Research | Egyptian Journal of Agricultural Research | Horticulture

Effect of Edible Coatings on Quality and Storability of Sweet Pepper Fruits

*Mona M. Haffez** and *Noura A. Gad El-Rab*

Address:

Department of Postharvest and Handling of Vegetable Crops, Horticulture Research Institute, Agricultural Research Center, Giza, Egypt.

*Corresponding author: ***Mona M. Haffez***: mona.montasser75@gmail.com

Received: 12-07-2023; **Accepted**: 25-09-2023; **Published**: 02-11-2023 **DOI**: 10.21608/ejar.2023.220618.1415

ABSTRACT

This experiment was carried out during 2021 and 2022 seasons on sweet peppers (*Capsicum annuum L.* Monist F1 hybrid) to study the influence of some coating treatments (aloe vera gel 4% and 6%, chitosan 0.5 % and 1 % and gum arabic 5% and 10%) compared to untreated fruits as a control on maintaining quality and improving storability of fruits throughout 4 weeks of storage at 10°C and 90-95% RH. According to the results, all coated treatments were effective in decreasing weight loss, decay, firmness loss, change of color and maintaining total soluble solids, total carotenoids content, ascorbic acid content and as well as the general appearance of fruits compared with untreated fruits during cold storage. Furthermore, fruit treated with chitosan at 0.5% and gum arabic at 10% treatments gave the Best outcomes in decreasing weight loss, decay, firmness loss, color difference, and preserving total soluble solids, total carotenoids content, and ascorbic acid content, as well as providing fruits a pleasant appearance without decay for 21 days.

Keywords: Sweet pepper, Chitosan, Gum Arabic, Aloe vera Gel, Storage, Quality Attributes.

INTRODUCTION

Sweet pepper (*Capsicum annuum* L.) is considered one of most important and popular vegetable crops farmed for both domestic and export consumption. One of highest vitamin C-containing vegetables is pepper. It also contains amount of vitamins A, B1, and other vitamins that are necessary for growth (Mc Collum, 1980). Sweet pepper has a long variety of plant nutrients that have been shown to have disease-preventing and health-promoting qualities (Howard *et al*., 2000).

Sweet pepper is a perishable vegetable with a limited shelf life and a high vulnerability to fungi (Hardenburg *et al*., 1990). Growth of deterioration and poor exterior appearance are the primary causes of sweet pepper quality decline during long-term storage (Ceponis *et al*., 1987). Loss of moisture causes not only noticeable weight loss, but also less appealing fruit due to weaker texture and wilted tissues, lowering fruit quality (Xie *et al*., 2004). In addition to refrigeration, edible coatings are employed to preserve the quality and extend the shelf life of sweet pepper fruits.

The application of edible coatings can improve the physical strength of food products, reduce particle clustering and improve visual and tactile features on product surfaces (Cisneros-Zevallos *et al*., 1997). Coatings are primarily used to improve food appearance while also protecting food products from moisture migration, microbial growth on the surface, light-induced chemical changes, nutrient degradation, and other factors (Ali *et al*., 2011). Edible coatings can operate as a barrier against oils, gases, or vapours as well as a carrier of active ingredients such as antioxidants, antimicrobials, colors, and tastes (Miller *et al*., 1998). When used to affect the environment of food surface conditions, edible coatings can be used as active films (Guilbert and Gontard, 2005).

Aloe vera is a tropical plant noted for its therapeutic properties and for preserving fruit quality by decreasing fungal rot (Valverde *et al*., 2005). The main liquid components are clear gel and yellow latex (Turner *et al.,* 2004). Aloe vera gel has recently been employed in a variety of horticultural crops such as Green Capsicum (Amirthaveni and Palak, 2016) and apples (Ergun and Satici, 2012). Aloe vera gel based edible coatings have been shown to prevent loss of moisture and softening decrease, control rate of respiration and senescence, delay oxidative browning and reduce proliferation of microorganism in fruits (Marpudi *et al*., 2011). *Staphylococcus aureus, Salmonella, Streptococcus, Escherichia coli, Aspergillus niger, Candida,* and other pathogenic and foodborne spoilage organisms are inhibited by aloe vera gel (Ullah *et al*., 2016). Furthermore, aloe vera gel coatings decreased

O_2 consumption and CO_2 production, preventing anaerobic conditions (Benítez *et al*., 2013). Aloe vera gel polysaccharides function as a barrier to moisture and O_2, resulting in a slow rate of respiration and the fruit quality preservation (Maan *et al*., 2018).

Chitosan is a deacetylated chitin derivate with a high molecular weight cationic linear polysaccharide comprised of d-glucosamine and to lesser extent, N-acetyl-d-glucosamine with a ß- 1,4- bond (Rinaudo, 2006). Chitosan is often produced of plentiful supply from shellfish exoskeletons or cell walls of various fungi and microorganisms (Hirano *et al*., 1976). Chitosan coatings are considered as best edible and biologically safe preservative coatings for various types of fruits and vegetables, with functional benefits; where chitosan coating acts as a semi - permeable barrier against moisture, oxygen and carbon dioxide, resulting in lower rates of respiration, water loss, and maintained quality and prolonged storage periods, reduced color changes, and controlled microbial growth. (Ardakani and Mostofi, 2019). An additional positive effect of chitosan coating is related to its ability to extend storage life of vegetables and fruits (Suseno *et al*., 2014).

Gum Arabic, often known as acacia gum, is a natural gum derived from the secretion of Acacia species stems or branches. It is a polysaccharide and glycoprotein blend used in industries for film formation, emulsification, and encapsulation. Previously, gum Arabic coating was used to improve the shelf life of tomatoes (Ali *et al*., 2010), mango (Khaliq *et al*., 2016), and green chilies (Chitravathi *et al*., 2014). Gums have also been employed in foods due to their various useful properties (Ghafoor *et al*., 2008). There has been a strong trend towards replacing synthetic materials by natural gums due to their non-toxicity, low cost, safety, and availability (Mirhosseini and Amid 2012).

Thus the objective of our present research was to investigate the effect of aloe vera gel, chitosan and gum Arabic coating on quality and sensory characteristics of sweet pepper fruits during cold storage.

MATERIALS AND METHODES

Sweet pepper (*Capsicum annum L*.) fruits Monist F1 hybrid were harvested at ¾ color stage (yellow green) during winter season on 17th and 19th of January in 2021 – 2022 seasons, respectively from a private farm in Abu Rawash, Giza Governorate. Sweet pepper fruits were transported to the laboratory of Postharvest and Handling of Vegetable Crops Research Department, Horticulture Research Institute, Agricultural Research Center, Giza Governorate. Uniform fruits in size, weight, shape and color, the fruit free of defects or fungal infections were selected for the storage experiment.

Preparation of Aloe Vera Gel solution:

Mature green Aloe vera plant leaves were obtained and cleaned with tap water to eliminate dirt and soil particles. To extract the colorless hydro parenchyma, the epidermis of the leaves was peeled and the gel matrix was removed from the outer cortex of the leaves. As a base coating, an aloe vera gel solution at a concentration of 4 or 6% (w/v) was utilized. It was made by blending 4 or 6 grams of obtained gel in a food blender. To remove fibers, fluid was filtered through muslin fabric. The acquired liquid was made up from fresh Aloe vera gel, which was then dissolved in 100 ml of distilled water to get appropriate concentration of solution (Yulianingsih, *et al*., 2013).

Preparation of Chitosan solution: Chitosan solutions (0.5% or 1%) were prepared by dissolving chitosan powder 5g or 10 g in 1000 ml of distilled water, the solution was stirred using a magnetic stirrer for initial homogenization at room temperature (23±1 ◦C) for 60 min. Glycerol (1.5% W/V) was added to mixture as plasticizer (Haffez, 2016).

Preparation of Gum Arabic solution: Gum Arabic at a concentration of 5% or 10% (w/v) was made by dissolving 5 or 10 grams of Gum arabic in 100 ml of distilled water, for 60 minutes, solution was swirled on a magnetic stirrer/hot plate (Neolab Motorless Magnetic Stirrer + Hot Plate) at the low temperature with high speed. After cooling, produced solution was filtered through muslin cloth to remove any undessolved contaminants (Hedayati and Niakousari, 2015).

Sweet pepper fruits were immersed for 2 minutes in the following solutions: Aloe vera gel at 4% and 6%, Chitosan at 0.5 and 1%, and Gum arabic at 5% and 10%, in addition to untreated fruits (dipped in distilled water) as a reference.

All sweet pepper fruit samples were air dried before being packaged in sealed polypropylene bags (30 m thickness, 3035 cm size), each bag containing three fruits represented as a replicate, labeled and weighted. Each treatment received twelve replicates. All treatments were stored at 10°C and 90-95 percent relative humidity for 28 days. The experimental design was completed randomized design with three replicates from each treatment were taken randomly and analyzed for following qualities immediately after harvest, 7, 14, 21, and 28 days at 10°C.

The properties were examined:

1- **Weight loss %**: was estimated according to following equation:

$$\text{Weight loss \%} = \frac{\text{Initial weight of fruits} - \text{weight of fruits at sampling date}}{\text{Initial weight of fruits}} \times 100$$

2- **General appearance**: was measured on score rating from 9 to 1, where 9 = excellent, 7 = good, 5 = fair, 3= poor and 1 = unsalable.

3- **Decay:** was measured on a scale of 1= none, 2= slight, 3= moderate, 4= severe, 5= extreme. (Risse & Miller, 1986).

4- Fruit firmness: was measured by a hand pressure tester (Italian model) expressed in kg/cm^2 (Abbott, 1999).

5- Surface color: was measured on two sides of each fruit by using Tistimulus Hunter Colorimeter Minolta, Ramsey, N.J. (Model Dp 9000 which measured L* value and b value) (Mc Guire, 1992).

6- Total soluble solids percentage (TSS) % was measured from the fresh materials using PR-101 digital refractometer

7- Total carotenoids content (mg/100g fresh weight): was determined according to A.O.A.C. (1990).

8- Ascorbic acid content (mg /100 g fruit fresh weight): was determined by titration method using 2, 6 dichloro-phenole-endo-phenole (A.O.A.C., 2000).

Statistical analysis:

According to Sendecor and Cochran's (1980) techniques, experiment was factorial with two components (storage period and edible coating treatments) in complete randomized design (CRD) with three replicates. Tukey's multiple range test was used to assess mean comparisons. at a 5% level of significance

RESULTS

Weight loss percentage:

Data in Table (1) indicate that the weight loss percentage of sweet pepper fruits significantly increased considerably and consistently with prolongation of storage period in two tested seasons. Similar results were obtained by Gad EL-Rab (2013). When compared to the control, all treatments preserved their weight during storage. Furthermore, sweet pepper fruits treated with 10% gum arabic resulted in a significant reduction in weight loss percentage, following chitosan 0.5 % and gum arabic 5%, with no significant difference between them in the two seasons. The untreated control had highest value of weight reduction percentage. These findings were consistent across both seasons and agreed with Amirthaveni and Palak (2016) for gum arabic and Chong *et al.* (2015) for chitosan. In terms of interaction between postharvest treatments and storage length, sweet pepper fruits dipped in 10% gum arabic were the most effective in lowering weight loss percentage for the entire storage periods. The greatest weight loss was recorded in untreated fruits throughout the storage period

Table 1. Effect of edible coating treatments on weight loss % of sweet pepper fruits during cold storage in 2021 and 2022 seasons.

Treatments	Storage period (days)					Mean
	0	7	14	21	28	
	First season					
Aloe vera Gel 4%	0.00 o	0.22 k-o	0.28 j-n	0.60 gh	1.50 c	**0.52 C**
Aloe vera Gel 6%	0.00 o	0.28 j-n	0.42 h-l	0.76 fg	2.10 b	**0.71 B**
Chitosan 0.5 %	0.00 o	0.18 l-0	0.24 k-o	0.40 h-m	1.00 ef	**0.36 D**
Chitosan 1 %	0.00 o	0.23 k-o	0.32 i-m	0.61 gh	1.60 c	**0.55 C**
Gum Arabic 5%	0.00 o	0.16 m-o	0.23 k-o	0.45 h-k	0.98 ef	**0.36 D**
Gum Arabic 10%	0.00 o	0.06 no	0.15 m-o	0.26 k-n	0.55 g-i	**0.20 E**
Control	0.00 o	0.52 g-j	1.13 de	1.80 c	2.75 a	**1.24 A**
Mean	**0.00 E**	**0.24 D**	**0.40 C**	**0.70 B**	**1.50 A**	
Second season						
Aloe vera Gel 4%	0.00 k	0.22 i-k	0.27 g-j	0.63 e	1.40 c	**0.50 C**
Aloe vera Gel 6%	0.00 k	0.27 g-j	0.48 e-g	0.68 e	1.73 b	**0.63 B**
Chitosan 0.5 %	0.00 k	0.16 i-k	0.27 g-j	0.47 e-h	1.14 d	**0.41 D**
Chitosan 1 %	0.00 k	0.22 i-k	0.30 f-i	0.64 e	1.48 c	**0.53 BC**
Gum Arabic 5%	0.00 k	0.18 i-k	0.23 h-k	0.53 ef	1.09 d	**0.41 D**
Gum Arabic 10%	0.00 k	0.05 jk	0.26 g-j	0.27 g-j	0.59 e	**0.24 E**
Control	0.00 k	0.63 e	1.11 d	1.8 b	2.48 a	**1.20 A**
Mean	**0.00 E**	**0.25 D**	**0.42 C**	**0.72 B**	**1.41 A**	

Values with same letter(s) are not significantly different at P≤ 0.05 level; using Tukey's multiple range test.

General appearance:

data in Table (2) illustrate the influence of postharvest interventions on sweet pepper overall appearance during storage. The general look of sweet pepper fruits reduced as the storage duration at 10oC was extended. Gad EL-Rab (2013) and Shehata *et al*. (2009) found similar results with pepper. When compared to untreated, all coating treatments considerably preserved the fruit appearance.

Table 2. Effect of edible coating treatments on general appearance (score) of sweet pepper fruits during cold storage in 2021 and 2022 seasons.

Treatments	Storage period (days)					Mean
	0	7	14	21	28	
	First season					
Aloe vera Gel 4%	9.00 a	7.67 a-c	6.33 c-e	5.67 d-f	5.00 e-g	**6.73 B**
Aloe vera Gel 6%	9.00 a	8.33 ab	6.33 c-e	6.33 c-e	5.67 d-f	**7.13 B**
Chitosan 0.5 %	9.00 a	9.00 a	9.00 a	7.67 a-c	6.33 c-e	**8.12 A**
Chitosan 1 %	9.00 a	7.00 b-d	5.67 d-f	5.00 e-g	3.67 gh	**5.97 C**
Gum arabic 5%	9.00 a	7.67 a-c	7.00 b-d	5.67 d-f	4.33 f-h	**6.73 B**
Gum arabic 10%	9.00 a	9.00 a	9.00 a	7.67 a-c	6.33 c-e	**8.12 A**
Control	9.00 a	6.33 c-e	5.00 e-g	3.00 h	1.00 i	**4.98 D**
Mean	**9.00 A**	**7.96 B**	**6.91 C**	**5.76 D**	**4.62 E**	
Second season						
Aloe vera Gel 4%	9.00 a	8.33 ab	7.67 a-c	5.67 d-f	5.00 e-g	**7.27 B**
Aloe vera Gel 6%	9.00 a	8.33 ab	7.00 b-d	6.33 c-e	5.00 e-g	**7.27 B**
Chitosan 0.5 %	9.00 a	9.00 a	9.00 a	7.67 a-c	6.33 c-e	**8.01 A**
Chitosan 1 %	9.00 a	8.33 ab	6.33 c-e	5.67 d-f	4.33 f-h	**6.60 C**
Gum arabic 5%	9.00 a	8.33 ab	7.67 a-c	5.00 e-g	3.67 gh	**6.87 BC**
Gum arabic 10%	9.00 a	9.00 a	9.00 a	7.67 a-c	6.33 c-e	**7.93 A**
Control	9.00 a	6.33 a-c	6.33 c-e	3.00 hi	1.67 i	**5.67 D**
Mean	**9.00 A**	**8.43 B**	**7.57 C**	**6.05 D**	**4.43 E**	

Values with same letter(s) are not significantly different at P≤ 0.05 level; using Tukey's multiple range test.

sweet pepper fruit. However, the general appearance of sweet pepper treated with chitosan 0.5 % or gum arabic 10% was better than the other treatments with no significant difference between them. Other words, these treatments gave highest score of appearance in both seasons, but untreated control obtained the lowest ones in this concern. These results are agreement with AL-Juhaimi *et al*. (2012) for gum arabic and Haffez (2016) for chitosan. The interaction between postharvest treatment and storage period reveals that sweet pepper dipped in chitosan 0.5 % or gum arabic 10% showed best appearance. It did not exhibit any changes in their general appearance till 14 days and gave good appearance till 21 days at 10 ºC, these results are true in two seasons.

Decay:

Data in Table (3) show that there was a significant increase in decay score with prolongation of storage period in two seasons. These results are in harmony with those obtained by Atress and Attia (2011) and Shehata *et al*. (2013). The sweet pepper fruits treated with all treatments had lower decay percentage in comparison to untreated control treatment during storage conditions. Moreover, the application of chitosan 0.5 % and gum arabic 10% treatments had lower scores of decay with no significant difference between them, when compared with other treatments. Above findings were completely similar in two seasons. Similar results have been reported by Chitravathi *et al*. (2014) for gum arabic and Haffez, (2016) for chitosan. Recording, the interaction between all used treatments and storage period, Results indicate that sweet pepper fruits obtained from treated chitosan 0.5 % and gum arabic 10% didn't show any decay until 21 days of cold storage with no significant difference between them. However, the decay in the untreated fruits appeared after 7 days of storage period in two seasons.

Table 3. Effect of edible coating treatments on decay (score) of sweet pepper fruits during cold storage period in 2021 and 2022 seasons.

Treatments	Storage period (days)					Mean
	0	7	14	21	28	
	First season					
Aloe vera Gel 4%	1.00 h	1.00 h	1.67 f-h	2.33 d-g	3.00 c-e	**1.80 C**
Aloe vera Gel 6%	1.00 h	1.00 h	2.67 c-f	3.00 c-e	3.67 bc	**2.32 B**
Chitosan 0.5 %	1.00 h	1.00 h	1.00 h	1.00 h	1.33 gh	**1.07 D**
Chitosan 1 %	1.00 h	1.00 h	2.33 d-g	2.67 c-f	3.33 b-d	**2.17 BC**
Gum arabic 5%	1.00 h	1.00 h	1.00 f-h	2.67 c-f	3.33 b-d	**1.96 BC**
Gum arabic 10%	1.00 h	1.00 h	1.00 h	1.00 h	1.33 gh	**1.07 D**
Control	1.00 h	2.00 e-h	3.33 b-d	4.33 ab	5.00 a	**3.13 A**
Mean	**1.00 D**	**1.15 D**	**1.95 C**	**2.43 B**	**3.00 A**	
Second season						
Aloe vera Gel 4%	1.00 f	1.00 f	1.00 f	2.67c-e	3.33 bc	**1.80 B**
Aloe vera Gel 6%	1.00 f	1.00 f	1.00 f	2.67 c-e	3.33 bc	**1.80 B**
Chitosan 0.5 %	1.00 f	1.00 f	1.00 f	1.00 f	1.33 f	**1.07 C**
Chitosan1 %	1.00 f	1.00 f	2.00 d-f	2.67 c-e	3.00 cd	**2.07 B**
Gum arabic 5%	1.00 f	1.00 f	1.00 f	2.67 c-e	3.33 bc	**1.80 B**
Gum arabic 10%	1.00 f	1.00 f	1.00 f	1.00 f	1.33 f	**1.07 C**
Control	1.00 f	2.00 d-f	3.33 bc	4.33 ab	5.00 a	**3.13 A**
Mean	**1.00 D**	**1.15 D**	**1.48 C**	**2.43 B**	**2.95 A**	

Values with same letter(s) are not significantly different at P≤ 0.05 level; using Tukey's multiple range test.

Fruit firmness:

According to the data in Table 4, fruit firmness reduced significantly as the storage period was extended. Gad EL-Rab (2013) found similar findings with sweet peppers. In terms of the effect of edible coating treatments, results show that the chitosan 0.5 % and gum Arabic 10% treatments offered highest mean values of fruit firmness when compared to other treatments and untreated control, with no notable difference between them in two seasons. Chitosan 1 % and untreated control had the lowest mean value of firmness, with no major difference between them in the second season only. These findings were consistent across both seasons and agreed with Abad Ullah *et al*. (2017) for gum arabic and Djioua *et al*. (2010) for chitosan. Gum arabic solution significantly maintained stiffness by acting as water loss barrier. Abad Ullah *et al.* (2017). The interplay between edible coating treatments and storage periods had a considerable effect on firmness. After 21 days of cold storage, data revealed that fruits treated with chitosan 0.5 % and gum arabic 10% treatments were the most noticeable in preserving fruit firmness throughout storage in the two seasons, whereas the untreated control had the least value of fruit firmness.

Table 4. Effect of edible coating treatments on fruit firmness (kg/cm^2) of sweet pepper fruits during cold storage period in 2021 and 2022 seasons.

Treatments	Storage period (days) 0	7	14	21	28	Mean
	First season					
Aloe vera Gel 4%	7.68 a	5.12 ef	4.53 h-j	4.28 j-l	3.93 l	**5.11 C**
Aloe vera Gel 6%	7.68 a	5.75 c	5.22 e	4.77 f-i	4.37 i-k	**5.56 B**
Chitosan 0.5 %	7.68 a	6.58 b	5.72 cd	5.08 ef	4.57 h-j	**5.93 A**
Chitosan 1 %	7.68 a	6.28 b	5.35 c-e	4.78 f-h	4.27 j-l	**5.67 B**
Gum arabic 5%	7.68 a	6.66 b	5.22 e	4.53 h-j	4.08 kl	**5.64 B**
Gum arabic 10%	7.68 a	6.68 b	5.73 c	5.01 ef	4.37 i-k	**5.90 A**
Control	7.68 a	5.32 de	4.58 g-j	3.12 m	2.57 n	**4.65 D**
Mean	**7.68 A**	**6.056 B**	**5.19 C**	**4.52 D**	**4.02 E**	
	Second season					
Aloe vera Gel 4%	7.13 a	4.91 c	4.52 c-e	3.93 gh	3.33 ij	**4.76 C**
Aloe vera Gel 6%	7.13 a	4.88 c	4.52 c-e	4.01 f-h	3.78 h	**4.87 C**
Chitosan 0.5 %	7.13 a	6.82 a	5.61 b	4.73 cd	3.94 gh	**5.60 A**
Chitosan 1 %	7.13 a	4.57 c-e	3.88 gh	3.76 h	3.00 j	**4.47 D**
Gum arabic 5%	7.13 a	5.53 b	4.87 c	3.96 gh	3.75 h	**5.05 B**
Gum arabic 10%	7.13 a	6.83 a	5.45 b	4.76 cd	3.97 f-h	**5.63 A**
Control	7.13 a	4.80 c	4.25 e-g	3.73 hi	2.58 k	**4.50 D**
Mean	**7.13 A**	**5.48 B**	**4.73 C**	**4.11 D**	**3.50 E**	

Values with same letter(s) are not significantly different at P≤ 0.05 level; using Tukey's multiple range test.

Surface color:

Data in Table (5) indicate that there was a significant decrease in L value for all treatments during storage. These results were true in the two seasons and confirm those of Shehata *et al*. (2019) on sweet pepper fruits. Concerning the impact of postharvest treatments, the highest value of L was achieved from fruits dipped in chitosan 0.5 percent and gum Arabic 10%, with no significant variations in color during storage at 10°C. However, lowest L value obtained from untreated control resulting in a deeper color. Coating treatments, cold storage and treatment interaction had a substantial impact on color of sweet pepper fruit. Sweet pepper fruit lightness (L) coated

Table 5. Effect of edible coating treatments on lightness (L* value) of sweet pepper fruits during cold storage period in 2021 and 2022 seasons.

Treatments	Storage period (days) 0	7	14	21	28	Mean
	First season					
Aloe vera Gel 4%	53.37 a	50.73 a-f	49.64 b-h	48.87 d-i	47.60 e-i	**50.04 BC**
Aloe vera Gel 6%	53.37 a	50.43 a-f	49.55 c-i	48.85 d-i	46.72 g-j	**49.78 C**
Chitosan 0.5 %	53.37 a	53.06 ab	51.09 a-d	50.80 a-e	48.84 d-i	**51.43 AB**
Chitosan 1 %	53.37 a	50.94 a-e	50.03 a-g	48.57 d-i	47.56 e-i	**50.09 BC**
Gum arabic 5%	53.37 a	49.51 c-i	48.74 d-i	47.25 f-i	46.39 h-j	**49.05 C**
Gum arabic 10%	53.37 a	52.51 a-c	52.02 a-d	50.72 a-f	49.91 a-g	**51.71 A**
Control	53.37 a	50.40 a-f	46.13 ij	43.39 jk	42.37 k	**47.13 D**
Mean	**53.37 A**	**51.08 B**	**49.60 C**	**48.35 D**	**47.06 E**	
	Second season					
Aloe vera Gel 4%	52.32 a	50.25 a-f	48.96 d-h	47.99 f-j	46.92 h-k	**49.29 CD**
Aloe vera Gel 6%	52.32 a	49.20 c-g	47.51 g-k	46.66 i-k	45.45 kl	**48.23 E**
Chitosan 0.5 %	52.32 a	51.91 ab	51.35 a-c	51.44 a-c	49.87 b-f	**51.38 A**
Chitosan 1 %	52.32 a	50.68 a-d	50.12 a-f	49.33 c-g	48.23 e-j	**50.13 BC**
Gum arabic 5%	52.32 a	48.83 d-i	48.17 e-j	46.86 h-k	46.26 j-l	**48.49 DE**
Gum arabic 10%	52.32 a	52.32 a	51.68 ab	50.32 a-e	48.80 d-i	**51.09 AB**
Control	52.32 a	47.43 g-k	46.47 jk	45.36 kl	44.17 l	**47.15 F**
Mean	**52.32 A**	**50.09 B**	**49.18 C**	**48.28 D**	**47.10 E**	

Values with same letter(s) are not significantly different at P≤ 0.05 level; using Tukey's multiple range test.

10% gum Arabic and chitosan 0.5 % exhibited higher $L*$ value than control fruit. These results were true in two seasons and in agreement with those reported by Hernandez-Munoz *et al*. (2008) for chitosan, Hedayati and Niakousari (2015) for gum Arabic. The data in Table (6) show that extending the storage duration increased the b value significantly in both seasons. With increased storage time, the color of sweet pepper fruits became fully yellow, which could be related to the breakdown of chlorophyll and the synthesis of carotenoids, a pigment that contributes to the yellow color in fruit. (Muharrem *et al*., 2005). Changes in b values of sweet pepper fruits during storage are indicator of senescence. Concerning effect of postharvest treatments, data reveal that all treatments had lowest value of $b*$ indicating delays color change. While untreated control fruits had a full yellow appearance after 28 days at 10°C (the highest b value). In contrast, the surface color of fruits dipped in chitosan at 0.5 % and gum arabic 10% never exceeded light yellow color (the lowest b value) at the same period, it is mean chitosan at 0.5 % and gum arabic 10% were the most effective for reducing change rate of yellow color. These results were true in the two seasons and in agreement with Fard *et al.* (2010) for chitosan and Hedayati and Niakousari (2015) for gum arabic.

Table 6. Effect of edible coating treatments on b value of sweet pepper fruits during cold storage period in 2021 and 2022 seasons.

Treatments	Storage period (days)					Mean
	0	7	14	21	28	
	First season					
Aloe vera Gel 4%	30.85 s	34.68 op	39.26 g-i	40.99 c-f	41.65 b-d	**37.49 B**
Aloe vera Gel 6%	30.85 s	35.62 m-o	37.90 i-l	39.86 e-h	41.46 b-e	**37.14 BC**
Chitosan 0.5 %	30.85 s	32.00 rs	34.61 op	39.12 g-j	41.28 b-e	**35.57 D**
Chitosan 1 %	30.85 s	33.45 p-r	36.72 l-n	38.65 h-k	42.33 bc	**36.40 C**
Gum arabic 5%	30.85 s	34.06 o-q	37.10 k-m	39.39 f-i	40.49 d-g	**36.54 C**
Gum arabic 10%	30.85 s	32.61 qr	35.38 no	38.81 g-k	41.30 b-e	**35.63 D**
Control	30.85 s	37.49 j-l	41.38 b-e	42.87 b	45.49 a	**39.62 A**
Mean	**30.85 E**	**34.27 D**	**37.48 C**	**39.96 B**	**42.00 A**	
Second season						
Aloe vera Gel 4%	32.23 n	35.46 l	38.61 g-j	40.30 b-f	41.47 bc	**37.61 B**
Aloe vera Gel 6%	32.23 n	35.19 l	38.67 f-j	39.12 f-i	41.53 b	**37.35 B**
Chitosan 0.5 %	32.23 n	33.30 mn	35.96 kl	37.61 ij	39.89 c-g	**35.80 D**
Chitosan 1 %	32.23 n	34.37 lm	35.89 kl	39.39 e-h	41.09 b-d	**36.60 C**
Gum arabic 5%	32.23 n	35.09 l	35.91 kl	38.55 f-j	41.28 b-d	**36.55 C**
Gum arabic 10%	32.23 n	33.10 mn	35.22 l	37.73 ij	41.00 b-e	**35.85 D**
Control	32.23 n	37.43 jk	39.78 d-g	41.48 bc	44.45 a	**39.07 A**
Mean	**32.23 E**	**34.85 D**	**37.15 C**	**39.12 B**	**41.53 A**	

Values with same letter(s) are not significantly different at P≤ 0.05 level; using Tukey's multiple range test.

Total soluble solids percentage (TSS) %:

Data in Table (7) show that extending the storage time resulted in a considerable drop in TSS in both seasons. These findings are consistent with those of Gad EL-Rab (2013) for sweet pepper fruits. In terms of effect of postharvest treatments, data revealed that sweet pepper fruits dipped in chitosan at 0.5% and gum Arabic at 10% retained more TSS content with no significant differences between them followed by fruits dipped in Aloe vera gel 4% and 6% with no significant differences between them. Untreated control gave the lowest value of TSS. These results are true in the two seasons and were in agreement with Shiri *et al*. (2013) for chitosan and Gurjar *et al.* (2018) for gum Arabic. generally, the interaction among postharvest treatments and storage length was significant; whereas, after 3 weeks of storage at 10°C, the interaction was no longer significant., sweet pepper fruits dipped in chitosan at 0.05% and gum Arabic at 10% recorded the highest value of TSS content with no significant differences between them, while untreated control gave lowest ones at same period.

Table 7. Effect of edible coating treatments on TSS (%) of sweet pepper fruits during cold storage period in 2021 and 2022 seasons.

Treatments	Storage period (days)					Mean
	0	7	14	21	28	
	First season					
Aloe vera Gel 4%	7.23 a	6.63 c-h	6.47 e-j	6.27 h-l	5.83 no	**6.49 B**
Aloe vera Gel 6%	7.23 a	6.80 b-e	6.50 d-i	6.02 l-n	5.87 m-o	**6.48 B**
Chitosan 0.5 %	7.23 a	6.98 a-c	6.70 b-f	6.63 c-g	6.20 j-n	**6.75 A**
Chitosan 1 %	7.23 a	6.50 d-i	6.30 g-l	6.02 l-n	5.60 o	**6.32 C**
Gum arabic 5%	7.23 a	6.40 f-k	6.23 i-m	6.03 k-n	5.63 o	**6.31 C**
Gum arabic 10%	7.23 a	7.07 ab	6.85 b-d	6.65 c-g	6.20 i-n	**6.80 A**
Control	7.23 a	6.12 j-n	6.02 l-n	5.63 o	5.05 p	**6.01 D**
Mean	**7.23 A**	**6.64 B**	**6.44 C**	**6.18 D**	**5.77 E**	
Second season						
Aloe vera Gel 4%	6.70 a	6.50 a-d	6.30 c-f	6.00 f-j	5.70 j-l	**6.24 C**
Aloe vera Gel 6%	6.70 a	6.40 b-e	6.30 c-f	6.10 f-h	5.87 g-k	**6.28 BC**
Chitosan 0.5 %	6.70 a	6.67 ab	6.60 a-c	6.40 b-e	5.90 g-k	**6.45 A**
Chitosan1 %	6.70 a	6.17 d-g	5.80 h-l	5.60 kl	5.50 lm	**5.95 D**
Gum arabic 5%	6.70 a	6.17 d-g	5.77 i-l	5.47 lm	5.20 m	**5.86 D**
Gum arabic 10%	6.70 a	6.65 ab	6.40 b-e	6.37 b-e	6.03 f-j	**6.43 A**
Control	6.70 a	6.10 e-i	5.63 kl	5.20 m	4.80 n	**5.69 E**
Mean	**6.70 A**	**6.39 B**	**6.11 C**	**5.85 D**	**5.57 E**	

Values with same letter(s) are not significantly different at P≤ 0.05 level; using Tukey's multiple range test.

Total carotenoids content:

Data in Table (8) demonstrate that total carotenoid levels in sweet pepper fruits increased at start of storage until 21 days of cold storage at 10°C and then declined until conclusion of storage in both seasons; similar observations were obtained by Gad EL-Rab (2013). In both seasons, there were substantial differences between postharvest treatments and untreated control. In both seasons, untreated control had the lowest total carotenoids levels. Antunes *et al*. (2012) achieved comparable results. In general, 10% gum arabic and 0.5% chitosan treatments.

Table 8. Effect of edible coating treatments on total carotenoids (mg/100g fresh weight) of sweet pepper fruits during cold storage period in 2021 and 2022 seasons.

Treatments	Storage period (days)					Mean
	0	7	14	21	28	
	First season					
Aloe vera Gel 4%	2.50 jk	2.62 h	2.78 de	2.88 c	2.43 k	**2.65 C**
Aloe vera Gel 6%	2.50 jk	2.62 h	2.79 de	2.98 a	2.54 ij	**2.69 B**
Chitosan 0.5 %	2.50 jk	2.66 gh	2.76 e	2.90 bc	2.72 e-g	**2.71 AB**
Chitosan 1 %	2.50 jk	2.65 h	2.79 de	2.96 ab	2.52 j	**2.68 B**
Gum arabic 5%	2.50 jk	2.63 h	2.74 ef	2.89 c	2.68 f-h	**2.69 B**
Gum arabic 10%	2.50 jk	2.61 hi	2.75 ef	2.90 bc	2.84 cd	**2.72 A**
Control	2.50 jk	2.62 h	2.79 de	2.74 ef	2.24 l	**2.58 D**
Mean	**2.50 E**	**2.63 C**	**2.77 B**	**2.90 A**	**2.57 D**	
Second season						
Aloe vera Gel 4%	2.68 m	2.76 lm	3.51 e-g	3.57 de	3.37 i	**3.18 C**
Aloe vera Gel 6%	2.68 m	2.75 m	3.42 hi	3.47 f-h	3.43 g-i	**3.15 C**
Chitosan 0.5 %	2.68 m	2.89 k	3.61 d	3.70 bc	3.62 cd	**3.30 A**
Chitosan 1 %	2.68 m	2.71 m	3.52 ef	3.61 d	3.41 hi	**3.18 C**
Gum arabic 5%	2.68 m	2.84 kl	3.47 f-h	3.51 e-g	3.64 cd	**3.23 B**
Gum arabic 10%	2.68 m	2.84 k	3.47 f-h	3.88 a	3.75 b	**3.32 A**
Control	2.68 m	2.71 m	3.41 hi	3.42 hi	3.23 j	**3.09 D**
Mean	**2.68 D**	**2.78 C**	**3.49 B**	**3.59 A**	**3.49 B**	

Values with same letter(s) are not significantly different at P≤ 0.05 level; using Tukey's multiple range test.

There was no significant variation in total carotenoids contents between these treatments that resulted in preserving total carotenoid contents throughout storage conditions. In terms of the interaction among postharvest different treatments period on total carotenoid content, data in Table 8 show that sweet pepper fruits treated with 10% gum arabic and 0.5 % chitosan were most effective treatments in preserving total carotenoid content at the end storage. These findings hold true for both seasons.

Ascorbic acid content:

Table (9) displays the influence of postharvest interventions on the ascorbic acid concentration of sweet pepper fruits throughout storage. The ascorbic acid concentration of sweet pepper fruits declined gradually as the cold storage period was extended in both seasons, similar to findings obtained by Shehata *et al*. (2009) on fresh-cut sweet pepper. All treatments were vastly more effective than untreated fruits at preventing ascorbic acid breakdown during storage (control). Furthermore, sweet pepper dipped in chitosan 0.5 percent and gum arabic 10% had higher fruit ascorbic acid content than other treatments and resulted in ascorbic acid retention. These findings apply to both seasons. In both seasons, the untreated control had the lowest values. Table 9 shows that sweet pepper treated with chitosan 0.5 % and gum Arabic 10% was the most efficient treatment in minimizing ascorbic acid loss during all storage period conditions in both seasons.

Table 9. Effect of edible coating treatments on ascorbic acid (mg/100 g) of sweet pepper fruits during cold storage period in 2021 and 2022 seasons.

Treatments	Storage period (days)					Mean
	0	7	14	21	28	
	First season					
Aloe vera Gel 4%	167.3 a	146.0 c-e	138.0 fg	134.7 g-i	130.0 hi	143.2 BC
Aloe vera Gel 6%	167.3 a	147.3 b-d	136.0 f-h	135.3 g-i	129.3 i	144.5 B
Chitosan 0.5 %	167.3 a	153.3 b	142.0 d-f	141.0 d-g	140.0 e-g	148.5 A
Chitosan 1 %	167.3 a	139.3 fg	136.7 fg	134.7 g-i	120.7 j	139.7 D
Gum arabic 5%	167.3 a	138.7 fg	136.0 f-h	136.0 f-h	135.3 g-i	142.7 CD
Gum arabic 10%	167.3 a	166.7 a	147.0 b-d	142.0 d-f	141.3 d-f	148.2 A
Control	167.3 a	148.7 bc	130.0 hi	113.3 k	101.7 l	133.1 E
Mean	167.3 A	148.6 B	138.0 C	134.0 CD	128.3 D	
Second season						
Aloe vera Gel 4%	182.0 a	155.3 c-e	153.0 c-f	153.3 c-f	150.7 c-f	158.9 B
Aloe vera Gel 6%	182.0 a	156.7 b-d	150.3 c-f	149.0 d-f	144.7 fg	156.5 BC
Chitosan 0.5 %	182.0 a	174.7 a	165.3 b	158.7 bc	155.3 c-e	163.7 A
Chitosan 1 %	182.0 a	152.3 c-f	151.3 c-f	147.0 ef	137.0 gh	154.0 C
Gum arabic 5%	182.0 a	155.3 c-e	152.7 c-f	152.0 c-f	146.0 f	157.6 BC
Gum arabic 10%	182.0 a	181.3 a	156.3 b-d	155.3 c-e	146.0 f	163.6 A
Control	182.0 a	157.3 b-d	145.3 fg	130.0 h	116.7 i	149.7 D
Mean	182.0 A	161.8 B	153.3 C	149.0 D	142.3 E	

Values with same letter(s) are not significantly different at P≤ 0.05 level; using Tukey's multiple range test.

DISCUSSION

Weight loss percentage:

According to the findings of this study, the drop in the percentage weight loss can be linked to loss of water, which is particularly quick to evaporate (Vasey, 2006). Weight loss is a normal result of horticulture products catabolism and is attributed to respiration and other senescence-related metabolic functions during cold storage (Watada & Qi, 1999). Reduced the weight loss in gum Arabic covered fruit could be attributed to stomatal and guard cell blockage, which reduced active metabolic processes and respiration. Furthermore, effect of semipermeable coating during respiration, moisture loss and solute transfer across the membrane (Amirthaveni & Palak, 2016). It is also possible that this is due to creation of a thin coating covering fruit, which limits moisture loss, lowers gas exchange, and so suppresses metabolic activity, resulting in lesser weight loss (AL-Juhaimi *et al*., 2012). Lowest weight loss in chitosan coated fruits due to that edible coating creates a modified atmosphere with a higher concentration of carbon dioxide and reduced oxygen around produce which slows down metabolic processes and transpiration (Haffez, 2016).

General appearance:

Shriveling, wilting, color change, and degradation could all cause a reduction in overall look during storage

(Banaras *et al*., 2005). The preservation of overall look by applying chitosan or gum Arabic may be attributable to effect of these treatments on weight loss, enzyme degradation, respiratory activity and microbial rot of fruits (Antunes *et al*., 2012) on fresh-cut sweet peppers.

Decay:

Results indicate that sweet pepper fruits obtained from treated chitosan 0.5 % and gum arabic 10% didn't show any decay till 21 days of storage. These findings could be attributed to the fruits' ongoing chemical and metabolic changes, such as the transition of complex chemicals into simpler forms that are more susceptible to fungal infection (Wills *et al*., 1998). These findings are consistent with those of Djioua *et al*. (2010), who found that antibacterial act of chitosan coating was more successful in reducing mango degradation during storage. Chitosan coating treatments in strawberries cause host resistance (Fajardo *et al.,* 1998). Also, Chien *et al.* (2007) and Meng *et al*., (2008) found that chitosan coating can form a film on the pepper surface and this film acts as a barrier, to protect the pepper from pathogen infection, which reduces decay during storage. Huang *et al*. (2021) found that gum arabic coating has a preventive effect in reducing fungal infection due to its ability to reduce the attacks from pathogenic fungi.

Fruit firmness:

Slow breakdown of proto-pectin to lower molecular fractions that are more soluble in water may be responsible for loss in fruit firmness, which is directly related to pace of softening of the fruits (Wills *et al*., 1998). In general, the hardness of vegetables is mostly determined by turgidity and weight loss. In other terms, softening is caused in part by turgor loss and chemical changes in the cell wall. Fruit softening is caused by deterioration of cell structure, cell wall composition, and intracellular contents (Seymour *et al*., 1993) and is a biochemical process involving the hydrolysis of pectin and starch by enzymes such as wall hydrolases. Depolymerisation or shortening of chain length of pectin compounds happens when the fruit ripens, accompanied by increases in pectin esterase and polygalacturonase activities (Yaman & Bayoindirli, 2002). Gum arabic may have an effect because it boosts cell wall turgor pressure and stabilizes cell membrane. AL-Juhaimi *et al*. (2012). Xing *et al*. (2011) discovered that peppers treated with chitosan had considerably lower malondialdehyde (MDA) levels and relative leakage rates, both of which are indicators of membrane integrity, than the control fruit. AL-Juhaimi *et al.* (2012) found that gum arabic treatment considerably preserved the firmness of the fruits, operated as a barrier against water loss, and prevented softening of the fruit as well as enzyme hydrolysis of pectin and starch.

Surface color:

Fard *et al.* (2010) discovered that chitosan coating reduced color loss in bell peppers and delayed green pepper degeneration as measured by exterior appearance. Furthermore, Xing *et al*. (2011) discovered that chitosan coating had a stronger control effect on lowered chlorophyll concentration in all treatments. A higher L value in coated sweet pepper fruit highlights the capacity of edible coatings to postpone chlorophyll breakdown and carotenoids synthesis. The green color change in pepper could be attributed to the conversion of chloroplasts to chromoplasts as the pigment content of pepper fruit varies as it ripens. These findings clearly demonstrate the efficiency of edible coatings in enhancing the visual appearance of sweet pepper fruit by balancing lower b values with greater L values. Our findings support those of Ali *et al.* (2010), who discovered that tomatoes coated with gum Arabic delayed color change due to reduced respiration. It was also demonstrated that coating a bell pepper with chitosan reduced the color change. Furthermore, Al-Juhaimi *et al*. (2012) found that cucumber coated with 5-20% gum arabic kept its bright green color for 12 days in cold storage.

Total soluble solids percentage (TSS) %:

TSS concentration may have decreased during storage due to a greater rate of sugar loss through respiration than water loss through transpiration (Wills *et al*., 1981). According to Shiri *et al*. (2013) and Gurjar *et al*. (2018), effect of chitosan or gum Arabic in preserving the TSS of fruits during storage may be related to these materials' lower rate of respiration and physiological changes of fruit during storage. Greater TSS levels in sweet peppers coated with edible coated material may be attributed to reduced respiration, which slows the fluctuations in TSS contents (Yonemato *et al*., 2002).

Total carotenoids content:

Previous research found that fruits dipped in gum Arabic 10% and chitosan 0.5 percent maintained their complete carotenoid content after storage. These results come from a gum Arabic or chitosan coat that delayed the ripening process by slowing down respiration and so retained a larger amount of total carotenoids until 21 days of storage. Results are consistent with those acquired by Ali *et al*. (2013), who discovered that changes in fruit color at end of storage occurred more slowly in gum Arabic treatment, although colors of untreated fruits quickly changed. The early increase in total carotenoids in control fruit shows that those fruits ripened earlier than those treated with gum Arabic or chitosan, as reported in a prior study where gum Arabic and chitosan coated fruit yielded better quality outcomes (Ali *et al*., 2010). This could be because sweet peppers treated with gum Arabic and chitosan reduced color loss and delaying green color degradation during storage, lowering their rate of ripening and deterioration. (Kays, 1991).

Ascorbic acid content:

Wills *et al*. (1981) hypothesize that the decline in ascorbic acid level during storage is due to high metabolic activity during storage as it is respired. This drop may also be attributed to faster rate of sugar loss via respiration than water loss via transpiration. (Wills *et al*., 1998).

CONCLUSION

Based on the previous findings, it is possible to conclude that sweet pepper fruits treated with 10% gum arabic and 0.5 % chitosan are a promising technique for preserving fruit quality attributes and did not display any changes in appearance of fruits after 21 days of storage at 10ºc without decay.

REFERENCE

A.O.A.C. (1990). Quality of Official Analytical Chemists, Washington DC. USA.

A.O.A.C. (2000). Association of Official Analytical Chemists. Washington DC. International 17th Edition, Revision I.

Abad Ullah N.; A. Abbasi; M. Shafique & A. A. Qureshi (2017). Influence of Edible Coatings on Biochemical Fruit Quality & Storage Life of Bell Pepper cv. (*Yolo Wonder*). *Journal of Food Quality,* Volume 2017, Article ID 2142409, 11 pages

Abbott, J.A. (1999). Quality measurements of fruits & vegetable *Postharvest Biology and Technology,* 15, 207-225.

Ali A.; M. Maqbool; S. Ramachandran & P. G. Alderson (2010). Gum arabic as a novel edible coating for enhancing shelf-life & improving postharvest quality of tomato (*Solanum lycopersicum* L.) fruit. *Postharvest Biology and Technology,* 58, 42–47.

Ali A.; T. M. M. Mahmud; S. Kamaruzaman & Y. Siddiqui (2011). Effect of chitosan coatings on the physico-chemical characteristics of Eksotika II papaya (*Carica papaya* L.) fruit during cold storage. *Food Chemistry*, 124, 620–626.

Ali A.; N. Zahid; S. Manickam; Y. Siddiqui; PG. Alderson & M. Maqbool (2013). Efectiveness of submicron chitosan dispersions in controlling anthracnose & maintaining the quality of dragon fruit. *Postharvest Biology and Technology,* 86(6), 147–153

Al-Juhaimi F.; K. Ghafoor & E. E. Babiker (2012). Effect of gum arabic edible coating on weight loss, firmness & sensory characteristics of cucumber (*Cucumis sativus* L.) fruit during storage. *Pakistan Journal of Botany,* 44, 1439-1444.

Amirthaveni M. & Palak Daga (2016). Effect of Aloe vera Gel & Gum Arabic Coating on Shelf Life & Nutrient Content of Green Capsicum (*Capsicum annuum* L.). *Indian Journal of Research in Food Science and Nutrition,* Vol.3, N. 2. Pp 37-43.

Antunes, M.D.; M.G. Miguel; A.M. Cavaco; V. Pantazis; S. Timianis & A.S. Siomos (2012). Effect of some dip treatments on the nutritional properties of fresh- cut tomato & pepper during storage. *Acta Horticulturae,* No. 934:627-632.

Ardakani, D. Maryam & Y. Mostofi (2019). Postharvest application of chitosan & Thymus essential oil increase quality of the table grape cv. 'Shahroudi'. *Journal of Horticulture and Postharvest Research,*

Atress, Amal S. H. & M. M. Attia (2011). Effect of 1-methylcyclopropene & hot water treatments on retarding ripeness of cantaloupe fruits during cold storagre. *Egyptian Journal of Agricultural Research,* 89 (3), 1089-1103.

Banaras, M.; P.W. Bosland & N.K. Lownds (2005). Effects of harvest time & growth conditions on storage & post-storage quality of fresh peppers (*Capsicum annuum* L.). *Pakistan Journal of Botany,* 37(2), 337-344.

Benítez, S.; I. Achaerandio; F. Sepulcre & M. Pujolà (2013). Aloe vera based edible coatings improve the quality of minimally processed 'Hayward' kiwifruit. *Postharvest Biology and Technology,* 81, 29–36.

Ceponis, M.J.; R.A. Cappellini & R.A. Lightner (1987). Disorders in fresh pepper shipments to the New York market. *Plant Disease,* 71, 380-382.

Chien, P. J.; F. Sheu & H. R. Lin (2007). Coating citrus (*Murcott tangor*) fruit with low molecular weight chitosan increases postharvest quality & shelf life. *Food Chemistry,* 100, 1160–1164.

Chitravathi K.; O.P. Chauhan & P.S. Raju (2014). Postharvest shelf-life extension of green chillies (*Capsicum annuum* L.) using shellac-based edible surface coatings. *Postharvest Biology and Technology. Volume 92,* Pages 146-148

Chong, J. X.; L. Shaojuan & Y. Hongshun (2015). Chitosan combined with calcium chloride impacts fresh-cut honeydew melon by stabilising nanostructures of sodium-carbonate-soluble pectin. *Food Control*, 53, 195-205.

Cisneros-Zevallos, L.; M. E. Saltveit & J. M. Krochta (1997). Hygroscopic coatings control surface white discoloration of peeled (minimally processes) carrots during storage. *Journal of Food Science,* 62, 363– 366.

Djioua, T.; F. Charles; M. Freire; H. Filgueiras; M.N. Ducamp-Collin & H. Sallanon (2010). Combined effects of postharvest heat treatments & chitosan coating on quality of fresh-cut mangoes (Mangifera indica L.) *International Journal of Food Science and Technology,* 45, 849-855.

Ergun M. & F. Satici (2012). "Use of Aloe vera gel as biopreservative for 'Granny Smith' & 'Red Chief' apples," *Journal of Animal and Plant Sciences,* vol. 22, no. 2, pp. 363–368.

Fajardo, J.E.; T.G. McCollum; R.E. McDonald & R.T. Mayer (1998). Differential induction of proteins induction of proteins in orange flaved by biologically based elicitors & challenged penicilliumdigitatumsacc. *Biological Control,* 13,143-151.

Fard, K.G.; M. Kamari; Ghasemnezhad & R.F. Ghazvini (2010). Effect of chitosan coating on weight loss & postharvest quality of Green pepper (*Capsicum annum* L.) *Acta Horticulturae,* 877, ISHS.

Ghafoor, K.; J. E. Jung & Y.H. Choi (2008). Effects of gellan, xanthan, & λ-carrageenan on ellagic acid sedimentation, viscosity, & turbidity of 'Campbell Early' grape juice. *Food Science and Biotechnology,* 17, 80-84.

Guilbert, S. & N. Gontard (2005). Agro-polymers for edible & biodegradable films: review of agricultural polymeric materials, physical & mechanical characteristics. In: Innovations in Food Packaging. (Ed.): J.H. Han. Elsevier Academic, Oxford, UK, pp. 263-276.

Gurjar P.S.; J. Bharati Killadi Lenka & D.K. Shukla (2018). "Effect of Gum Arabic Coatings on Physico-Chemical & Sensory Qualities of Guava (Psidium guajava L) cv. Shweta". *International Journal of Current Microbiology and Applied Science*, 7(5), 3769-3775

Haffez, M.M., (2016). Effect of postharvest treatments on quality & storability of fresh cut cantaloupe. Ph.D. Thesis, *Faculty of Agricultural, Ain Shams University,* Cairo.

Hardenburg, R.E.; A. Watada & C.Y. Wang (1990). The commercial storage of fruits, vegetables, florist & nursery stocks. Washington, DC: US Department of Agriculture, *Agriculture Handbook,* No. 66. pp. 23-25.

Hedayati S. & M. Niakousari, (2015). "Effect of Coatings of Silver Nanoparticles & Gum Arabic on Physicochemical & Microbial Properties of Green Bell Pepper (*Capsicum annuum*)," *Journal of Food Processing and Preservation,* vol. 39, no. 6, pp. 2001–2007.

Hernandez-Munoz, P.; E. Almenar; V. Del; Valle, D. Velez & R. Gavara (2008). Effect of chitosan coating combined with postharvest calcium treatment on strawberry (*Fragaria ananassa*) quality during refrigerated storage. *Food Chemistry*, 110, 428-435.

Hirano, S.; Y. Ohe & H. Ono (1976). Selective N-acylation of chitosan. *Carbohydrate Research,* 47, 315–320.

Huang Q.; Ch. Wan; Y. Zhang; Ch. Chen & J. Chen (2021). Gum Arabic Edible Coating Reduces Postharvest Decay & Alleviates Nutritional Quality Deterioration of Ponkan Fruit During Cold Storage. *Nutrition and Food Science Technology,* 8, article 717596.

Howard, L.R.; S.T. Talcott; C.H. Brenes & B. Villalon (2000). Changes in phytochochemical & antioxidant activity of selected pepper cultivars (*Capsicum species*) as influenced by maturity. *Journal of Agricultural and Food Chemistry,* 48, 1713-1720.

Kays, S. J. (1991). Secondary metabolic processes & products: An overview. In S.J. Kays (Ed.) Postharvest physiology of perishable plant products. Univ. *Georgia Athens.,* pp. 187-213.

Khaliq, G. M. T.; H. M. Muda Mohamed; P. Ghazali, Ding, & A. Ali, (2016). "Influence of gum arabic coating enriched with calcium chloride on physiological, biochemical & quality responses of mango (*Mangifera indica* L.) fruit stored under low temperature stress," *Postharvest Biology* & *Technology,* vol. 111, pp. 362–369.

Maan, A.A.; A. Nazir; M.K.I. Khan; T. Ahmad; R. Zia; M. Murid & M. Abrar (2018). The therapeutic properties & applications of Aloe vera: A review. *International journal of herbal medicine,* 12, 1–10.

Marpudi S.L.; L.S.S. Abirami; R. Pushkala and N. Srividya (2011). Enhancement of storage life & quality maintenance of papaya fruits using Aloe vera based antimicrobial coating. *Indian Journal of Biotechnology,* 83-89.

Mc Collum, J.P., (1980). Producing Vegetable Crop 3rd ed. The Interstate Printer & Publisher. USA., P. 607.

MC Guire, R. G. (1992). Reporting of objective color measurements. *Hort-Science,* 27, 1254-1255.

Meng X.H.; B. Q. Li; J. Liu & S.P. Tian (2008). Physiological responses & quality attributes of table grapefruit to chitosan preharvest spray & postharvest coating during storage. *Food Chemistry*, 106, 501–508.

Miller, K. S.; S. K. Upadhyaya and J. M. Krochta (1998). Permeability of d-limonene in whey protein films. *Journal of Food Science,* 63, 244–247.

Mirhosseini H. & BT. Amid (2012). A review study on chemical composition & molecular structure of newly plant gum exudates & seed gums. Food Res Int [Internet]. 46(1), 387-98. Available from: ttp://dx.doi.org/10.1016/j. foodres.2011.11.01

Muharrem. E.; J. Jeong; D. J. Huber & D. J. Canliffe. (2005). Suppression of ripening & softening of Galia melons by 1-Methylcyclopropene applied at pre-ripe or ripe stages of development. *HortScince,* 40 (1), 170-175.

NORA, A. Gad EL-Rab (2013). Effect of some pre & postharvest treatments on yield, quality & storability of Sweet Pepper Productivity & Quality. M.Sc. Thesis, *Faculty of Agricultural, Cairo University,* Cairo, Egypt, 101 p.

Rinaudo, M. (2006). Chitin & chitosan properties & applications. *Progress in Polymer Science,* 31, 603-632.

Risse, R.A. & W.R. Miller (1986) Individual film wrapping of Florida cucumbers, eggplant, peppers & tomatoes for extending shelf life. *Journal of Plastic Film and Sheeting,* 2, 164-171.

Seymour, G.B.; J.E. Taylor & G.A. Tucker. (1993). Biochemistry of Fruit Ripening. *Chapman and Hall,* London, UK.

Shehata, S.A.; M.Y. Hashem; M.S. Emam & M.A. Rageh (2009). Effect of hot water & calcium chloride treatments on fresh cut sweet pepper during cold storage. *Annals of Agricultural Sciences,* Moshtohor, 47(3), 445-455.

Shehata, S.A.; M.I.A. Ibrahim; M.M. El-Mogy & K.F. Abd El-Gawad (2013). Effect of hot water dips & modified atmosphere packaging on extend the shelf life of bell pepper fruits. *Wulfenia Journal,* 20 (3), 315-328.

Shehata, S. A.; M. EL- M. Saad; M.A. Saleh & S. A. Atala (2019). Effect of some Biostimulants Materials on Growth, Yield, Quality & Storability of Sweet Pepper. *Annals of Agricultural Sciences,* Moshtohor, Vo. 57(1), 77 – 88

Shiri, M.A.; D. Bakhshi; M. Ghasemnezhad; M. Dadi; A. Papachatzism & H. Kalorizou, (2013). chitosan coating improves the shelf life & postharvest quality of table grape (*Vitis vinifera*) cultivar shahroudi. *Turkish Journal of Forestry,* 37, 148-156.

Snedecor, G.W. & W.G. Cochran, (1980). Statistical Methods. 8th Ed., Iowa State Univ. Press, Ames, Iowa, USA., 476 p.

Susenoa Natalia, Emma Savitria , Lanny Sapeia , Karsono S. Padmawijayaa (2014). Improving shelf-life of Cavendish Banana Using Chitosan Edible Coating. *Procedia Chemistry*, (9)113 – 120

Turner D.; Y. Ni; KM. Yates, & I. Tizard (2004). Isolation & characterization of structural components of Aloe vera L. leaf pulp. *International Immuno Pharmacology,* 4(14), 1745-55.

Valverde JM.; D. Valero; D. Martinez-Romero; F. Guillen; S. Castillo & M. Serrano (2005). Novel edible coating based on Aloe vera gel to maintaintable grape quality & safety. *Journal of Agricultural and Food Chemistry,* 53, 7807-7813.

Vasey, C. (2006). The water prescription: For health, vitality, & rejuvenation. United States: *Healing Arts Press,* March 20, Publication Date: October 5, 2010.

Ullah, N.; A. Parveen; R. Bano; I. Zulfiqar; M. Maryam; S. Jabeen; A. Liaqat & S. Ahmad (2016). In vitro & in vivo protocols of antimicrobial bioassay of medicinal herbal extracts: A review. *Asian Pacific Journal of Tropical Disease,* 6, 660–667.

Watada, A.E. & L. Qi, (1999). Quality of fresh-cut produce. *Postharvest Biology and Technology,* 15, 201-205.

Wills, R.B.H.; T.H. Lee; D. Grahum; W.B. McGlasson & E.G. Hall (1981). Postharvest, An introduction to physiology & handling of fruits & vegetables. Inc. Westport, Connectiut, USA.

Wills, R.; Mcglasson, B.; Graham, D. & Joyce, D. (1998). Post-harvest: An Introduction to the Physiology & Handling of fruit, Vegetables & Ornamentals. Wallingford: CAB International, 262 pp.

Xie, M.H.; J.M. Zhu & J.M. Xie (2004). Effect factors on storage of green pepper. *Journal of Gansu Agricultural University,* 3, 300-305.

Xing, Y.G.; X. H. Li; Q.L. Xu; J. Yung; Y.Q. Lu & Y. Tang (2011). Effect of chitosan coating enriched with cinnamon oil on qualitative properties of sweet pepper (*Capsicum annum* L.), *Food Chemistry*, 124,1443-1450.

Yaman, O. & L. Bayoindirli, (2002). Effects of an edible coating & cold storage on shelf-life & quality of cherries. *Lebensmittel Wissenschaft und-Technologie*, 35, 146–150

Yonemato Y. & H. K. Higuchi, (2002). Effect of storage temperature & coating on ethylene production, respiration & Shelf-Life in cherimoya fruit-Japanese soc for *HortScince,* 71, 643-650.

Yulianingsih R.; DM. Maharani; LC. Hawa & L. Sholikhah (2013). Physical quality observation of edible coating made from aloe vera on cantaloupe (*Cucumis melo* L.) minimally processed. *Pakistan Journal of Nutrition,* 12, 800–5.