1.09	0.77	**1.03**	1.08	0.99	1.10	1.00	**1.04**
Mixture solution*	1.17	0.83	1.10	0.73	**0.96**	1.08	0.93	1.12	0.98	**1.03**
Control (water only)	1.17	1.06	1.01	0.79	**1.01**	1.08	1.05	0.97	0.98	**1.02**
Mean (B)	**1.17**	**0.98**	**1.08**	**0.77**	**-**	**1.08**	**0.97**	**1.08**	**0.99**	**-**
LSD at 5%	A=0.064 B=0.057 AB=0.128					A=N.S. B=0.040 AB=0.091				
Treatments (A)	**TSS/Acidity ratio**									
17% Aloe Vera	14.62	18.08	14.83	22.58	**17.53**	16.38	19.07	15.84	17.11	**17.10**
20% Honey solution	14.62	17.93	17.52	23.81	**18.47**	16.38	17.33	16.16	18.32	**17.05**
0.5g/l Salicylic acid	14.62	16.49	15.63	23.59	**17.58**	16.38	17.25	15.60	17.81	**16.76**
Mixture solution*	14.62	20.70	15.28	24.99	**18.90**	16.38	18.66	15.36	18.40	**17.20**
Control (water only)	14.62	16.30	16.99	23.28	**17.80**	16.38	16.76	18.42	18.24	**17.45**
Mean (B)	**14.62**	**17.90**	**16.05**	**23.65**	**-**	**16.38**	**17.81**	**16.27**	**17.98**	**-**
LSD at 5%	A=N.S. B=1.31 AB=2.93					A=N.S. B=0.762 AB=1.704				

* Mixture solution= 17% *Aloe vera* + 20% honey solution + 0.5g/l salicylic acid.

TSS/Acidity ratio:

Juice TSS/acidity ratio as affected by postharvest treatments on the average under cold storage conditions (5±1ºC, with 85-90% RH) during the two seasons are presented in Table (5). The obtained TSS/acidity ratios showed that, throughout the 1st season both treatments with the mixture and that of 20% honey insignificantly raised this ratio to the highest magnitude in comparison with other treatments, whereas the lowest ratios were noticed with *Aloe vera* and salicylic acid treatments. While, in the 2nd season the control and mixture treatment had an insignificant higher TSS/acidity ratio than that remaining treatments. By the extension of cold storage period, TSS/acidity ratio was significantly increased during 1st season and significant fluctuation occurred in the 2nd season where significant reduction occurred after 60 days followed by significant increase.

Interaction data revealed that, during the two seasons at 90 days, the lowest TSS/acidity ratio was attributed to 17% *Aloe vera* treatment in both seasons compared with other treatments. Furthermore, treatments with the mixture and that of honey had a higher TSS/acidity ratio at 90days throughout both seasons.

Aloe vera gel treatment delaying ethylene production rate by creating a modified atmosphere, which consequently delayed ripening[69]. On the other hand, the current results of honey treatment are confirmed with the pervious findings of [33]on guava fruits. They concluded that the highest significant value of the TSS/acid ratio was noticed with fruits for control and 15% honey treatments through both seasons. Furthermore, methyl salicylate reduced TSS/TA ratio in Hayward kiwifruit compared with untreated fruits during storage at 0.5°C and 90% RH for 5 months[70].

Anthocyanins content (mg.100g^{-1}F.W):

Anthocyanins are water soluble polyphenolic compounds responsible for the red coloration in pomegranate arils[71]. On the average as shown in Table (6), in 2013 and 2014 seasons, fruits treated with *Aloe vera* extract had a significant lower anthocyanins contents in relative to control fruits.

Regardless effects of postharvest treatments, anthocyanins content of treated Wonderful fruits was slightly increased with some fluctuations throughout most of cold storage durations in comparison with anthocyanins content at zero time during the 1st and 2nd seasons. Also, it was observed that the differences between 0days and either 90 days for the 1st season or 60days for the 2nd season did not attained significant levels.

Taking the interaction effects into consideration, the recorded data demonstrate that, the highest anthocyanins content at 90 days was scored by fruits treated with the mixture solution and control fruits throughout the two seasons. Levels of significant differences differ between different interactions. Moreover, the lowest anthocyanins content at 90 days was recorded with fruits treated with salicylic acid in 2013season and that treated with *Aloe vera* extract throughout 2014 season in comparison with control fruits content.

The current results are accordance with results obtained by[72] on strawberry fruits and [73]on peach fruits they concluded that, salicylic acid treatments showed lower anthocyanin values when compared with control fruits during cold storage. In addition, the results agreement with those mentioned by[74], who stated that, total anthocyanin content of Bhagwa and Ruby cvs. pomegranate juice increased with prolong cold storage periods (5 ^{o}C for 4 months).

The explanation for the lowest anthocyanins content of Wonderful fruits treated by 17% *Aloe vera* could be due to a modified atmosphere created by the *Aloe vera* extract therefore delaying anthocyanin accumulation[69]. The observed increasing of anthocyanins content may be attributed to the biosynthesis and accumulation of anthocyanin, which is known to be induced in pomegranates at lower temperatures[75].

Table 6. Influence of aloe vera extract, honey solution, salicylic acid and mixture treatments on anthocyanin content (mg.100g^{-1}F.W) of Wonderful fruits for 90 days storage in 5±1°C during 2013 and 2014 seasons.

Treatments (A)	Anthocyanin content (mg.100g^{-1} F.W)									
	2013 Season					2014 Season				
	Storage period (days) (B)					Storage period (days) (B)				
	0	30	60	90	Mean (A)	0	30	60	90	Mean (A)
17% Aloe Vera	30.00	21.04	21.06	25.12	**24.31**	31.00	22.73	28.00	28.04	**27.44**
20% Honey solution	30.00	50.02	18.08	26.89	**31.25**	31.00	59.10	28.99	35.87	**38.74**
0.5g/l Salicylic acid	30.00	39.04	27.15	22.05	**29.56**	31.00	52.15	30.85	33.93	**36.98**
Mixture solution*	30.00	48.95	23.99	38.94	**35.47**	31.00	45.96	29.96	46.07	**38.25**
Control (water only)	30.00	48.91	27.06	38.14	**36.03**	31.00	48.13	30.88	39.98	**37.49**
Mean (B)	**30.00**	**41.59**	**23.47**	**30.23**		**31.00**	**45.61**	**29.74**	**36.78**	**-**
LSD at 5%	A=6.99 B=6.25 AB=13.98					A=2.98 B=2.66 AB=5.96				

* Mixture solution= 17% *Aloe vera* + 20% honey solution + 0.5g/l salicylic acid.

Conclusion

According to present study, it could concluded that treatment with *Aloe vera* extract at 17% as natural and safe material followed by 0.5g/l salicylic acid treatment were the most effective treatments in maintaining the overall quality attributes of Wonderful pomegranate fruits during cold storage (5°C) for 60 days, whereas after 90days of cold storage non of the used treatments was clearly effective.

References

1. Pezeshki Rad, G. H., Z. Golshiri Esfahani and M. Chizari. Learner satisfaction with pomegranate production extension education courses in Yazd Province, Iran. J. Agr. Sci. Tech., 200911: 49-55.
2. Opara, L. U., M. R. Al-Ani and Y. Al-Shuaibi. Physico-chemical properties, vitamin C content, and antimicrobial properties of pomegranate fruit (*Punica granatum* L.). Food Bioprocess Tech., 2009,2: 315–321.
3. Sadeghi, N., B. Jannat, M. R. Oveisi, M. Hajimahmoodi and M. Photovat, 2009. Antioxidant activity of Iranian pomegranate (*Punica granatum* l.) seed extracts. J. Agr. Sci. Tech., 11: 633-638.
4. Wetzstein, H. Y., Z. Zhang, N. Ravid and M. E. Wetzstein. Characterization of attributes related to fruit size in pomegranate. HortScience, 2011,46: 908–12.
5. Elyatem, S. M. and A. A. Kader. Post-harvest physiology and storage behavior of pomegranate fruits. Scientia Horticulturae, 1984, 24: 287-298.
6. Arendse, E., O. A. Fawole, and U. L. Opara. Discrimination of pomegranate fruit quality by instrumental and sensory measurements during storage at three temperature regimes. J. Food Process. Preserv., (November), 2014, 1–15. Retrieved from http://doi.wiley.com/10.1111/jfpp.12424.
7. Caleb, O. J., U. L. Opara and C. R. Witthuhn. Modified atmosphere packaging of pomegranate fruit and arils. A review. Food Bioprocess Tech., 2012, 5:15–30.
8. Tyler, V. The Honest Herbal: A sensible guide to use of herbs and related remedies. Third Edition. Binghamton; N.Y: Pharmaceutical Products Press,1993.
9. Linda, S. and M. D. Cheek. Herb survival manual for north America. Book. 2013, pp.3.
10. Ni, Y., D. Turner, K. M. Yates, I. Tizard. Isolation and characterization of structural components of *Aloe vera* L. leaf pulp. International Immunopharmacology, 2004, 4 (14): 1745-1755.
11. Park, Y. I. and T. H. Jo. Perspective of industrial application of *Aloe vera*. In: New Perspective on Aloe. (Eds.): Y.I. Park and S.K. Lee. Springer Verlag, New York, USA, 2006. pp: 191-200. ISBN: 0387317996.
12. Hamman, J. H. Composition and application of aloe vera leaf gel, Molecules, 2008, 13. 1599-1616.

13. Zapata, P. J., D. Navaro, F. Guillén, S. Castillo, D. Martínez-Romero, D. Valero and M. Serrano. Characterisation of gels from different Aloe spp. as antifungal treatment: potential crops for industrial application. Ind. Crops Prod., 2013,42, 223–230.
14. Ergun, M. and F. Satici. Use of *Aloe Vera* gel as biopreservative for Granny smith and Red chief apples. The Journal of Animal and Plant Sciences, 2012, 22 (2): 363-368.
15. Arowora, K. A., J. O. Williams, C. O. Adetunji, O. B. Fawole, S. S. Afolayan, O. O. Olaleye, J. B. Adetunji and B. A. Ogundele. Effects of *Aloe Vera* coatings on quality characteristics of oranges stored under cold storage. Greener J. Agric. Sci., 2013, 3(1): 39–47.
16. Benitez, S., I. Achaerandio, F. Sepulcre and M. Pujola. *Aloe vera* based edible coatings improve the quality of minimally processed "Hayward" kiwifruit. Postharvest Biol. Technol., 2013, 81: 29–36.
17. Asghari, M., L. Ahadi and S. Riaie. Effect of salicylic acid and edible coating based *Aloe vera* gel treatment on storage life and postharvest quality of grape (*Vitis vinifera* L . cv .Gizel Uzum). Int. J. Agric. Crop Sci., 2013, 5 (23): 2890-2898.
18. Shahkoomahally, S. and A. Ramezanian. Effect of natural *Aloe vera* gel coating combined with calcium chloride and citric acid treatments on grape (*Vitis vinifera* L . cv. Askari) quality during storage. Am. J. Food Sci. Technol., 2014, 2 (1): 1–5.
19. Srivastava, M. K. and U. N. Dwivedi. Delayed ripening of banana fruit by salicylic acid. Plant Sci., 2000, 158: 87–96.
20. Zainuri Joyce, D. C., A. H. Wearing, L. Coates and L. Terry. Effects of phosphonate and salicylic acid treatments on anthracnose disease development and ripening of 'Kensington Pride' mango fruit. Aust. J. Ex. Agric., 2001, 41: 805– 813.
21. Kang, G., C. Wang, G. Sun and Z. Wang. Salicylic acid changes activities of H_2O_2-metabolizing enzymes and increases the chilling tolerance of banana seedlings. Environ. Expl. Bot., 2003, 50: 9-15.
22. Ozeker, E. Salicylic acid and its effects on plants. E.U. Faculty of Agriculture J., 2005, 42(1): 213- 223 (Tr).
23. Chan, Z. and S. Tian. Induction of H_2O_2-metabolizing enzyme and total protein synthesis by antagonistic yeast and salicylic acid in harvested sweet cherry fruit. Postharv. Biol. Technol., 2006, 39: 314-320.
24. Aghdam, M. S., Y. Mostofi, A. Motallebiazar, M. Ghasemneghad and M. J. Fattahi. Effects of MeSA vapor treatment on the postharvest quality of Hayward kiwifruit. In 6th International Postharvest Symposium. Antalya, Turkey., 2009, 8-12 April.
25. Asgharia, M. and M. Aghdam. Impact of salicylic acid on post-harvest physiology of horticultural crops. Trends in Food Science and Technology, 2010, 21: 502-509.
26. Barman, K. and R. Asrey.Salicylic acid pre-treatment alleviates chilling injury, preserves bioactive compounds and enhances shelf life of mango fruit during cold storage. J. Sci. Ind. Res., 2014, 73 (November), 713–718.
27. Airborne Honey. Honey enzymes [Electronic Version]. Airborne Honey Ltd. Retrieved 02/08/2006 from www.airborne.co.nz, 2003.
28. Waikato Honey Research Unit. What is special about active manuka honey? [Electronic Version], 2005. Retrieved 07/06/2006 from http://bio.waikato.ac.nz.
29. Viuda-Martos, M., Y. Ruiz-Navajas, J. Fernandez-Lopez and J. A. Perez-Alvarez. Functional properties of honey, propolis, and royal jelly. J. Food Sci., 2008, 73: 117–124.
30. EL-Kalyoubi, M. H., M. M. Khalaf, A. S. Nadir, W. M. Abozeid and M. E. Mansour. Antioxidant and antimicrobial evaluation of Egyptian bee honey. Journal of Applied Sciences Research, 2013, 9 (11): 5712-5717.
31. Ergun, M. and E. Ergun. Extending shelf-life of fresh-cut persimmon by honey solution dips. Journal of Food Processing and Preservation, 2010, 34 (1): 2-14.
32. Sabir, A., F. K. Sabir and Z. Kara. Effects of modified atmosphere packing and honey dip treatments on quality maintenance of minimally processed grape cv. Razaki (*Vitis vinifera* L.) during cold storage. J. Food Sci. Technol., 2011, 48 (3): 312–318.
33. Abd El-Moneim, E. A. A., H. M. Kamel, Z. A. Zaki and M. E. Abo Rehab. Effect of honey and citric acid treatments on postharvest quality of fruits and fresh-cut of guava. World Journal of Agriculture Sciences, 2015, 11 (5): 255-267.
34. Mphahlele, R. R., O. J. Caleb, O. A. Fawolea and U. L. Opara. Effects of different maturity stages and growing locations on changes in chemical, biochemical and aroma volatile composition of 'Wonderful'

pomegranate juice. Journal of the Science of Food and Agriculture. March, 2015. wileyonlinelibrary.com/jsfa.

35. Hanafy, M. S., F. M. Saadawy, S. M. Milad and R. M. Ali. Effect of some natural extracts on growth and chemical constituents of *Schefflera arboricola* plants. Journal of Horticultural Science & Ornamental Plants, 2012, 4 (1): 26-33.
36. Serrano, M, J. Valverde, F. Guillen, S. Castillo, D. Martinez-Romero, and D. Valero. Use of *Aloe vera* gel coating preserves the functional properties of table grapes. Journal of Agricultural and Food Chemistry, 2006, 54 (11): 3882-3886. (Cited by Misir, J., F. H. Brishti and M. M. Hoque. *Aloe vera* gel as a novel edible coating for fresh fruits: A review. American Journal of Food Science and Technology, 2014, 2 (3): 93-97.
37. Sivakumar, D., N. K. Hewarathgamagae,R. S. Wijeratnam and R. L. Wijesundera. Effect of ammonium carbonate and sodium bicarbonate on anthracnose of papaya. Phytoparasitica, 2002, 30: 1-7.
38. Caleb, O. J., U. L. Opara, P. V. Mahajan, M. Manley, L. Mokwena, A. G. Tredoux. Effect of modified atmosphere packaging and storage temperature on volatile composition and postharvest life of minimally-processed pomegranate arils (cvs. 'Acco' and 'Herskawitz'). Postharvest Biology and Technology, 2013, 79: 54–61.
39. A.O.A.C. Methods of Analysis. Association of Official Analytical Chemists, 14th Ed., Washington, USA.,1990.
40. Ranganna, S. Manual of Analysis of Fruits and Vegetable Products. Tata McGraw- Hill Publishing Co. Ltd., New Delhi., 1979.
41. Snedecor, G. W. and W.G. Cochran. Statistical Methods. 7th Ed., Iowa Stat. Univ. Press. Amer. Iowa, U.S.A., 1980, pp: 50.
42. Abd-Alla, M. A., G. E. Nadia and R. H. Eman. Effect of some natural plant extracts & plant essential oils on suppressive of *Penecillium digitatium* (Pers.:Fr.) Sacc. and its enzyme activity which caused citrus green mold for Navel oranges in Egypt. Journal of Applied Sciences Research, 2013, 9(6): 4073-4080.
43. Wang, L. J., S. J. Chen, W. F. Kun, S.H. Li and D. D. Archbold. Salicylic acid pretreatment alleviates chilling injury and affects the antioxidant system and heat shock proteins of peach during cold storage. Postharvest Biol. Technol., 2006, 41: 244-251.
44. Babalar, M., M. Asghari, A. Talaei and A. Khosroshahi. Effect of pre- and postharvest salicylic acid treatment on ethylene production, fungal decay and overall quality of Selva strawberry fruit, Food Chem., 2007, 105: 49-453.
45. Jasso de Rodriguez, D., D. Hernandez-Castillo, R. Rodrıguez-Garcia and J. L. Angulo-Sanchez. Antifungal activity in vitro of *Aloe vera* pulp and liquid fraction against plant pathogenic fungi. Ind. Crop Prod., 2005, 21: 81-87.
46. Sitara, U., N. Hassan and J. Naseem. Antifungal activity of *Aloe Vera* gel against plant pathogenic fungi. Pak. J. Bot., 2011, 43 (4): 2231–2233.
47. Amborabe, B. E., P. F. Lessard, J. F. Chollet, G. Roblin. Antifungal effects of salicylic acid and other benzoic acid derivatives towards Eutypa lata: structure–activity relationship. Plant Physiol. Biochem., 2002, 40:1051–1060.
48. Cai, X. Z. and Z. Zheng. Induction of systemic resistance in tomato by and incompatible race of *Cladosporium fulvum* and the accumulation dynamics of salicylic acid in tomato plants, Acta Hort., 1999, 29:261-264.
49. Qin, Q. Z., S.P. Tian, Y. Xu and Y. K. Wan. Enhancement of biocontrol efficacy of antagonistic yeasts by salicylic acid in sweet cherry fruit. Physiological and Molecular Plant Pathology, 2003, 62:147-154.
50. Xu, X. B., G. Z. Qin and S. P. Tian. Effect of microbial biocontrol agents on alleviating oxidative damage of peach fruit subjected to fungal pathogen. International Journal of Food Microbiology, 2008, 126: 153–158.
51. Asghari, M., H. Khalili, Y. Rasmi and A. Mohammadzadeh. Influence of postharvest nitric oxide and *Aloe vera* gel application on sweet cheery quality indices and storage life. Int. J. Agron. Plant Prod., 2013, 4 (9): 2393–2398.
52. Morillon, V., F. Debeaufort, G. Blond, M. Capelle and A. Voilley. Factors affecting the moisture permeability of lipid-based edible films: A review. Critical Reviews in Food Science and Nutrition, 2002, 42 (1): 67-89.

53. Serrano, M., J. M. Valverde, F. Guillen, S. Castillo, D. Martinez-Romero and D. Valero. Use of *Aloe vera* gel coating preserves the functional properties of table grapes. Journal of Agricultural and Food Chemistry, 2006, 54 (11): 3882-3886.
54. Brishti, F. H., J. Misir and A. Sarker. Effect of biopreservatives on storage life of papaya (*Carica papaya L.*). Int. J. Food Stud., 2013, 2 (April): 126–136.
55. Adel, D. and A. Awad. Postharvest salicylic acid treatment reduces chilling injury of 'Taify' cactus pear fruit during cold storage Journal of Food, Agriculture & Environment, 2012, 10(2): 120-124.
56. Korkar, H. M.. Effects of some postharvest treatments on extending storability of 'Kitt' mangoes under chilling temperature stress storage. Journal of Applied Sciences Research, 2013, 9(1): 402-412.
57. Brummell, D. and M. Harpster. Cell wall metabolism in fruit softening and quality and its manipulation in transgenic plants. Plant Molecular Biology, 2001, 47(1-2): 311–340.
58. Martinez-Romero, D., N. Alburquerque, J. Valverde, F. Guillen, S. Castillo, D. Valero and M. Serrano. Postharvest sweet cherry quality and safety maintenance by *Aloe vera* treatment: A new edible coating. Postharvest Biology and Technology, 2006, 39(1): 93-100.
59. Mart, D., S. Castillo, D. Valero and M. Serrano. Postharvest sweet cherry quality and safety maintenance by *Aloe vera* treatment: A new edible coating. Postharvest Biol. Technol., 2006, 39: 93–100.
60. Cai, C., C. J. Xu, X. Li, I. Ferguson and K. S. Chen. Accumulation of lignin in relation to change in activities of lignification enzymes in loquat fruit flesh after harvest. Postharvest Biol. Technol., 2006, 40: 163-169.
61. Tripathi, P. and N. Dubey. Exploitation of natural products as an alternative strategy to control postharvest fungal rotting of fruit and vegetables. Postharvest Biology and Technology, 2004, 32(3): 235-245.
62. Peng, L., Y. Jiang. Exogenous salicylic acid inhibits browning of fresh–cut Chinese water chestnut. Food Chem., 2006, 94: 535–540
63. Ghafir, S. A., I. Z. Ibrahim and S. A. Zaied, 2010. Response of local variety "Shlefy" pomegranate fruits to packaging and cold storage. Acta Hortic., 2010, 877: 427–432.
64. Lu, X., S. Dequan, L. Yunhe, S. Wenqi and S. Guangming. Pre and post-harvest salicylic acid treatments alleviate internal browning and maintain quality of winter pineapple fruit. Scientia Horticulturae, 2011, 130: 97-101.
65. Muhammad, J. T., A. A. Nadeem and A. H. Ishfaq. Effect of salicylic acid treatments on storage life of peach fruits cv. "Flordaking,". Pak. J. Bot., 2012, 44(1): 119-124.
66. Yaman, O. and L. Bayoindirli. Effects of an edible coating and cold storage on shelf-life and quality of cherries. Lebensm. Wiss Und. Technol., 2002, 35: 146-150.
67. Al-Juhaimi, F. Physicochemical and sensory characteristics of Arabic gum-coated tomato (*Solanum lycopersicum* L.) fruits during storage. J. Food Process. Preserv., 2013, DOI: 10.1111/jf. 12053 pp.
68. Rathore, H. A., T. Masud, S. Sammi and A. H. Soomro. Effect of storage on physico-chemical composition and sensory properties of Mango (*Mangifera indica* L.) variety Dosehari. Pakistan J. Nutrition, 2007, 6(2): 143-148.
69. Carrillo-Lopez, A., F. Ramirez-Bustamante, J. Valdez-Torres, R. Rojas-Villegas and E. Yahia. Ripening and quality changes in mango fruit as a acted by coating with an edible film. Journal of Food Quality, 2000, 23(5): 479-486.
70. Aghdam, M. S., M. Alireza, M. Younes, F. M. Javad and G. Mahmood. Methyl salicylate affects the quality of 'Hayward' kiwifruits during storage at low temperature. Joumal of Agricultural Science, 2011, 3(2): 149-156.
71. Sayyari, M., S. Castillo, D. Valero, H. M. Diaz-Mula and M. Serrano. Acetyl salicylic acid alleviates chilling injury and maintains nutritive and bioactive compounds and antioxidant activity during postharvest storage of pomegranates. Postharvest Biol. Technol., 2011, 60: 136–142.
72. Shafiee, M., T. S. Taghavi and M. Babalar. Addition of salicylic acid to nutrient solution combined with postharvest treatments (hot water, salicylic acid, and calcium dipping) improved postharvest fruit quality of strawberry. Scientia Hort., 2010, 124: 40-45.
73. Tareen, M. J., N. A. Abbasi and I. A. Hafiz. Effect of salicylic acid treatments on storage life of peach fruits cv. 'Flordaking'. Pakistan J. Bot., 2012, 44 (1): 119–124.
74. Fawole, O.A. and U. L. Opara. Effects of storage temperature and duration on physiological responses of pomegranate fruit. Ind. Crop Prod., 2013, 47: 300–309.

75. Miguel, M. G., C. Fontes, D. Antunes, A. Neves and D. Martins. Anthocyanin concentration of 'Assaria' pomegranate fruits during different cold storage conditions. J. Biomed. Biotechnol., 2004, 5: 338–342.

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