Efficacy of Henna Leaves Extract and Alginate on Quality Attributes during Cold Storage and Marketing Ability of "Maamoura" Guava Fruit

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ABSTRACT

Guava is rapidly perish with higher weight loss, fungal decay which limits its marketability. So, this experiment was carried out to study the efficacy of postharvest coating henna leaves extract at (2% and 4%) and sodium alginate at (2% and 4%) on the quality attributes during cold storage and shelf life of "Maamoura" guava fruit. The fruits were stored at 7±1˚C and 90±5% R.H. for 21 days followed by shelf life period at room temperature under conditions (25±2˚C and 65±5% R.H. Fruit quality was evaluated at harvest, during cold storage and evaluate number of days that fruits suitable for market at shelf life. Results showed that, all of postharvest treatments of 4% alginate or 4% henna leaves extract had positively affected postharvest quality properties including decreased weight loss, decay percentage, keeping visual appearance, fruit firmness, total soluble solids, titratable acidity, vitamin C and total soluble sugars during cold storage compared to the control (untreated fruits), the coverage treatments also increased the number of days for the fruits to be marketable. The study suggests that coating treatments can be used for keeping quality for longer time in markets of guava fruits.

Keywords: "Maamoura" guava fruits- Sodium alginate- Henna leaves extract- Cold storage- Fruit quality

INTRODUCTION

Guava (*Psidium guajava*, L.) is a major fruit crop in tropical and subtropical regions; they are rich in sugars and nutrients and a great source of vitamin C. As a climacteric fruit, guavas have a short shelf life and are extremely perishable. Because of their low pH, fruits are susceptible to fungal degradation (Singh and Sharma, 2007). It is a climacteric fruit that shows ethylene and respiratory peaks as it ripens (Bashir and Abu-Goukh, 2003). Guava is a strong source of pectin and is the fruit with the highest concentration of vitamin C. In both domestic and foreign markets, guava fruits are highly sought after for both fresh and processed uses (Bhooriya et al., 2018).

One of the serious problems facing of guava world trade is short postharvest life. Led to a significant loss of guava production during harvest, handling and transportation to the far markets (Jha et al., 2015). Fruit cannot be kept for longer than three days at room temperature (Kanwal et al., 2016). Because of their sharp ripening nature, delicate skin, high respiration, and strong ethylene production, fruits quickly deteriorate and lose more weight owing to fungal decay, which restricts their marketability. So, controlling the ripening of guava fruit is therefore essential to improving its marketability and storability (Mitra et al., 2012). Cold storage-maintained quality of fruit due to reducing ripening, transpiration, respiration rate, ethylene production, disease incidence, enzymatic reactions subsequently extend fruit shelf life (Bron et al., 2005).

Consumer preferences indicate that the most desirable postharvest practices are those that are safe, natural, chemical-free, and biodegradable. For that it can be considered as an alternative preservative coating for vegetables and fruits (Kubheka et al., 2020). Moreover, the demand for production safety food increases with increasing importance of food security concern, people awareness and organic farming (Basra and Lovatt, 2016). Many storage techniques have been developed to extend the practical selling distances and holding periods for fresh horticultural products after harvest. Alginate is a hydrophilic biopolymer with coating properties that can be utilized for thickening, suspension creation, gel formation, and emulsion stabilization due to its unique colloidal properties (Acevedo et al., 2012). Sodium alginate is a natural polysaccharide that is extracted from brown seaweed called *Macrocystis pyrifera* of the family Phaeophyceae and comprises the two uronic acids, _-D-manuronic and _-L-guluronic. Sodium alginate consists of block polymers of sodium poly-L-guluronate, sodium poly-D-mannuronate, and alternate sequences of both sugars (Parreidt et al., 2018). It has been effective on maintaining postharvest quality in peach (Maftoonazad et al., 2008) and sweet cherries (Díaz-Mula et al., 2012), strawberry fruits.

Henna leaves (*Lawsonia inermis*) is contain flavonoids (acacetine, acacetin-7-O-glucoside, luteolin, luteolin-7-O-g apigenin-7-O-β-D-glucopyranoside, apigenin-40-O-β-D-glucopyranoside, luteolin-30-O-βD glucopyranoside, apiin, cosmosiin, isoscutellarin, lawsochrysin, lawsochrysinin, lawsonaringenin, 30,40-dimethoxyflavone, 7-hydroxyflavone, 3,30,40,7-tetrahydroxyflavanone and rhoifolin) and also contain Mucilage (Gallo et al., 2014). Possesses strong antioxidant, antifungal, and antibacterial properties (Mohammed et al., 2007). Additionally, Abd El-Migeed et al. (2021) investigated the effects of henna extract on the quality and storability of "Maamoura" guava fruit. The findings showed that the henna extract prolonged the storage period to three weeks while significantly lowering the percentage of weight loss and decay content when compared to the control, which was only kept in cold storage for two weeks. The present study aimed to investigate the efficacy of henna leaves extract and sodium alginate on the quality attributes during cold storage and evaluate number days that fruits suitable for market at shelf life of "Maamoura" guava fruit.

MATERIALS AND METHODS

Plant material:

20-year-old guava trees were used as the plant material for this study are grown in a private orchard in Kafr El-Dawar, El-Beheira Governorate, Egypt. Guava trees were planted 5 by 5 meters apart in a loamy clay soil with flood irrigation. Guava trees devoted for this work were healthy and standard agricultural practices recommended by the Ministry of Agriculture and Land Reclamation.

Harvested guava fruits:

"Maamoura" guava fruits were gathered when reached the maturity stage (yellowish green) in the second week of August according to Mercado-Silva et al. (1998). Fruits were transported to the horticulture laboratory without signs of mechanical damage and deterioration were selected and standardized in fruits showing homogeneous size, color and form, then randomly distributed into 5 treatments. The current study was conducted in the Sabahiya Horticulture Research Station laboratory in Alexandria, Egypt, during the 2023 and 2024 seasons.

Fruit preparation:

Guava fruits are washing with a 0.01% sodium hypochlorite water solution to clean their surfaces, the sound fruits at the same development stage were allowed to air dry at room temperature until any remaining moisture was entirely gone.

Preparation of Sodium alginate:

Alginate (alginic acid sodium salt from brown algae) was made at two concentrations (2% and 4% w/v) dissolved in hot water (45°C) while being continuously shaken until the solution turned clear. The alginate was acquired from Sigma, Madrid, Spain. After cooling to 20°C, glycerol at 20% v/v was added as plasticizer, (Zapata et al., 2008).

Preparation of Henna leaves extract:

Henna leaves extract was prepared by soaking 100 g of air-dried henna leaves in one liter of distilled water for 24 hrs., (Abd El-Migeed et al., 2021). Then diluted after filtered with distilled water to prepare 2% and 4% concentrations by dissolving 2ml and 4 ml of filtered solution plus 3ml glycerol in 100ml distilled water in a beaker, respectively, and treatments were performed by dipping the fruits for five minutes in five liter of aqueous solutions containing Tween-80 at a concentration of 0.05% (v/v) to improve wettability and adherence to guavas surface.

Finally, treatments were performed by dipping the fruits twice in fresh coating solution for 1 min to assure the uniformity of the coating of the whole surface and control treatment preparing by adding 3ml glycerol in 100ml distilled water.

Storage guava fruits:

The fruits in each treatment and control were then placed in cardboard boxes measuring 45 x 35 x 10 cm and wrapped in foam plates topped with 0.04 mm thick perforated polyethylene sheets. For 21 days, each box contains 2 Kg fruits, all experience boxes were kept at 7±1˚C and 90±5% R.H. Following harvest, the fruit's physical and chemical characteristics were evaluated every seven days throughout the cold storage phase.

Experimental design:

Forty five box guava fruits were selected in a completely randomized design and divided into 5 groups. Each group was replicated three times and each replicate was repeated 3 times (5x3x3).The experiment was repeated twice (2023 and 2024 seasons).

Post-harvest treatments:

1- Control (water only).
2- Henna leaves extract 2%.
3- Henna leaves extract 4%.
4- Sodium Alginate 2%.
5- Sodium Alginate 4%.

Assessments performed:

Fruit physical characteristics:

Weight loss percentage: Was calculated by the following formula: [(fruit weight before storage - fruit weight after each period of cold storage) / fruit weight before storage] × 100.

Decay percentage: The number of decayed fruits resulting from fungal or microorganism-induced infections was counted every seven days of cold storage. The decay percentage was then calculated as a percentage of the initial number of fruits stored using the following formula: (number of decayed fruits at specified storage period/initial number of stored fruit) × 100.

Visual appearance: Score was measured by a rating system, fruit scored: very good = 9, good = 7, acceptable = 5, unacceptable = 3 and poor = 1.

Firmness (lb/inch^2): A hand-held fruit firmness tester (FT-327, Italy) with an 8 mm cylindrical stainless steel plunger tip was used to evaluate the firmness of three guava fruits per replicate at two equatorial sites in order to calculate the penetration force (Watkins and Harman, 1981).

Fruit chemical characteristics:

Fruit ascorbic acid analysis (mg/100 ml of the juice): Was estimated according to A.O.A.C. (2005). Samples of fruit juice were used, oxalic acid solution was added to each sample and titrated with 2,6-dichlorophenol-indophenol dye solution and expressed as a milligram of ascorbic acid and was calculated as mg/100 ml of the juice.

Total soluble solids percentage: Using a hand refractometer with a 0-32 scale (ATAGO N-1E, Japan), the TSS content of the fruit was measured and expressed in Brix° after making the temperature rectification at 20°C according to A.O.A.C. (2005).

Fruit titrable acidity (TA) percentage: Was assayed based on the method of adopting the procedure described by A.O.A.C. (2005). Aliquot of fruit juice was taken and titrated against 0.1 N NaOH in the presence of phenolphthalein as an indicator to the end point and expressed as a percentage of citric acid.

Total sugars percentage: Was determined by using the methods of Smith et al. (1956) and the concentration were calculated as gm glucose per 100 gm. fresh weight.

Marketable period (in days):

After 21 days of cold storage at 7±1˚C a guava fruit sample from each replicate was taken out and placed at ambient conditions (25±2˚C and 65±5% R.H.). The number of days the fruits are in good condition and suitable for market is recorded.

Statistical analysis:

Data of study were subjected to the analysis of variance test (ANOVA) as complete randomized design (CRD). Where the first factor was for five treatments mentioned before, the second factor was for storage period. The least significant differences (LSD) at the 5%

level of probability were calculated using a computer program Costat according to Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

Weight loss percentage:

The results in **Table (1),** demonstrated the effectiveness of sodium alginate and henna leaves extract on the weight loss percentage of fruit weight loss percentages increased with increasing storage periods, in the two seasons of study. The loss of fruit weight during cold storage is caused by water exchange between the internal and external atmosphere, the transpiration rate being accelerated by cellular breakdown (Woods, 1990). The increases in physiological loss of weight of guavas during cold storage are attributing to the increase in transpiration rate, ethylene production and cellular breakdown of fruits (Razzaq et al., 2014). Moreover, Biodegradable films with appropriate oxygen transmission rate play an important role in the development of modified atmosphere and quality maintenance of fresh fruits during storage. Water vapor permeability of packaging materials is essential to limit weight losses of product during storage (Chiabrando and Giacalone, 2017). Moreover, henna leaves extract and sodium alginate treatments at all concentrations significantly decreased fruit weight loss percentage during cold storage periods as compared to the control. Sodium alginate at 4% was more effective on decreasing fruit weight loss, and the differences as compared with other treatments were big enough to be significant in both seasons of study. The interaction effect between the tested storage periods and post-harvest treatments with henna leaves extract and sodium alginate, it is obvious that all post-harvest treatments had the lowest weight loss percentage at 21 days of storage in both seasons. In previous studies, extending guava fruit quality and storability via natural edible coating under cold storage conditions (8+/- 1°C) by Abd El-Migeed et al. (2021) and they reported that henna leaf extract extended storage period till three weeks with a significant reduction in weight loss percent compared to the control which stored for only two weeks under cold storage conditions. The promising effect of henna leaf extract in delaying fruit weight loss percent comes from antioxidant activity (Mohammed et al., 2007 and Dalal et al., 2019). Furthermore, Othman et al. (2017) reported that, weight loss of guava samples coated with alginate and stored at cooling temperature was lower than that occurred in samples kept at room temperature.

Table(1). Efficacy of henna leaves extract and sodium alginate on weight loss percentage of "Maamoura" guava fruits during cold storage at (7±1°C and 90±5% R.H.) in 2023 and 2024 seasons.

Treatments	Storage Periods (Days)				
	0	7	14	21	Means
	Season 2023				
Control	0.00	6.25	8.11	15.92	**7.67**
Henna Leaves Extract 2%	0.00	3.80	7.11	12.39	**5.82**
Henna Leaves Extract 4%	0.00	3.44	5.01	11.64	**5.02**
Sodium Alginate 2%	0.00	3.30	6.29	10.65	**5.06**
Sodium Alginate 4%	0.00	3.07	4.50	9.23	**4.20**
Means	**0.00**	**3.97**	**6.20**	**11.97**	
LSD at $_{0.05}$		**(T): 0.06**	**(D): 0.05**	**(T×D): 0.12**	
	Season 2024				
Control	0.00	5.56	7.83	15.33	**7.18**
Henna Leaves Extract 2%	0.00	4.93	6.42	13.26	**6.15**
Henna Leaves Extract 4%	0.00	3.85	5.65	11.98	**5.37**
Sodium Alginate 2%	0.01	3.93	5.92	12.60	**5.61**
Sodium Alginate 4%	0.00	3.44	5.11	10.77	**4.83**
Means	**0.00**	**4.34**	**6.18**	**12.79**	
LSD at $_{0.05}$		**(T): 0.10**	**(D): 0.09**	**(T×D): 0.19**	

T: Treatments D: Storage Periods (Days) T×D: Interaction

Decay percentage:

Results in **Table (2)** revealed that the variations in fruit deterioration across all tested storage periods were statistically significant when compared to the start date in the two study seasons.

In addition, henna leaves extract and sodium alginate treatments significantly decreased fruit decay percentages during cold storage periods as compared to the control. Furthermore, sodium alginate at 4% was more effective on decreasing fruit decay percentages during cold storage periods, and the differences were big enough to be significant, as compared with other treatments. The promising effect of henna leaf extract in delaying decay percent come from the antimicrobial and antifungal effects beside antioxidant activity (Mohammed et al., 2007 and Dalal et al., 2019). Moreover, all post-harvest treatments maintained on the lowest decay for "Maamoura" guava fruit in this respect with regard to the effect of the interaction during the different periods of storage in two successive seasons of study. In previous studies, extending guava fruit quality and storability via natural edible coating under cold storage conditions (8+/-1°C) by Abd El-Migeed et al. (2021), they reported that henna leaf extract extending the storage period to three weeks with a significant reduction in decay percentage compared to the control which stored for only two weeks under cold storage conditions. Furthermore, Othman et al. (2017) reported that, coating of guava with alginate prolonged the guava stored at cooled temperature for 20 days as compared with control samples.

Table (2). Efficacy of henna leaves extract and sodium alginate on decay percentage of "Maamoura" guava fruits during cold storage at (7±1°C and 90±5% R.H.) in 2023 and 2024 seasons.

Treatments	Storage Periods (Days)				
	0	7	14	21	Means
	Season 2023				
Control	0.00	0.00	6.00	17.56	**5.89**
Henna Leaves Extract 2%	0.00	0.00	3.54	11.98	**3.88**
Henna Leaves Extract 4%	0.00	0.00	2.80	8.56	**2.84**
Sodium Alginate 2%	0.00	0.00	2.93	7.83	**2.69**
Sodium Alginate 4%	0.00	0.00	1.90	6.46	**2.09**
Means	**0.00**	**0.00**	**3.43**	**10.48**	
LSD at $_{0.05}$		**(T): 0.19**	**(D): 0.17**	**(T×D): 0.37**	
	Season 2024				
Control	0.00	0.00	5.00	16.90	**5.47**
Henna Leaves Extract 2%	0.00	0.00	2.97	8.06	**2.76**
Henna Leaves Extract 4%	0.00	0.00	2.41	6.49	**2.22**
Sodium Alginate 2%	0.00	0.00	2.55	5.89	**2.11**
Sodium Alginate 4%	0.00	0.00	1.75	5.34	**1.77**
Means	**0.00**	**0.00**	**2.94**	**8.54**	
LSD at $_{0.05}$		**(T): 0.05**	**(D): 0.04**	**(T×D): 0.11**	

T: Treatments D: Storage Periods (Days) T×D: Interaction

Firmness:

Table (3) cleared that, the effects of sodium alginate and henna leaves extract on the firmness of "Maamoura" guava fruits during cold storage at 7±1°C and 90±5% R.H. in the 2023 and 2024 seasons. In two seasons, it is evident that firmness declined as storage times increased. In previous research, Yaman and Bayoindirli (2002) suggested that delayed breakdown of insoluble protopectin to the more soluble pectic acid and pectin may be used to highlight the retention of firmness that transpired during storage. Fruit ripening increases the activities of pectin esterase and polygalacturonase, which results in the depolymerization or shortening of the pectin compounds' chain length. According to

Othman et al. (2017), fruit firmness is crucial for overall product approval because it is considered one of the basic of quality that a consumer evaluates. Guava's short postharvest life and vulnerability to fungal infection are mostly caused by its quick loss of firmness during senescence. One of the primary factors affecting fruit quality and post-harvest shelf life is loss of firmness (Barth et al., 1993).

Sodium alginate and henna leaves extract treatments improved the firmness compared to control fruits. Additionally, compared to other treatments, sodium alginate at 4% was more successful in enhancing fruit firmness of two seasons. It is clear that all tested treatments had the highest fruit degradation during 21 days storage in both seasons, indicating an interaction effect between the investigated storage periods and post-harvest treatments with sodium alginate and henna leaves extract. These results are in agreement with those obtained by Othman et al. (2017) reported that, coating protected fruit and reduce loss of firmness of guava fruits. When compared to samples stored at room temperature, the firmness of guava samples coated with alginate and kept at a cooling temperature was higher. The loss of firmness during climacteric fruit ripening is directly related to the disintegration of cell wall components and the modification of pectin fractions, mostly as a result of an increase in pectin solubilization (Lohani et al., 2004). These changes result from increased activity of cell wall hydrolases, which have been closely associated with ethylene (Brummel and Harpster, 2001). According to Rastegar et al. (2019), mango fruits' hardness considerably declined over the course of storage. The treated fruits were noticeably firmer than the control over the first two weeks of storage. The fruits treated with 3% alginate had the highest firmness over the final two weeks of storage. Researchers argue that the fresh pineapple (Azarakhsh et al., 2014) and plum (Valero et al., 2013) kept their firmness after applying the alginate-based edible coating. The higher firmness of the coated fruits was maybe due to the presence of coating and transferring structural rigidity to the fruit's surface (Duan et al., 2011). Edible coatings act as an extra layer which coats the stomata and guard cells and formation of a film on the top of the skin acting as an additional barrier that reduced respiration and transpiration and ultimately resulted in reduced moisture loss and gaseous exchange from the fruits (Diaz-Mula et al., 2012).

Table (3). Efficacy of henna leaves extract and sodium alginate on firmness (lb/inch^2) of "Maamoura" guava fruits during cold storage at (7±1°C and 90±5% R.H.) in 2023 and 2024 seasons.

Treatments	Storage Periods (Days)				
	0	7	14	21	Means
			Season 2023		
Control	58.11	18.47	8.88	3.30	**22.19**
Henna Leaves Extract 2%	58.11	47.67	28.27	23.61	**39.41**
Henna Leaves Extract 4%	58.11	49.56	31.57	25.64	**41.22**
Sodium Alginate 2%	58.11	50.29	32.32	26.33	**41.76**
Sodium Alginate 4%	58.11	53.88	35.33	27.02	**43.58**
Means	**58.11**	**43.98**	**27.27**	**21.18**	
LSD at $_{0.05}$		**(T): 1.12**	**(D): 1.00**	**(T×D): 2.21**	
			Season 2024		
Control	65.02	21.42	10.63	4.04	**25.27**
Henna Leaves Extract 2%	65.02	54.44	33.32	25.85	**44.66**
Henna Leaves Extract 4%	65.02	57.75	35.83	29.38	**46.99**
Sodium Alginate 2%	65.02	60.94	36.77	30.18	**48.23**
Sodium Alginate 4%	65.02	63.15	40.50	35.17	**50.96**
Means	**65.02**	**51.54**	**31.41**	**24.93**	
LSD at $_{0.05}$		**(T): 0.85**	**(D): 0.76**	**(T×D): 1.68**	

T: Treatments D: Storage Periods (Days) T×D: Interaction

Visual appearance:

Data in **Table (4)** showed that the visual look of the "Maamoura" guava fruits declined over time as they were stored at 7±1˚C and 90±5% R.H. These findings also showed that after the conclusion of the cold storage period, the lowest visual appearance scores for the first and second seasons, respectively, were 7.47 and 5.93. These results are in harmony with those obtained by Abd El-Gawad (2019) who worked on "Maamoura" guava fruits and reported that, gradual and significant decreases in fruit visual appearance values were observed with the advancement of cold storage period at 7±1˚C in both seasons, as compared to untreated fruits (control).

The results indicated that postharvest treatments of sodium alginate and henna leaves extract of "Maamoura" guava fruits resulted in considerably higher visual appearance score values. Henna leaves extract at 4% was more successful in delaying the decline in fruit appearance of the two seasons. Evaluating the interaction effect between storage periods and the tested treatments, data indicated that the interactions of the 21 days cold storage period, registered the highest values of fruit visual appearance with henna leaves extract followed by sodium alginate in both seasons of study.

According to earlier research, the strong flavors associated with natural antimicrobial agents may alter the inherent flavors of foods when they are incorporated into edible coatings (Rojas-Graü et al., 2007). According to several authors, samples that earn ratings of five or higher can be deemed acceptable (Sipahi et al., 2013), also, customers disapproved of the samples if their scores were less than five. Additionally, the impact of applying alginate coatings on the Andean blueberries' sensory qualities was documented. Scores greater than five were obtained by all samples, indicating good consumer acceptability.

Table (4). Efficacy of henna leaves extract and sodium alginate on visual appearance of "Maamoura" guava fruits during cold storage at (7±1°C and 90±5% R.H.) in 2023 and 2024 seasons.

Treatments	Storage Periods (Days)				
	0	**7**	**14**	**21**	**Means**
			Season 2023		
Control	9.00	7.67	6.33	4.33	**6.83**
Henna Leaves Extract 2%	9.00	9.00	7.67	7.00	**8.16**
Henna Leaves Extract 4%	9.00	9.00	8.33	7.67	**8.50**
Sodium Alginate 2%	9.00	8.33	7.00	6.33	**7.67**
Sodium Alginate 4%	9.00	9.00	7.67	7.00	**8.17**
Means	**9.00**	**8.60**	**7.40**	**7.47**	
LSD at $_{0.05}$		**(T): 0.82**	**(D): 0.74**	**(T×D): 0.63**	
			Season 2024		
Control	9.00	9.00	5.67	3.67	**6.83**
Henna Leaves Extract 2%	9.00	9.00	7.00	6.33	**7.83**
Henna Leaves Extract 4%	9.00	9.00	7.67	7.00	**8.17**
Sodium Alginate 2%	9.00	7.67	6.33	5.67	**7.17**
Sodium Alginate 4%	9.00	8.33	6.33	7.00	**7.67**
Means	**9.00**	**8.60**	**6.60**	**5.93**	
LSD at $_{0.05}$		**(T): 0.83**	**(D): 0.74**	**(T×D): 1.63**	

T: Treatments D: Storage Periods (Days) T×D: Interaction

Total soluble solids percentage:

Data in **Table (5)** indicated that, a gradual and significant increase in fruit TSS values was observed with the advancement of the cold storage period at 7±1˚C in both seasons. These results indicated that, the maximum TSS values (10.92 and 11.21) in the first and second seasons, respectively, were recorded at the end of the cold storage period in the first and second seasons, respectively. Excessive increase in TSS observed in control fruits indicates quality deterioration, which may be attributed to the utilization of organic acid in the pyruvate decarboxylation reaction occurring during the ripening process of fruits or due to breakdown of complex polymer into simple sugars by hydrolytic enzymes, which might be further metabolized during respiration, and level decreased during subsequent storage.

The untreated fruits (control) had the highest total soluble solids value in two study seasons, where, the best treatments gave the lowest increment of total soluble solids were sodium alginate at 4% and henna leaves extract at 4%. According to (Wills et al., 1980) the increase in TSS content during storage might result from hydrolysis of starch into sugars. After starch hydrolysis was finished, the sugar level did not rise any more, and as the sugars were broken down during respiration, the TSS content decreased. Similar results were found by other studies that used coatings to extend the shelf life of some fruits (Duan et al., 2011 and Silva et al., 2011). Additionally, Rastegar et al. (2019) studied that as storage times increased, the TSS of all samples increased gradually. On the other hand, the alginate-coated samples showed a delay in increasing of TSS as delayed the ripening process, controlled moisture loss, and blocked gaseous exchange; it decreased respiration rate and metabolic activity, resulting in less accumulated TSS in the coated mango fruit (Vieira and others, 2016).

Table (5). Efficacy of henna leaves extract and sodium alginate on total soluble solids percentage of "Maamoura" guava fruits during cold storage at (7±1°C and 90±5% R.H.) in 2023 and 2024 seasons.

Treatments	Storage Periods (Days)				
	0	7	14	23	Means
			Season 2023		
Control	7.68	10.70	12.10	11.51	**10.50**
Henna Leaves Extract 2%	7.68	10.40	11.82	11.28	**10.29**
Henna Leaves Extract 4%	7.68	8.78	11.08	10.93	**9.61**
Sodium Alginate 2%	7.68	9.87	10.89	10.87	**9.82**
Sodium Alginate 4%	7.68	8.63	10.95	10.77	**9.51**
Means	**7.68**	**9.67**	**11.37**	**11.07**	
LSD at $_{0.05}$		**(T): 0.14**	**(D): 0.13**	**(T×D): 0.28**	
			Season 2024		
Control	8.48	10.10	11.81	11.49	**10.47**
Henna Leaves Extract 2%	8.48	9.87	11.60	11.36	**10.32**
Henna Leaves Extract 4%	8.48	9.61	11.45	11.27	**10.20**
Sodium Alginate 2%	8.48	9.72	11.53	11.32	**10.26**
Sodium Alginate 4%	8.48	9.47	11.33	11.12	**10.10**
Means	**8.48**	**9.75**	**11.54**	**11.31**	
LSD at $_{0.05}$		**(T): 0.07**	**(D): 0.06**	**(T×D): 0.14**	

T: Treatments D: Storage Periods (Days) T×D: Interaction

Titratable acidity percentage:

Results presented in **Table (6)** showed the efficacy of henna leaves extract and sodium alginate on titratable acidity percentage of "Maamoura" guava fruits during cold storage at (7±1°C and 90±5% R.H.) in 2023 and 2024 seasons. Data showed that, the titratable acidity percentage decreased gradually and significantly with the progress of cold storage in both seasons. The loss of organic acids caused with metabolic processes. These results agreed by Alana et al. (2015), who observed that acidity gradually rose with storage duration for all guava fruit postures. Guava fruits had primary organic acid, citric acid, is crucial for preserving fruit quality, and a sharp decline in acidity speeds up fruit senescence (Jain et al., 2003). The steady decline in guava content in TA over storage may be due to the respiration process's utilization of organic acids and the enzymes' conversion of acids into salts and sugars. In addition, a decrease in total acidity is typical during postharvest storage has been attributed to the use of organic acids (such as citric acid) as substrates for the respiratory metabolism (Gol et al., 2013).

According to interaction data, treatment of 4% henna leaves extract had the lowest titratable acidity among treatments and storage times. Higher retention of acidity in coated fruits is due to its ability to lower the respiration rates and delays the metabolic activities thereby, preventing the loss of organic acids during the storage (Munoz et al., 2008). A decrease in total acidity is typical during postharvest storage and has been attributed to the use of organic acids as substrates for the respiratory metabolism. Alginate coating delays the utilization of organic acids (Yaman and Bayoindirli, 2002).

Table (6). Efficacy of henna leaves extract and sodium alginate on titratable acidity percentage of "Maamoura" guava fruits during cold storage at (7±1°C and 90±5% R.H.) in 2023 and 2024 seasons.

Treatments	Storage Periods (Days)				
	0	7	14	21	Means
			Season 2023		
Control	1.19	0.96	0.78	0.65	**0.89**
Henna Leaves Extract 2%	1.19	0.79	0.57	0.52	**0.77**
Henna Leaves Extract 4%	1.19	0.74	0.53	0.48	**0.73**
Sodium Alginate 2%	1.19	0.83	0.64	0.58	**0.81**
Sodium Alginate 4%	1.19	0.80	0.59	0.53	**0.78**
Means	**1.19**	**0.82**	**0.62**	**0.55**	
LSD at $_{0.05}$		**(T): 0.01**	**(D): 0.01**	**(T×D): 0.03**	
			Season 2024		
Control	1.10	0.89	0.70	0.61	**0.83**
Henna Leaves Extract 2%	1.10	0.75	0.53	0.49	**0.72**
Henna Leaves Extract 4%	1.10	0.66	0.48	0.43	**0.67**
Sodium Alginate 2%	1.10	0.79	0.58	0.54	**0.75**
Sodium Alginate 4%	1.10	0.72	0.53	0.48	**0.71**
Means	**1.10**	**0.76**	**0.57**	**0.51**	
LSD at $_{0.05}$		**(T): 0.01**	**(D): 0.01**	**(T×D): 0.02**	

T: Treatments D: Storage Periods (Days) T×D: Interaction

Vitamin C (mg/100 ml of the juice):

Data shown in **Table (7)** for both experimental seasons indicated that fruit vitamin C content significantly decreased as the storage period extended till the end of the storage period 21 days. The rapid conversion of L-ascorbic acid to dehydroascorbic acid in the presence of oxidizing enzymes such as ascorbic acid oxidase and ascorbate peroxidase may be the cause of the guavas' decreased ascorbic acid content throughout the cold storage period (Davey et al., 2000). In the two seasons of study, results also showed that all postharvest treatments caused a significantly increase in fruit vitamin C content compared with the control. In addition, in both seasons, henna leaves extract at 4% was more effective on increasing fruit vitamin C content than those other treatments. Concerning the effect of the interaction between the tested postharvest treatments and storage period, the highest values for vitamin C were founded with henna leaves extract at 4% compared to all other treatments in the first and second seasons.

Othman et al. (2017) reported that, coating protected fruit and reduced the loss of ascorbic acid content of guava fruits. The decrease in ascorbic acid during storage may be due to conversion of ascorbic acid to dehydroascorbic acid due to the action of ascorbic acid oxidase (Mapson, 1970 and Singh et al., 2005). Moreover, Rastegar et al. (2019) worked on mango fruit and they reported that, a significant decline in the levels of ascorbic acid was detected throughout the storage period, fruits treated with the alginate coating showed significantly more ascorbic content than the control. So that, the highest ascorbic acid content was observed in 3% alginate-coated fruits. The higher level of the ascorbic acid in 4% alginate-coated fruits might be due to the influence of the alginate on reducing respiration as well as oxidation in the fruits. The reduction in the ascorbic acid of the fruit during storage might be due to the rapid conversion of l-ascorbic acid into dehydroascorbic acid because of the action of ascorbic acid oxidase (Choudhary et al., 2016). Researchers believe that ascorbic acid removes the superoxide and hydroxyl radicals; it also regenerates a-tocopherol (Davey et al., 2000). The edible coating reduces the activity of the enzyme by decreasing the permeability of the oxygen and thus prevents ascorbic acid oxidation (Wang and Gao, 2013). When applied as a coating to fruits like mandarin (Chen et al., 2016) and carambola (Gol et al., 2015), Alginate has been reported to play an important role in maintaining ascorbic acid.

Table (7). Efficacy of henna leaves extract and sodium alginate on vitamin C (mg/100 ml of the juice) of "Maamoura" guava fruits during cold storage at (7±1°C and 90±5% R.H.) in 2023 and 2024 seasons.

Treatments	Storage Periods (Days)				
	0	7	14	21	Means
	Season 2023				
Control	109.24	83.72	68.42	43.78	**76.29**
Henna Leaves Extract 2%	109.24	98.53	87.22	68.55	**90.88**
Henna Leaves Extract 4%	109.24	104.38	96.32	74.34	**96.07**
Sodium Alginate 2%	109.24	94.37	80.74	64.08	**87.11**
Sodium Alginate 4%	109.24	99.90	94.02	70.60	**93.44**
Means	**109.24**	**96.18**	**85.34**	**64.27**	
LSD at $_{0.05}$		**(T): 1.06**	**(D): 0.95**	**(T×D): 2.09**	
	Season 2024				
Control	111.68	85.00	71.74	45.35	**78.44**
Henna Leaves Extract 2%	111.68	102.02	90.48	71.02	**93.80**
Henna Leaves Extract 4%	111.68	105.81	97.64	77.44	**98.14**
Sodium Alginate 2%	111.68	97.27	88.04	68.28	**91.32**
Sodium Alginate 4%	111.68	99.94	94.78	74.38	**95.20**
Means	**111.68**	**98.01**	**88.54**	**67.29**	
LSD at $_{0.05}$		**(T): 0.99**	**(D): 0.89**	**(T×D): 1.96**	

T: Treatments D: Storage Periods (Days) T×D: Interaction

Total sugars percentage:

Table (8) showed that as the storage period increased, the amount of total sugars significantly increased. An increase in sugars during storage may have caused starch to be converted to simple sugar (Samra et al., 2019). Improvement in sugar percent may be because of converting some cell wall material like hemicelluloses to reducing content under long storing conditions (Stahi and Camp, 1971). These findings closely resemble those of Parihar and Kumar (2007), who discovered that guava's total sugar content increased as its storage time increased.

Furthermore, the current data show that, in comparison to untreated fruits, had the highest means of total sugars at the end of the storage period in both seasons, the lowest values of total sugars were recorded for guava fruits treated with postharvest treatments of sodium alginate at 4%, henna leaves extract at 4%, and sodium alginate at 2%. Maintaining storability of Brahee Date Palm fruits with postharvest edible coating by using alginate salts (Samra et al., 2019). The interaction between treatments and storage period was significant, where, "Maamoura" guava fruits treated with henna leaves extract and sodium alginate were recorded that, as having lowest values of total sugars as compared with untreated fruits along the storage period.

Table (8). Efficacy of henna leaves extract and sodium alginate on total sugars percentage of "Maamoura" guava fruits during cold storage at (7±1°C and 90±5% R.H.) in 2023 and 2024 seasons.

Treatments	Storage Periods (Days)				
	0	7	14	21	Means
	Season 2023				
Control	5.54	8.11	9.22	10.14	**8.25**
Henna Leaves Extract 2%	5.54	7.93	8.87	9.73	**8.02**
Henna Leaves Extract 4%	5.54	7.67	8.27	9.41	**7.72**
Sodium Alginate 2%	5.54	7.72	8.72	9.54	**7.88**
Sodium Alginate 4%	5.54	7.35	8.16	9.02	**7.52**
Means	**5.54**	**7.75**	**8.65**	**9.57**	
LSD at $_{0.05}$		**(T): 0.09**	**(D): 0.08**	**(T×D): 0.19**	
	Season 2024				
Control	5.76	7.72	8.69	10.02	**8.05**
Henna Leaves Extract 2%	5.76	7.67	8.58	9.60	**7.90**
Henna Leaves Extract 4%	5.76	7.52	7.99	9.18	**7.61**
Sodium Alginate 2%	5.76	7.53	8.09	9.46	**7.71**
Sodium Alginate 4%	5.76	7.34	7.84	8.90	**7.46**
Means	**5.76**	**7.56**	**8.24**	**9.43**	
LSD at $_{0.05}$		**(T): 0.15**	**(D): 0.13**	**(T×D): 0.30**	

T: Treatments D: Storage Periods (Days) T×D: Interaction

Marketing life (number days):

When compared to untreated fruits (control), the data in **Table (9)** showed that all postharvest applications of "Maamoura" guavas extended the shelf life duration at ambient settings (25±2˚C and 65±5% R.H.). Following fruits treated with henna leaf extract at 2% (7.48 and 6.99 days) incorporated with sodium alginate at 2% (7.29 and 6.71 days) in the first and second seasons, respectively, these findings showed that guavas treated with henna leaf extract at 4% (8.15 and 7.55 days) incorporated with sodium alginate at 4% (7.76 and 7.13 days) in 2023 and 2024 seasons achieved the longest days of shelf life period. Conversely, untreated fruits (control) had the shortest shelf life periods in 2023 and 2024 seasons, at 2.47 and 1.93 days, respectively. In agreement with these results are those obtained by Díaz-Mula et al. (2012), they reported that, alginate treatment is an effective tool to delay the postharvest ripening process of sweet cherry. Overall, the results show that coated cherries could be kept for up to 16 days at 2°C plus an additional 2 days at 20°C with maximum antioxidant activity and quality, the maximum storability duration of control fruits could be determined to be 8 days at 2°C plus 2 days at 20°C.

Table (9). Efficacy of henna leaves extract and sodium alginate on shelf life of period (Days) of "Maamoura" guava fruits at ambient conditions (25±2°C and 65±5% R.H.) in 2023 and 2024 seasons.

Treatments	Season 2023	Season 2024
Control	2.47	1.93
Henna Leaves Extract 2%	7.48	6.99
Henna Leaves Extract 4%	8.15	7.55
Sodium Alginate 2%	7.29	6.71
Sodium Alginate 4%	7.76	7.13
LSD $_{at\ 0.05}$	**0.35**	**0.15**

CONCLUSION

According to the study's findings, sodium alginate at 4% and henna leaves extract at 4% postharvest treatments significantly decreased weight loss, decay percentages, and preserved the quality of "Maamoura" guava fruits throughout their shelf life and cold storage duration. Additionally, to improve the storability of "Maamoura" guava fruits and maintain their quality characteristics throughout cold storage conditions and shelf life, postharvest applications of sodium alginate at 4% and henna leaf extract at 4% may be suggested, also, these treatments are safe and can be applied for local and export markets guava fruits.

REFERENCES

A.O.A.C. (2005). Official Method of Analysis of Association of Official Analytical Chemist International. 18th ed., North Frederick Avenue, Gaithersburg, Maryland, USA.

Abd El-Gawad, M.G. (2021). Influence of Propolis Extract and Oxalic Acid on Preserving Quality of Guava Fruits during Postharvest Cold Storage. Plant Archives, 21(1): 127-138.

Abd El-Migeed, M.M.M., Eman, A.A. Abd EL-Moniem., Gihan, M. Ali, and Ahmed, A. Rashedy. (2021). Influence of Some Natural Edible Coatings Post-Harvest Treatments on "Maamoura" Guava Fruit Quality and Storability. Journal of Horticultural Science & Ornamental Plants, 13 (3): 282-288.

Acevedo, C.A., Lόpez, D.A., Tapia, M.J., Enrione, J., Skurtys, O., Pedreschi, F., Brown, D.I., Creixell, W. and Osorio, F. (2012). Using RGB image processing for designating an alginate edible film. Food and Bioprocess Technology, 5: 1511–1520.

Alana, B.A., Arie, F.B. and Luciana, C.L.A. (2015). Impact of edible chitosan–cassava starch coatings enriched with Lippia gracilis Schauer genotype mixtures on the shelf life of guavas (*Psidium guajava*, L.) during storage at room temperature. Food Chemistry, 171(15): 108-116.

Azarakhsh, N., Osman, A., Ghazali, H.M., Tan, C.P. and Adzahan, N.M. (2014). Lemongrass essential oil incorporated into alginate-based edible coating for shelf-life extension and quality retention of fresh-cut pineapple. Postharvest Biology and Technology, 88: 1–7.

Barth, M.M., Kerbel, E.L., Perry, A.K. and Schmidt, S.J. (1993). Modified atmosphere packaging affects ascorbic acid, enzyme activity and market quality of broccoli. J. Food Sci., 58(1): 140-143.

Bashir, H.A. and Abu-Goukh, A.A. (2003). Compositional changes during guava fruit ripening. Food Chem., 80: 557-563.

Basra, M.A.S. and Lovatt, C.J. (2016). Exogenous applications of moringa leaf extract and cytokinins improve plant growth, yield and fruit quality of cherry tomato. HortTechnology, pp: 327-337.

Bhooriya, M.S., Bisen, B.P. and Pandey, S.K. (2018). Effect of post-harvest treatments on shelf life and quality of

Guava (*Psidiun guavajava*) fruits. International Journal of Chemical Studies, 6(4): 2559-2564.

Bron, I.U., Ribeiro, R.V., Cavalini, F.C., Jacomino, A.P. and Trevisan, M.J. (2005). Temperature related changes in respiration and Q10 coefficient of guava. Scientia Agricola, 62(5): 458-463.

Brummel, D. and Harpster, M. (2001). Cell wall metabolism in fruit softening and quality and its manipulation in transgenic plants. Plant Mol. Biol., 77: 311-340.

Chen, C., Peng, X., Zeng, R., Chen M., Wan, C. and Chen, J. (2016). Ficus hirta fruits extract incorporated into an alginate-based edible coating for Nanfeng mandarin preservation. Scientia Horticulturae, 202: 41–48.

Chiabrando, V. and Giacalone, G. (2017). Quality evaluation of blueberries coated with chitosan and sodium alginate during postharvest storage. International Food Research Journal, 24(4): 1553-1561.

Choudhary, M.L., Dikshit, S.N., Shukla, N. and Saxena, R.R. (2016). Evaluation of guava (*Psidium guajava*, L.) varieties and standardization of recipe for nectar preparation. Journal of Horticultural Science, 3(2): 161–163.

Dalal, N., Bisht, V. and Dhakar, U. (2019). Review Article henna (*LAWSONIA INERMIS*, L.): from plant to palm neeraj. International Journal of Agriculture Sciences, 11(24): 9370-9372.

Davey, M.W., Montagu, M.V., Inze, D., Sanmartin, M., Kanellis, A., Smirnoff, N. and Fletcher, J. (2000). Plant L-ascorbic acid: Chemistry, function, metabolism, bioavailability and effects of processing. Journal of the Science of Food and Agriculture, 80(7), 825–860.

Diaz-Mula, H. M., Serrano, M. and Valero, D. (2012). Alginate coatings preserve fruit quality and bioactive compounds during storage of sweet cherry fruit. Food and Bioprocess Technology, 5: 2990–2997.

Duan, J., Wu, R., Strik, B.C. and Zhao, Y. (2011). Effect of edible coatings on the quality of fresh blueberries (Duke and Elliott) under commercial storage conditions. Postharvest Biology and Technology, 59(1), 71–79.

Gallo, F., Multari, G., Palazzino, G., Pagliuca, G., Zadeh, S.M.M., Biapa, P.C.N., Nicoletti, M. (2014). “Henna through the Centuries: A quick HPTLC analysis proposal to check identity.” Revista Brasiliera de Farma Cognisia. 24: 2.

Gol, N.B., Chaudhari, M.L. and Rao, T.R. (2015). Effect of edible coatings on quality and shelf life of carambola (*Averrhoa carambola*, L.) fruit during storage. Journal of Food Science and Technology, 52(1): 78–91.

Gol, N.B., Patel, P.R. and Rao, T.V.R. (2013). Improvement of quality and shelf-life of strawberries with edible coatings enriched with chitosan. Postharvest Biology and Technology 85: 185–195.

Jain, N., Dhawan, K., Malhotra, S. and Singh, R. (2003). Biochemistry of fruit ripening in guava (*Psidium guajava*, L.) compositional and enzymatic changes. Plant Foods for Human Nutrition, 58: 309-315.

Jha, S.N., Vishwakarma, R.K., Ahmad, T., Rai, A. and Dixit, A.K. (2015). Report on assessment of quantitative harvest and post-harvest losses of major crops and commodities in India. All India Coordinated Research Project on Post-Harvest Technology, ICAR-CIPHET, Ludhiana.

Kanwal, N., Randhawa, M.A. and Iqbal, Z. (2016). A review of production, losses and processing technologies of guava. Asian Journal of Agriculture and Food Sciences, 4(2): 96-101.

Kubheka, S.F., Tesfay, S.Z., Mditshwa, A. and Magwaza, L.S. (2020). Evaluating the efficacy of edible coatings incorporated with moringa leaf extract on postharvest of ‘Maluma’ avocado fruit quality and its biofungicidal effect. Hortscience, 55(4): 410-415.

Lohani, S., Trivedi, P. and Nath, P. (2004). Changes in activities of cell wall hydrolases during ethylene induced ripening in banana: effect of 1-MCP, ABA, and IAA. Postharvest Biol. Technol., 31: 119-126.

Maftoonazad, N., Ramaswamy, H.S. and Marcotte, M. (2008). Shelf-life extension of peaches through sodium alginate and methyl cellulose edible coatings. International Journal of Food Science & Technology, 43: 951–957.

Mapson, C.W. (1970). Vitamins in Fruits: Stability of l-Ascorbic acid in Biochemistry of Fruits and their Products. Academic Press, London, pp: 376-387.

Mercado-Silva, E., Benito-Bautista, P. and Garcia-Velasco, M.A. (1998). Fruit development, harvest index and ripening changes of guavas produced in central Mexico. Postharvest Biology and Technology, 13: 143-150.

Mitra, S.K., Devi, H.L., Chakraborty, I. and Pathak, P.K. (2012). Recent development in postharvest physiology and storage of guava. Acta Horticulturae, 959: 89-95.

Mohammed, H., Abass, U.A.M. and Al-Abadi, A.M.S. (2007). The effeciency of henna leaves extracts and some fungicide to reduce the fungal contamination of date palm (*Phoenix dactylifera*, L) Tissue cultures. Iraqi Journal of Biotechnology, 6(2): 21-40.

Munoz, H.P., Almenar, E., Ocio, M.J. and Gavara, R. (2006). Effect of Calcium dips and Chitosan Coating on postharvest life of strawberries (*Fragaria* x *ananassa*). Postharvest Biology and Technology. 39:247-253.

Othman**,** M.E., EL-Badry, N., Mahmoud, S. and Amer, M. (2017). The Effect of Edible Coating Contained Essential Oil on the Quality Attributes and Prolonging the Shelf Life of Guava Fruit. Middle East J. Agric. Res., 6(1): 161-174.

Parihar, P. and Kumar, S. (2007). Shelf life studies on guava fruits under different packaging materials. Indian Journal of Agricultural Biochemistry, 20(1), 27-29.

Parreidt, T.S., Müller K. and Schmid, M. (2018). Alginate-based edible films and coatings for food packaging applications. Foods, 7: 170.

Rastegar, S., Khankahdani, H.H. and Rahimzadeh, M. (2019). Effectiveness of alginate coating on antioxidant enzymes and biochemical changes during storage of mango fruit. J Food Biochem. 2019;43:e12990.

Razzaq, K., Khan, A.S., Malik, A.U., Shahid, M. and Ullah, S. (2014). Role of putrescine in regulating fruit softening and antioxidative enzyme systems in ‘Samar Bahisht Chaunsa’ mango. Postharvest Biology and Technology, 96, 23-32.

Rojas Graü, M.A., Tapia, M.S., Rodríguez, F.J., Carmona, A. and Martin Belloso, O. (2007). Alginate and gellan-based edible coatings as carriers of anti browning agents applied on fresh-cut Fuji apples. Food Hydrocolloid 21: 118-127.

Samra**,** N. R., Ameer, M.S. and Basma, T.E. **(**2019). Maintaining Storability of Brahee Date Palm Fruits with Postharvest Edible Coating by using Alginate Salts. J. of Plant Production, Mansoura Univ., 10 (12):983 -993.

Silva, M., Atarassi, M., Ferreira, M. and Mosca, M.A. (2011). Qualidade pós-colheita de caqui 'fuyu' com utilização de diferentes concentrações de cobertura comestível. Ciência e Agrotecnologia, v. 35, p. 144-151.

Singh, D. and Sharma, R.R. (2007). Postharvest diseases of fruit and vegetables and their management. In: Prasad, D. (Ed.), Sustainable Pest Management. Daya Publishing House, New Delhi, India.

Singh, S., Singh, A.K. and Joshi, H.K. (2005). Prolong storability of Indian Gooseberry (*Emblica officinalis*, Gaertn.) under semiarid ecosystem of Gujarat. Indian J. Agric. Sci., 75: 647-650.

Sipahi, R.E., Castell-Perez, M.E., Moreira, R.G., Gomes, C. and Castillo, A. (2013). Improved multilayered antimicrobial alginate-based edible coating extends the shelf life of fresh-cut watermelon (*Citrullus lanatus*). LWT Food Sci. Technol., 51: 9–15.

Smith, F., Gilles, A., Hamitn, J.K. and Gedees, A.P. (1956). Colourimetric methods of determination of sugar and related substances. Anal. Chem., 28, 350.

Snedecor, G.W. and Cochran, W.G. (1980). Statistical methods. 6. ED. The Lowa St. Univ. press Ames U.S.A.

Stahi, A.L. and Camp, A.F. (1971). Citrus fruits. In: The Biochemistry of Fruits and their Products, 2, (Ed. Hulme, A.C.), 107-169.

Valero, D., Díaz-Mula, H.M., Zapata, P.J., Guillén, F., Martínez-Romero, D., Castillo, S. and Serrano, M. (2013). Effects of alginate edible coating on preserving fruit quality in four plum cultivars during postharvest storage. Postharvest Biology and Technology, 77:1–6.

Vieira, J.M., Flores-López, M.L., de Rodríguez, D.J., Sousa, M.C., Vicente A.A. and Martins, J.T. (2016). Effect of chitosan–Aloe vera coating on postharvest quality of blueberry (*Vaccinium corymbosum*) fruit. Postharvest Biology and Technology, 116: 88–97.

Wang, S.Y. and Gao, H. (2013). Effect of chitosan-based edible coating on antioxidants, antioxidant enzyme system, and postharvest fruit quality of strawberries (*Fragaria x aranassa* Duch.). LWT-Food Science and Technology, 52(2): 71–79.

Watkins, C. and Harman, J. (1981). Use of penetrometer to measure flesh firmness of fruit. Orchadist, N.Z., 14-16.

Wills, R.B.H., Bembridge, P.A., and Scott, K.J. (1980). Use of flesh firmness and other objective tests to determine consumer acceptability of Aust. J. 'Delicious' apples. Exp. Agric. Anim., 20: 252–256.

Woods, J.L. (1990). Moisture loss from fruits and vegetables. Postharvest news and information, 1 (3): 195-199.

Yaman, O. and Bayoindirli, L. (2002). Effects of an edible coating and cold storage on shelf-life and quality of cherries. Lebnsm.-Wiss.Und.Technol., 35: 146-150.

Zapata, P.J., Guillén, F., Martínez-Romero, D., Castillo, S., Valero, D., and Serrano, M. (2008). Use of alginate or zein as edible coatings to delay postharvest ripening process and to maintain tomato (*Solanum lycopersicon*, Mill) quality. Journal of the Science of Food and Agriculture, 88: 1287–1293.

الملخص العربى

فاعلية مستخلص أوراق الحناء والألجينات على خصائص الجودة أثناء التخزين المبرد والقدرة التسويقية لثمار الجوافة "المعمورة"

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الجوافة فاكهة تفسد بسرعة، مصحوبةً بفقدان كبير في الوزن، وتالف بالفطريات، مما يحد من تسويقها. لذا، أُجريت هذه التجربة لدراسة فعالية معاملات ما بعد الحصاد من مستخلص أوراق الحناء بتركيزين (2٪ , 4٪)، وألجينات الصوديوم بتركيزين (2٪ , 4٪)، مقارنة بالكنترول (ثمار غير معاملة) على صفات الجودة أثناء التخزين البارد وتقييم مدة الصلاحية للتسويق لثمار الجوافة "المعمورة". تم التخزين البارد للثمار عند درجة حرارة 7±1 درجة مئوية ورطوبة نسبية 90±5٪ لمدة 21 يومًا تليها فترة الصلاحية على درجة حرارة الغرفة تحت ظروف (25±2 درجة مئوية ورطوبة نسبية 65±5٪. تم تقييم جودة الثمار عند الحصاد وأثناء التخزين البارد وتقييم عدد الأيام التي تكون فيها الثمار مناسبة للتسويق عند فترة الصلاحية. أظهرت النتائج أن جميع معاملات ما بعد الحصاد بمستخلص ألجينات الصوديوم 4٪ أو مستخلص أوراق الحناء 4٪ كان لها تأثير إيجابي على خصائص جودة ما بعد الحصاد بما في ذلك إنخفاض فقدان الوزن ونسبة التالف والمحافظة على المظهر المرئي وصلابة الثمار والمواد الصلبة الذائبة الكلية والحموضة وفيتامين (ج) والسكريات الذائبة الكلية أثناء التخزين البارد مقارنة بالكنترول (الثمار الغير معاملة) أيضاً معاملات التغطية زادت من عدد أيام صلاحية الثمار للتسويق. تشير الدراسة إلى أنه يمكن إستخدام معاملات التغطية بعد الحصاد للحفاظ على الجودة وزيادة فترة البقاء في الأسواق بحالة جيدة.