KEEPING THE QUALITY AND EXTENDING SHELF-LIFE OF STRAWBERRIES FRUIT BY USING ARBIC GUM AS EDIBLE COATING

Gomaa M. A., Abdelrasoul E.A. and Gomaa Maha M.
Food Technol. Res. Inst., Agric. Res. Cent., Giza, Egypt

ABSTRACT

Coating of strawberries fruit with Arabic gum has been found to enhance their shelf-life and postharvest quality. Arabic gum in aqueous solutions of 5, 10, 15 and 20% were applied as a novel edible coating to gardener-mature strawberries which were stored at 20 ◦C and 80–90% Relative humidity (RH) for 10 days. Fruit coated with 10% Arabic gum showed a significant ($P \leq 0.05$) delay in changes of weight, firmness, titratable acidity, soluble solids concentration, ascorbic acid content, decay percentage and color development compared to uncoated fruit control. Sensory evaluation proved the efficacy of 10% Arabic gum coating by maintaining the overall quality of strawberries fruit during the storage period. The results suggest that by using 10% Arabic gum as an edible coating, the ripening process can be delayed and the storage life of strawberries stored at 20 ˚C and at the breaker stage can be extended up to 10 days without any spoilage and off-flavor.

Keywords: Strawberries, shelf-life, Arabic gum, edible coating.

INTRODUCTION

According to Food and Agriculture Organization (FAO) of the United Nations, world production of strawberries has exceeded 4 million tons since 2007. In 2010, approximately 28 percent of the total production came from the United States, the largest producer among countries where statistical data are available. Other major strawberry producing countries are Turkey, Spain, Egypt, Korea, Mexico, and Poland. Although Spain, Korea, and Poland still have a high production, the growth has been slow or even negative. For example, Spain's production in 2010 was 275,000 tons, down 12 percent from ten years ago. Korea showed an upward trend, but only grew 14 percent during the same period. In contrast, Turkey, Egypt, and Mexico experienced a high growth in the same period. Production in Egypt increased more than 3 times from 70,000 tons to 240,000 tons, and Turkey's production rose from 130,000 tons to 300,000, becoming the second largest strawberry producer in the world **(Bouffard, 2012)**. Strawberries are one of the most popular summer fruits worldwide that are characterized with unique and highly desirable taste and flavor. They are rich in polyphenols and anthocyanins, vitamins and amino acids. The main characteristics related to the quality of the ripe strawberries are their texture, flavor (organic acids and soluble sugars content) and color **(Campaniello *et al.*, 2008; Koyuncu and Dilmaçünal, 2010)**. Due to their very active metabolism strawberries are highly perishable and have high physiological postharvest activities which lead to short ripening and senescence periods that make their marketing a challenge (**Garcia *et al*., 1998**). Loss of quality in this fruit is connected with its sensitivity to fungal infection and susceptibility to water loss, bruising, mechanical injuries and texture softening due to the lack of protective rind (**Atress *et al*., 2010**).

Several techniques such as modified atmosphere, controlled atmosphere, edible coatings, low temperature, ionizing radiation, plant growth regulators and chemicals have been used to reduce deterioration, extend the shelf-life and maintain quality of strawberries fruits (**Singh and Singh, 2012**). Modified or controlled atmosphere are common techniques for retaining quality and extending fruit shelf-life **(Pesis *et al*., 2000)**. However, in modified or controlled atmosphere CO2accumulation can causes off flavor and anaerobic respiration **(Bender *et al*., 1994)**. Fungicides has been used to reduce postharvest decay and extend the storage life of fruit, although fungicide resistance by pathogens, along with consumer concerns about possible risks associated with the residue of fungicides on the fruit surface **(Charles *et al*., 1994)**.

Arabic gum is a polysaccharide natural secretion from Acacia species and used in industries for film forming, emulsification and encapsulation purposes (**Motlagh *et al*., 2006)**. Arabic gum coatings effectively maintained total antioxidant and phenolic contents in tomato fruit **(Ali *et al*., 2013)** and in papaya **(Addai *et al*., 2013)**. Arabic gum treatment reduced browning, loss of ascorbic acid and total phenolic contents of tomato slices **(Eltoum and Babiker, 2014)**. Calcium chloride has been extensively used in the fruits and vegetables sector for whole and fresh-cut commodities as preservative and firming agent. It has been observed that calcium is associated with fruit firmness, stress tolerance, ripening and senescence **(Martin-Diana *et al*., 2007)**. Low temperature caused physiological disorders that are related to calcium content. Calcium chloride dip treatment reduced flesh browning of peach fruit **(Manganaris *et al.,* 2007)**. Calcium chloride combined with chitosan maintained a high level of vitamin C and reduced sensitivity to chilling injury of peach fruit during refrigerated storage **(Ruoyi *et al*., 2005)**.

Although, to the best of our knowledge, there is no report about the combined effect of Arabic gum coating on post-harvest qualities of strawberries fruits. Therefore, the objective of this study was to elucidate the effect of Arabic gum pretreatments on physiological, biochemical and quality aspects of strawberries fruits stored at 80-90% RH for 20ºC for 10 days.

MATERIALS AND METHODS:

Strawberry (*Fragaria ananassa* Duch.) was chosen for this study. Strawberries were purchased from a local market at Kafr El-Sheikh City, Egypt and selected for uniformity of size and ripeness, and fruit with apparent injuries were removed. Fruit were stored at 4±1 ◦C prior to processing. All materials used for the coating in this study were of food grade, including Arabic gum powder (KB-120, Food Grade) was supplied by Elattar Trading Co., Kafr El-Sheikh, Egypt. The chemicals were obtained from El-Gomhoria Co. for Chemical and Drugs, Tanta City, Egypt, are of analytical grade. All of these experiments were conducted in the laboratory of Food Technology Research Institute at Sakha, ARC, Egypt.

Preparation of edible film:

Arabic gum coating solutions at 5, 10, 15, 20% (w/v) from 5, 10, 15 and 20 g of powder was dissolved in 100 mL distilled water. The solutions were stirred with low heat (40 ˚C) for 60 min on a magnetic stirrer/hot plate (Model: HTS-1003), then filtered to remove any undissolved impurities using a vacuum flask. After cooling to 20˚C, glycerol monostearate (1.0%) was added as a plasticiser to improve the strength and flexibility of the coating solutions. The pH of the solutions was maintained at 5.6 using 1N NaOH. Arabic gum films were prepared according to the method described by **(Ghulam *et al*., 2015).** The coating treatments were selected according to preliminary experiments in strawberry to assure adherence and steadiness of the coatings. Fruits were washed with 0.01% sodium hypochlorite water solutions for 2 min and then air dried at ambient temperature for one hour. The strawberries were randomly divided into five lots each one containing kilogram of fruits. The strawberry fruits were immersed in each concentration of gum Arabic coating solution (5, 10, 15 and 20%) for 2–3 min and the coating solution was applied uniformly on the whole surface, while control fruit were dipped in purified water. After treatment, fruit were air-dried for 1 h. All fruits were packed in plastic boxes (40 × 30 × 12 cm) covered with polyethylene film (0.02 mm thickness) to maintain relative humidity (RH) were stored at 20±1 ˚C and 80–90% RH for 10 days. The samples were taken at zero time and after every two days from storage intervals for 10 days of shelf-life.

Decay percentage:

The decay percentage of uncoated and coated fruits wer calculated as the number of decayed fruit divided by initial number of all fruit multiplied by 100 **(El-Anany *et al*., 2009).**

Weight loss percentage:

Strawberry samples (10 fruits per replication) were weighed at initial and at the end of each storage interval. The difference between initial and final fruit weight was considered as total weight loss during that storage interval and calculated as percentages on a fresh weight basis by the standard (**AOAC, 2005)** method.

Fruit firmness:

Fruits firmness were assessed by using an Instron Universal Testing Machine (Model 5543 P5995 USA) connected with a computer. The force required to penetrate 10 mm inside the fruit using a probe diameter of 6 mm was measured. The machine was set with compression mode and speed of 20 mm min−1. Readings were recorded on 3 points in the equatorial region of the whole fruit with skin removed and the results were expressed in terms of force recorded in Newtons (N). (**Zapata *et al.*, 2008).**

Color:

Color was determined according to **McGuire, (1992)** using the Hunter Lab System, Miniscan XE Plus colorimeter model (Model: 45/0-5, Reston Virginia, USA). Values were recorded as L* [white (100) to black (0)] and hue angle (h◦) [h◦ represents red-purple at an angle of 0◦, yellow at 90◦, bluish green at 180◦, and blue at 270◦]. The mean values of L* and h◦ were obtained from two different points along the strawberry circumference. Before readings were taken during each sampling day, the Miniscan XE Plus colorimeter was calibrated using calibration black and white tiles with values of X = 79.0, Y = 83.9 and Z = 87.9.

Soluble solids, titratable acidity and ascorbic acid:

The strawberries from each treatment were ground in a blender and juice from the fruits were used to determine the soluble solids concentration (SSC) using a Palettle Digital Refractometer (Model: PR-32_, Atago Co., Ltd. Japan). The machine was standardised using purified water before readings were taken. Titratable acidity (TA) was determined using the method of **(Ranggana, 1977)** by measuring the amount of 0.1N NaOH. Ascorbic acid contents were estimated using the dye 2,6-dichlorophenol–indophenol titration (DCPIP) method after **(Ranggana, 1977)**.

Sensory evaluation:

Sensory evaluation of the fruits for pulp color, texture, flavor and overall acceptability for all the samples were done at the end of the storage period using the method of **Bai *et al*. (2003)** with some modifications. Based on their consistency and reliability of judgment, a panel of seven judges with age ranging from 25 to 40 years was set up. Panelists were asked to score the difference between samples where 0–2 represented extreme dislike; 3–5 fair; 6–8 good; and 9 excellent for pulp color, texture, flavour and overall acceptability.

Statistical analysis:

The experiment was conducted using a completely randomized design (CRD) with four replications. The data were subjected to analysis of variance (ANOVA) using the computer software MSTAT-C **(Freed and Scott, 1986)**, while least significant difference (LSD) tests were used to compare differences between treatments at the 95% confidence level of each variable **(Chase and Brown, 1997).**

RESULTS AND DISCUSSION

Decay incidence (DI):

There was no visible sign of decay in coated or control fruit until two day of the storage period (Table 1). Thereafter, the coatings significantly ($P \leq 0.05$) reduced decay compared to control fruit and fruit treated with 10% Arabic gum coating remained disease free even after 8 days of storage. Many of the control fruit (68.37%) were spoiled after 6 days of storage.

Table 1: Effect of different concentrations of Arabic gum coatings on strawberries fruit decay (%) during storage

Treatments (%)	Storage time (day)					
	0	2	4	6	8	10
Control	00.00 m	00.00 m	36.45 e	68.37 c	92.89 b	100.00 a
5	00.00 m	00.00 m	00.00 m	27.34 f	38.23 e	46.86 d
10	00.00 m	00.00 m	00.00 m	00.00 m	00.00 m	09.24 k
15	00.00 m	00.00 m	00.00 m	04.06 l	09.23 k	12.23 k
20	00.00 m	00.00 m	03.00 m	10.56 k	17.10 j	22.67 f

Treatments are deferment concentrates of Arabic gum .
Values in table not followed by the same letter are significantly different ($P \leq 0.05$).

The decrease in decay percentage was probably due to the effect of the coating on delaying senescence, which makes the commodity more vulnerable to pathogenic infection as a result of loss of cellular or tissue integrity (**Tanada-Palmu and Grosso, 2005**). **Bai *et al*. (2003)** found that 'Gala' apples coated with 10% zein maintained their quality, similar to that achieved with the use of commercial shellac formulation, and extended apple shelf-life compared with non-coated controls. Also, **Tanada-Palmu and Grosso (2005)** noted that wheat gluten coatings and films extended the shelf-life of strawberries and delayed senescence for up to 16 days when stored at 7–10 ◦C.

Weight loss percentage:

Fruit coated with 10 and 15% Arabic gum had less weight loss during storage than the control (Table 2; P≤0.05) and weight loss increased gradually during the storage period. A significantly higher weight loss in 5 and 20% Arabic gum coatings was observed compared to 10 and 15% Arabic gum coatings, which could be explained by the thickness of coatings. The 5% Arabic gum coating was not so thick that it provided a sufficient barrier against moisture loss while the 20% Arabic gum coating was so thick that it completely covered the surface of the fruit. Similar results were reported by **Asgar *et al*. (2010)** who found that tomato fruit coated too thickly with a corn-zein film resulted in O_2 concentrations which were too low and excessive CO_2 concentrations, resulting in ethanol production. The primary reason for increased weight loss of thickly coated tomatoes might be the generation of heat and production of end-products from anaerobic fermentation **(Weichmann, 1987)**. The basic mechanism of weight loss from fresh fruit and vegetables is by vapor pressure at different locations **(Yaman and Bayoindirli, 2002)**, although respiration also causes a weight reduction **(Pan and Bhowmilk, 1992)**. This reduction in weight loss was probably due to the effects of the coating as a semi-permeable barrier against O_2, CO_2, moisture and solute movement, thereby reducing respiration, water loss and oxidation reaction rates **(Baldwin *et al*,. 1999; Park, 1999)**. The results are in agreement with the findings of **Ben-Yehoshua (1969)** for oranges coated with wax and those of **Banks (1984)**, who reported that sucrose ester-based coatings on banana fruit extended their storage life through reduction in water loss and a modification of the internal atmosphere.

Table 2: Effect of Arabic gum coatings on weight loss (%) of strawberries fruit during storage

Treatments (%)	**Storage time (day)**					
	0	**2**	**4**	**6**	**8**	**10**
Control	00.00	05.78^{gh}	07.64^{e}	09.56^{b}	10.55^{a}	11.42^{a}
5	00.00	04.54^{hi}	06.84^{efg}	08.09^{bc}	09.26^{bc}	10.62^{ab}
10	00.00	04.02^{hi}	05.43^{g}	06.98^{ef}	07.67^{d}	09.03^{bc}
15	00.00	03.07^{i}	05.06^{gh}	06.04^{fg}	07.12^{de}	08.53^{bc}
20	00.00	03.04^{i}	04.66^{h}	06.00^{fg}	06.94^{ef}	08.12^{cd}

Treatments are a deferment concentrates of the Arabic gum.
Values in table not followed by the same letter are significantly different (P≤0.05).

Fruit firmness:

Firmness of fruit significantly (P≤0.05) decreased with storage period for both treated and control fruit (Table 3). At the end of storage, control fruit clearly showed the lowest firmness. The maximum firmness was maintained by the 20% Arabic gum treated strawberry fruits until 6 day and after that time no significant differences were found among coated strawberries. Softening of fruits is due to deterioration in the cell structure, cell wall composition and intracellular materials **(Seymour *et al*., 1993)** and is a biochemical process involving the hydrolysis of pectin and starch by enzymes e.g. wall hydrolases. As the process of fruit ripening progresses, depolymerisation or shortening of chain length of pectin substances occurs with an increase in pectinesterase and polygalacturonase activities **(Yaman and Bayoindirli, 2002)**. Low levels of O_2 and high levels of CO_2 limit the activities of these enzymes and allow retention of the firmness during storage **(Salunkhe *et al*., 1991)**. In agreement with these findings, **Park *et al*., (1994)** reported that respiration and O_2 consumption of corn-zein coated tomatoes were lower than for non-coated tomatoes. Reduction in respiration rates of coated tomatoes could be responsible for delaying ripening which resulted in retention of firmness during storage. Similarly, **Tanada-Palmu and Grosso (2005)** reported that refrigerated strawberries coated with wheat gluten-based films retained their firmness better than control fruit.

Table 3: Effect of Arabic gum coatings on strawberries fruit firmness (*N*) during storage

Treatments (%)	**Storage time (day)**					
	0	**2**	**4**	**6**	**8**	**10**
Control	33^{a}	21^{d}	10^{f}	06^{g}	03^{h}	02^{h}
5	33^{a}	30^{b}	24^{c}	22^{d}	18^{e}	16^{e}
10	33^{a}	28^{b}	24^{c}	21^{d}	17^{e}	17^{e}
15	33^{a}	29^{b}	25^{c}	20^{d}	16^{e}	15^{e}
20	33^{a}	30^{b}	26^{c}	20^{d}	15^{e}	14^{e}

Treatments are a deferment concentrates of the Arabic gum.
N = Expressed in terms of force recorded in Newtons.
Values in table not followed by the same letter are significantly different (P≤0.05).

Color:

The lightness (*L**) gradually decreased during storage in both uncoated and coated fruits (data not shown). The highest decrease in lightness was observed in uncoated strawberries followed by 5% coated fruits, while the fruits coated with 10, 15 and 20% Arabic gum retained their lightness values at the end of the experiment. There was a significant (P≤0.05) decrease in lightness during the storage period. As the concentrations of Arabic gum increased the lightness value also increased. Significant (P≤0.05) changes were found in hue angle and the value of (h◦) decreased sharply in control as well as 5% Arabic gum coated strawberry until day 4 of storage, thereafter the reduction was slower (Table 4).

Table 4: Effect of Arabic gum coatings on color [hue angle (h°)] of strawberries fruit during storage

Treatments (%)	Storage time (day)					
	0	2	4	6	8	10
Control	118[a]	082[e]	061[f]	050[g]	041[h]	035[i]
5	118[a]	093[d]	078[e]	062[f]	051[g]	043[h]
10	118[a]	117[a]	117[a]	110[ab]	104[bc]	096[cd]
15	118[a]	117[a]	116[a]	115[a]	113[a]	111[ab]
20	118[a]	117[a]	116[a]	116[a]	115[a]	113[a]

Treatments are a deferment concentrates of the Arabic gum.
h = hue angle (h°) [h° represents red-purple at an angle of 0◦, yellow at 90◦, bluish green at 180◦, and blue at 270◦].
Values in table not followed by the same letter are significantly different (P≤0.05).

The hue angle was maintained in fruit coated with 10, 15 and 20% Arabic gum until day 8 of storage, with a subsequent slight decrease, however no significant differences were found between 15 and 20% Arabic gum treated strawberries. The color change in uncoated strawberries were enhanced and they attained pink to red color within 2–4 days of storage compared to the fruit coated with 5 and 10% Arabic gum (6–8 days) while the fruit coated with 15 and 20% remained green even after 10 days of storage. The mechanism behind this is not fully understood and needs further investigation. It is possible that Arabic gum provided a thick barrier against ethylene production and gas exchange between inner and outer environments, and therefore delayed the ripening of the fruit during storage. Similar results were observed by **Park *et al*. (1994)** when they stored tomatoes coated with a corn-zein film at 21 ˚C. Color is an important criterion of quality and consumer acceptability, especially with respect to tomatoes **(Aked, 2000)**. During ripening, the green chlorophyll pigment is degraded and there is accumulation of carotenoids, particularly lycopene giving the red color to the ripe tomato **(Khudairi, 1972)**. During ripening of tomatoes, high CO_2 levels decrease ethylene synthesis, which can delay color changes **(Buescher, 1979)**. In this study, coating of tomatoes with Arabic gum delayed color change, which was probably due to an increase in CO_2 and decrease in O_2 levels.

Soluble solids:

In general, there was a gradual increase in soluble solids concentration (SSC) during the complete storage period (Table 5). The SSC was significantly higher (P≤0.05) in control compared to coated fruits and the reduction in SSC in coated fruit was directly proportional to the concentration of the coating. The lowest SSC at the end of the storage period was recorded in fruit coated with 20% Arabic gum, and showed that the coatings provided an excellent semi-permeable film around the fruit, modifying the internal atmosphere by reducing O_2 and/or elevating CO_2 and suppressing ethylene production. Decreased respiration rates also slow down the synthesis and use of metabolites resulting in lower SSC **(Yaman and Bayoindirli, 2002)**.

Table 5: Effect of Arabic gum coatings on soluble solids (%) of strawberries fruit during storage

Treatments (%)	Storage time (day)					
	0	**2**	**4**	**6**	**8**	**10**
Control	04.4^{f}	05.7^{de}f	07.0^{cd}	08.2^{bc}	09.4^{ab}	10.8^{a}
5	04.4^{f}	05.1^{def}	05.9^{de}	07.0^{cd}	08.3^{b}	10.0^{a}
10	04.4^{f}	04.7^{f}	05.3^{ef}	05.9^{de}	07.1^{cd}	07.7^{cd}
15	04.4^{f}	04.8^{f}	05.0^{ef}	05.4^{ef}	05.9^{de}	07.2^{cd}
20	04.4^{f}	04.6^{f}	04.9^{ef}	05.4^{ef}	05.2^{ef}	06.4^{de}

Treatments are a deferment concentrates of the Arabic gum.
Values in table not followed by the same letter are significantly different ($P \leq 0.05$).

Titratable acidity:

The titratable acidity (TA) values of uncoated and coated fruits during storage decreased with storage time (Table 6) and the value was significantly higher ($P \leq 0.05$) in 20% Arabic gum treated fruit compared to the control. The increase in TA was directly proportional to the Arabic gum concentration. The low level of (TA) in control fruit compared to coated fruit suggests that the Arabic gum coating delayed ripening by providing a semi-permeable film around the fruit. Since organic acids, such as malic or citric acid, are primary substrates for respiration, a reduction in acidity is expected in highly respiring fruit **(El-Anany *et al*., 2009)**. It is also considered that coatings reduce the rate of respiration and may therefore delay the utilization of organic acids **(Yaman and Bayoindirli, 2002)**. Retention of titratable acidity has been reported previously for
various fruit treated with edible coatings and films **(Yaman and Bayoindirli, 2002; Tanada-Palmu and Grosso, 2005)**.

Table 6: Effect of Arabic gum coatings on titratable acidity (%) of strawberries fruit during storage

Treatments (%)	Storage time (day)					
	0	**2**	**4**	**6**	**8**	**10**
Control	0.36^{a}	0.35^{ab}	0.30^{de}	0.26^{fg}	0.23^{hi}	0.21^{ij}
5	0.36^{a}	0.33^{bc}	0.28^{ef}	0.24^{gh}	0.21^{i}	0.19^{j}
10	0.36^{a}	0.31^{cd}	0.29^{de}	0.25^{fg}	0.19^{j}	0.20^{ij}
15	0.36^{a}	0.34^{ab}	0.30^{de}	0.26^{fg}	0.21^{ij}	0.20^{ij}
20	0.36^{a}	036^{a}	0.31^{cd}	0.26^{fg}	0.22^{hij}	0.22^{hij}

Treatments are a deferment concentrates of the Arabic gum.

Values in table not followed by the same letter are significantly different (P≤0.05).

Ascorbic acid:

The ascorbic acid (vitamin C) content of coated and uncoated strawberry fruit increased to maximum after 8 days of storage and subsequently declined after 10 days (Table 7). The highest levels of ascorbic acid were observed in control fruits, closely followed by fruits coated with 5% Arabic gum. This increase in ascorbic acid content was in parallel with the increase in other parameters associated with ripening. In strawberries fruits, ascorbic acid content increases with maturity and stage of ripening **(Mathooko, 2003)**, however once fruits reach the full ripe stage, ascorbic acid content starts to decline **(AOAC, 1984)**. The slower increase in ascorbic acid in coated fruits suggests that the coating slowed down but did not prevent the synthesis of ascorbic acid during ripening. Similar slowing down of the increase in ascorbic acid during ripening has been reported with high CO_2 storage atmospheres for tomatoes **(Mathooko, 2003)**.

Table 7: Effect of Arabic gum coatings on ascorbic acid (mg/100g) of strawberries fruit during storage

Treatments (%)	Storage time (day)					
	0	2	4	6	8	10
Control	09.3^{k}	15.3^{ef}	18.2^{c}	20.4^{ab}	21.1^{a}	20.5^{ab}
5	09.3^{k}	14.2^{fg}	16.4^{de}	18.7^{c}	20.2^{ab}	19.7^{bc}
10	09.3^{k}	10.9^{jk}	12.3^{hi}	13.0^{gh}	13.9^{fgh}	12.8^{h}
15	09.3^{k}	09.8^{k}	10.8^{jk}	11.7^{ij}	12.5^{hi}	11.7^{ij}
20	09.3^{k}	09.9^{k}	10.7^{jk}	11.8^{ij}	12.6^{hi}	11.9^{hij}

Treatments are a deferment concentrates of the Arabic gum.
Values in table not followed by the same letter are significantly different (P≤0.05).

Sensory evaluation:

Sensory evaluation of uncoated and coated fruits at the end of the storage period revealed significant (P≤0.05) differences in pulp color, texture, flavor and overall acceptability (Table 8). The 10% Arabic gum coated fruit had the highest scores in all parameters after 10 days of storage, while those coated with 15 and 20% Arabic gum developed poor pulp color and inferior texture and had flavors. The latter fruit were not acceptable to the panel of experts. Compared with 10% Arabic gum, control fruit and fruit treated with 5% Arabic gum had lower scores for flavor and overall acceptability. These results suggest that Arabic gum up to10% can be used successfully as an edible coating for prolonging the shelf-life and improving strawberry fruit quality during storage at 10°C. Similar results were observed by **El-Anany *et al*. (2009)** when they treated ‘Anna’ apples with Arabic gum coating.

Table 8: Sensory evaluation of strawberries fruit after treatment with different concentrations of Arabic gum and 20 day of storage

Treatments (%)	Pulp color	Flavor	Texture	Overall acceptability
Control	2.3^{d}	1.6^{e}	1.2^{e}	1.5^{e}
5	4.3^{bc}	4.2^{bc}	3.6^{c}	3.5^{c}
10	8.2^{a}	8.0^{a}	8.5^{a}	8.3^{a}
15	4.4^{b}	4.3^{b}	4.2^{b}	4.3^{b}
20	3.9^{c}	4.1^{bc}	3.6^{c}	3.8^{c}

Treatments are a deferment concentrates of the Arabic gum.
Values in table not followed by the same letter are significantly different (P≤0.05).

CONCLUSION

The results of this study indicate that strawberries fruit coated with 10% Arabic gum showed a significant delay in the change of weight, firmness, titratable acidity, soluble solids concentration and color during storage at 20 °C as compared to uncoated control fruit. In addition, sensory evaluation showed that 10% Arabic gum coating maintained the overall quality of the strawberries fruit during storage. Further studies should be conducted on the gaseous exchange of Arabic gum coatings in relation to the development of new formulations and their application to different climacteric fruits and vegetables.

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الحفاظ على جودة ثمار الفراولة وإطالة فترة صلاحيتها باستخدام الصمغ العربي كغطاء صالح للأكل

محمد عبد الحميد حسن جمعة، السيد عوض شعبان عبد الرسول، مها محفوظ عبد الحميد جمعة

معهد بحوث تكنولوجيا الأغذية، مركز البحوث الزراعية، الجيزة، مصر.

الملخص العربي

درسنا الصمغ العربي كغطاء صالح للأكل، في تغطية ثمار الفراولة، بهدف الحفاظ على جودتها وزيادة عمرها التخزينى بعد الحصاد. حيث استخدمنا عدة تركيزات من محلوله، وهي 5 و10 و15و20٪ لتغطية ثمار الفراولة تم حصادها في مرحلة النضج البستاني (الأخضر)، ثم تخزينها بعد ذلك على درجة حرارة 20°م ورطوبة نسبية 80-90٪ لمدة عشرة أيام. أخذت عينات منها عند صفر و2 و4 و6 و8 و10 أيام بهدف معرفة تأثير تركيز الصمغ العربي (كغطاء) ومدة التخزين على بعض الخصائص الطبيعية والكيميائية كنسبة إتلاف الثمار، ونقص وزنها، وصلابتها، وتطور لونها، ونسبة حموضتها، ونسبة المواد الذائبة بها، ومحتواها من حامض الاسكوربيك، ومدى قبولها حسياً. وأوضحت الدراسة أن تركيز 10٪ من محلول الصمغ العربي كان الأكثر معنوية على كل الخصائص. وتشير النتائج إلى أن استخدام الصمغ العربي بتركيز 10٪ كغطاء صالح للأكل لتغطية ثمار الفراولة أدى إلى تأخير نضجها وبالتالي زيادة فترة صلاحيتها للاستهلاك عند تخزينها على درجة حرارة 20°م ورطوبة نسبية 80-90٪ ولمدة 10 يوم.