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Color and weight changes of fresh-cut banana slices coated by quince seed gum: Effect of concentration, storage temperature and duration

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Abstract

The consumer's acceptance significantly reduces during the storage of fresh cut fruits. Edible coating is one of the most innovative ways to maintain quality and improve shelf life of fresh fruits and vegetables. The objective of this study was to assess the suitability of quince seed gum (QSG) at different concentrations (0.5, 1 and 1.5%) as edible coatings for banana slices and to determine their influence on changes in physicochemical properties during storage at 4°C and 40°C. Data on shrinkage, weight loss and color were collected and subjected to statistical analysis. Banana slices which coated with 1% of QSG and stored at 4°C showed significantly better physicochemical characteristics. Higher temperatures result in more rapid changes of quality parameters. On the other hand, samples coated with gum reduced the weight loss and shrinkage during storage. It is recommended that 1% quince seed gum can be used to reduce the surface fresh-cut banana browning.

Keywords: Banana, Coating, Fresh fruits cut, Quince seed gum

Introduction

Fresh fruits and vegetable are susceptible to decay, and loss of their important beneficial components, if they are not preserved properly (Asnaashari, Tajik, & Khodaparast, 2015). Fruit decay is caused by several agents like loss of quality and shorten the shelf life, loss of water and moisture, process of Millard, texture damage and microbial contamination (Rojas-Graü, Tapia, & Martín-Belloso, 2008). Several techniques, like low temperature, controlled atmosphere packaging (CAP), and modified atmosphere packaging (MAP) were applied to maintain the quality of fresh food. However, each preservative technique has positive and negative effects on freshness and quality of fruits.

Edible coating exerts to maintain the quality and freshness of fruit slices and vegetables, hinder the microbial activity and decreasing metabolic processes like respiration in the fresh fruit. This technique used for increase the storage time of the fresh cut fruit (Fisk, Silver, Strik, & Zhao, 2008; Gonzalez-Aguilar et al., 2008; Vargas, Pastor, Chiralt, McClements, & Gonzalez-Martinez, 2008).

Edible coatings have demonstrated the capability of improving food quality and prolonging shelf life of fresh fruits and vegetables. Edible coatings can be used to help in the preservation of minimally processed fruits, providing a partial barrier to moisture, oxygen and carbon dioxide, improving mechanical handling properties, carrying additives, avoiding volatiles loss, and even contributing to the production of aroma volatiles (Olivas & Barbosa-Cánovas, 2005).

Gums are polysaccharides, which have high molecular weight and easily disperse in water, thus they can increase the viscosity of solutions (Asnaashari, Motamedzadegan, Farahmandfar, & Rad, 2016). Gums obtained from different sources (plant, epiphyte and animal extracts) are widely used in the food systems for various purposes, such as thickeners, stabilizers, gelling agents and texture modifiers. Hydrocolloids from plants have also the advantage over those from

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animals due to more acceptability by consumer. Plants seeds are a traditional and ancient source of gums (Koocheki, Taherian, Razavi, & Bostan, 2009).

Postharvest processes such as respiration can be reduced by coating with protective compound, by changing the atmosphere around the fruits, thereby delay ripening. Some researchers showed that edible coatings preserve quality and extended shelf life of fruits (Ali, Muhammad, Sijam, & Siddiqui, 2011; Brasil, Gomes, Puerta-Gomez, Castell-Perez, & Moreira, 2012), apples (Chiumarelli & Hubinger, 2014), strawberries (Gol, Patel, & Rao, 2013), red bell peppers (Poverenov et al., 2014), and guavas (Hong, Xie, Zhang, Sun, & Gong, 2012).

Quince seeds contain hydrocolloid, which is native of middle east which include Caucasus region, Iran, Dagestan, Syria, Afghanistan and Antalya (Trigueros, Pérez-Alvarez, Viuda-Martos, & Sendra, 2011). Experiment of quince seeds gum shows that its seeds have antioxidant compounds and have medicinal use, for diarrhea and stomach ulcers (Šarić-Kundalić, Dobeš, Klatte-Asselmeyer, & Saukel, 2011). Qum extracted from quince seed can apply for encapsulation of essential oil (Jouki, Mortazavi, Yazdi, & Koocheki, 2014), and have positive effect for removal of T-2 toxin in dermal of rabbit (Hemmati, Kalantari, Jalali, Rezai, & Zadeh, 2012). Study of quince seed gum shows this seed have several polysaccharide such as cellulose (Vignon & Gey, 1998).

Banana is a fruit usually growth in tropical, and popular among people. It includes mineral and micronutrient such as vitamin which are positive for health human. While harvested banana, they are unripe and placed at room temperature. Banana become decay quickly, especially to be ripe, during storage (Golding, Shearer, Wyllie, & McGlasson, 1998; Marriott & Palmer, 1980). Purpose of this work was to determine the effect of quince seed edible coating on quality and shelf life extension of cut slice banana and also maintain of moisture and its possible effect on discoloration and shrinkage of cut slice during storage.

Materials and Methods

Extraction and preparation of solution gum

Quince seed purchased from the local market at Mahmudabad in Iran. QSG prepared according to the method of (Jouki, Yazdi, Mortazavi, & Koocheki, 2013). About 10 g of quince seeds sieved and washed with its triple weight of ethanol (96%, w/v) for 5 min under constant stirring. Then ethanol was removed and the seeds dried in an oven at 45°C. Aqueous quince seed mucilage was extracted from whole seeds using distilled water (water to seed ratio of 30:1). Then, the swelled seeds were stirred with a rod paddle blender (Rondo-2500, KA702, France) at 6000 rpm and 50°C for 20 min to scrape the mucilage layer off the seed surface. The solutions were then filtered with cheese cloth and the obtained mucilage was dried by an oven at 45°C. Solution of gum (w/v) was prepared by slowly dissolving 0.5, 1, and 1.5 g gum powder in 100 ml distilled water and constant stirring at 45°C for 15 min. Then solution gum prepared placed in 4°C temperature.

Preparation of banana slices

Banana was purchase from local market (Mahmoudabad in Iran). Banana fruit for this study were selected based on uniformity in size and color and lack of spot. Banana slices was similar in size and shape. Then they were immersed into quince seed coating solution with different concentrations for one minute. Weight and diameter of each of samples is 3.5 to 5.5 g and 0.5 ± 0.05 cm.

Weight loss determination

Each slice banana was weighted on each inspector. Weight loss calculated by comparison the weight of coat sample at its initial condition and its final condition (Farahmandfar, Mohseni, & Asnaashari, 2017).

Shrinkage

Change of size and diameter toward smaller defined as shrinkage (Farahmandfar et al., 2017). Reason of this change was egress of banana moisture during storage, which cause change pressure balance between inside and outside banana. This stress leads shrinkage in material. Apparent shrinkage (Sapp) is defined as the ratio of the apparent volume at a given moisture content (V_{app}, m^3) to the initial apparent volume of materials before processing (V_{0app}, m^3):

$$S_{app} = \left(\frac{V_{app}}{V_{0app}} \right) \times 100 \qquad (1)$$

Analysis of color

The changes in color of banana slice was calculated by measuring the L*, a* and b* parameters (Eshghi, Asnaashari, Haddad Khodaparast, & Hosseini, 2014). Sample illumination was achieved with two fluorescent lights (10 W, 40 cm in length), were placed in a wooden box (0.5×0.5×0.5 m^3). The interior walls of the box were painted black to minimize background light. A color digital camera was located vertically at a distance of 20 cm from the sample (Panasonic, Model DMC-FS42, Japan). Since the computer vision system perceived color as RGB signals, which is device-dependent, the images taken were converted into L* (lightness/darkness), a* (redness/greenness) and b* (yellowness/blueness) units to ensure color reproducibility. The measure color parameters for estimate changes in total color and whiteness index (No, Meyers, Prinyawiwatkul, & Xu), based on following equation:

$$\Delta E = \sqrt{(L^* - L)^2 + (a^* - a)^2 + (b^* - b)^2} \qquad (2)$$

While L*, a* and b* are the color parameter values of the white standard backgrounds (L*= 93.49, a*= -0.25 and b*= -0.09) and L*, a* and b* are the color parameters of sample.

Statistical Analysis

For statistical analysis, a completely randomized factorial design with at least three replications for each treatment was applied. Analysis of variance (ANOVA) was performed to study the differences between the effects of coating, storage temperature and storage time on quality parameters of banana slice using (SPSS). Between groups means were analyzed by Duncan's multiple-range test. Statistical significance was set at 0.05 probability level.

Results and Discussion

Shrinkage

Shriveling and withering can cause loss of weight, lead to decrease consumer acceptance. The means of shrinkage percentage during storage at two temperatures of 4°C and 40°C are shown in Table 1 and 2. for coated banana slices sample and the control.

Table 1. Effect of coating treatment and storage time on shrinkage (%) at 4°C

	Storage time (hours)									
Treatments	**0**	**12**	**24**	**36**	**48**	**60**	**72**	**84**	**96**	**108**
Control	88±0.98^{a}	04±0.33^{a}	.66±0.36^{a}	.07±0.39^{a}	.99±0.09^{b}	.93±0.12^{d}	.66±0.64^{b}	.67±1.64^{a}	.48±0.96^{b}	72±0.44^{a}
QSMF 0.5%	02±3.93^{a}	34±3.79^{a}	.89±5.37^{a}	.92±3.76^{a}	.12±0.83^{a}	.57±1.83^{a}	.99±1.28^{a}	.12±1.43^{a}	.91±1.06^{a}	06±3.37^{a}
QSMF 1%	65±0.47^{a}	92±0.39^{a}	.46±0.87^{a}	.78±0.93^{a}	.48±0.72^{a}	.15±0.64^{b}	.74±2.67^{b}	.70±4.98^{a}	.09±0.17^{a}	70±1.03^{a}
QSMF 1.5%	78±0.38^{a}	30±0.20^{a}	.82±0.20^{a}	.47±0.37^{a}	.99±1.06^{a}	.74±0.99^{c}	66±1.66^{ab}	.39±1.73^{a}	.68±0.55^{a}	31±3.35^{a}

Different letters in each row show significant difference at P < 0.05. (C, Control/ Quince seed mucilage fraction)

The result of experimental showed with increasing the storage time, shrinkage value enhanced while the volume of banana slices became smaller. Moreover, as the temperature of the storage time increased, the shrinkage was also enhanced. So that, the rate of increasing shrinkage values of control samples and sample with 0.5% were higher than the other samples. However, the percentage of shrinkage at samples with higher concentrations of gum was lower, remarkably. The reason was that gum with higher concentrations could easily inhibit water loss. In this study, at temperatures 4°C and 40°C, samples with 1.5% of the gum showed the lowest shrinkage value. These results showed quince seed gum could be a marvelous barrier in banana slices.

Weight loss

Table 3 and 4 showed the effect of different coating and storage temperatures on weight loss. Results showed that it was a significant difference between control sample and coated samples at both temperatures 4 and 40°C, which explains that quince gum prevents the loss of water and moisture in coated samples. Although weight loss in control sample higher than all coated sample, in higher temperatures more changes of weight loss were happened. However, when fruit stored, its moisture was removed and caused weight loss. Coating the samples with quince seed gum in all concentrations was not change the weight loss significantly. However, at 1.5% of the quince seed gum, the weight loss was slightly lower. As it was shown Table 2, at high temperature (40°C), the rate of aspiration and metabolic process in banana was higher, that caused diminish substrates resulting into more decrease weight loss of banana. Indeed, one of the agent's effects to the weight loss is respiration. The principle mechanism of weight loss from fruit is exit of water from inside fruit to environment by vapor pressure at different locations in banana.

Color changes evaluation

Color change in fresh fruits is one of the reasons for the reduction of consumer acceptability during storage (Farahmandfar *et al*., 2017). Effect of edible coating and storage conditions on color parameter of fresh-cut banana was demonstrated by ANOVA Duncan test. The experimental results for the color changes in fresh-cut banana coated with the different concentrations of gum and uncoated samples by lightness L*, redness a*, yellowness b* and total color difference (ΔE) in the storage temperatures 4 and 40°C are shown in Figure 1 and 2. The results showed that the fresh-cut banana using coating and store at low temperature cause reduce of color changes. L* and b* changes increased with increasing time at both temperatures studied. Also, it was observed that with an increase in storage time, a* and ΔE increased. In this research, all of the coating samples reduced L* changes during storage.

Table 2. Effect of coating treatment and storage time on shrinkage (%) at 40°C.

	Storage time (hours)						
Treatments	**0**	**16**	**24**	**32**	**40**	**48**	**56**
Control	18.90±0.00^{Fa}	19.47±0.19^{Eab}	19.69±0.09^{Eab}	20.28±0.29^{Da}	21.89±0.00^{Cab}	26.28±0.60^{Bb}	31.49±0.13^{Aa}
QSMF 0.5%	19.85±3.62^{Ea}	21.49±2.81^{Eab}	22.66±3.45^{Eab}	25.65±4.93^{Da}	28.78±3.99^{Ca}	31.42±2.33^{Ba}	34.68±3.14^{Aa}
QSMF 1%	16.09±3.57^{Ea}	16.21±3.59^{Eb}	16.41±3.71^{Eb}	17.95±2.77^{Da}	19.62±1.43^{Cb}	27.65±0.19^{Bab}	33.19±3.29^{Aa}
QSMF 1.5%	21.78±0.89^{Ea}	22.94±1.00^{Ea}	24.66±2.47^{Da}	25.09±2.84^{Da}	27.71±3.74^{Ca}	32.95±2.62^{Ba}	36.61±2.07^{Aa}

* Means followed by the same capital letter is in line and the same lower case letter in the columns, do not differ statistically at P>0.05.

The data showed that with an increase of storage time, sample treated with concentration 1% of gum quince seed had the lowest value of L* changes. For example, L* changes of control, QSMF 0.5, 1 and 1.5% at the end of storage at 4°C were -16.21, -13.38, -12.28 and -12.7, respectively. The lowest value of b* changes was observed in 1% QSMF during time. The lowest and the highest changes of a* and ΔE have seen for sample treated with concentration 1% of gum and control, respectively. Usually, changes in L* value are appertained to tissue surface modifications caused by polyphenol oxidases activity, so this reduction can be relative to the obstacle formed by the coating on samples (Soliva-Fortuny, Lluch, Quiles, Grigelmo-Miguel, & Martín-Belloso, 2003).

Regarding L* changes, several researchers have indicated that a decrease in this parameter associated to an increase in pigment concentration and the using of a coating, since this act could restrict the action of polyphenol oxidase as an oxygen barrier (Rojas-Graü et al., 2008). L* values decreased for coated and uncoated sample during the storage time, possibly because of surface moisture loss, which could be caused seen darker color (Perdones, Sánchez-González, Chiralt, & Vargas, 2012).

Table 3. Effect of coating treatment and storage time on weight loss (%) at 4°C.

	Storage time (hours)									
Treatments	**0**	**12**	**24**	**36**	**48**	**60**	**72**	**84**	**96**	
Control	10.80±0.24^{a}	24.61±0.98^{a}	36.94±0.10^{a}	46.03±0.49^{a}	51.88±0.64^{a}	55.81±1.10^{a}	62.66±3.15^{a}	63.57±3.67^{a}	64.26±3.89^{a}	64.85±3.95^{a}
QSMF 0.5%	7.00±1.23^{b}	17.64±0.20^{b}	30.20±0.16^{b}	38.39±0.32^{b}	44.94±0.00^{b}	48.57±1.23^{b}	56.22±0.12^{b}	57.13±0.62^{b}	58.04±0.04^{a}	58.77±0.34^{a}
QSMF 1%	2.55±1.03^{c}	18.68±0.19^{b}	30.94±0.31^{b}	39.83±0.35^{b}	45.55±0.26^{b}	50.25±0.70^{b}	57.30±0.88^{b}	58.12±1.47^{ab}	58.74±1.78^{a}	59.04±1.63^{a}
QSMF 1.5%	3.98±0.02^{c}	14.46±0.50^{c}	30.92±2.11^{b}	40.56±1.57^{b}	47.07±1.90^{b}	51.99±2.08^{b}	58.17±1.37^{ab}	59.63±0.38^{ab}	59.75±1.83^{a}	59.96±1.54^{a}

Different letters in each row show significant difference at P < 0.05. (C, Control/ Quince seed mucilage fraction)

Table 4. Effect of coating treatment and storage time on weight loss (%) at 40°C.

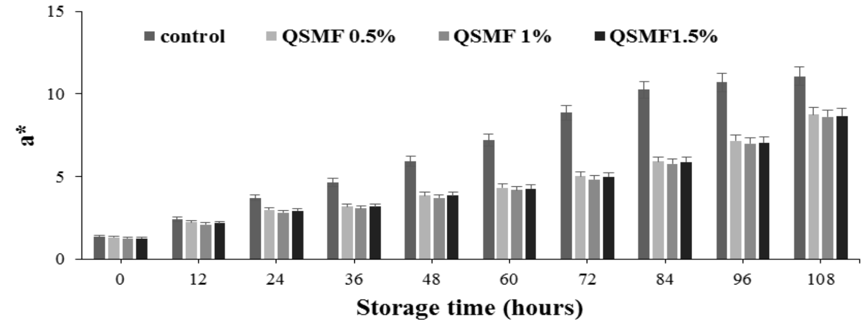
	Storage time (hours)							
Treatments	**0**	**16**	**24**	**32**	**40**	**48**	**56**	**64**
Control	48.47±0.42^{Da}	64.59±0.5^{Ca}	69.63±0.5^{Ba}	70.15±0.18^{Ba}	71.14±0.25^{Aa}	71.73±0.48^{Aa}	72.03±0.59^{Aa}	72.12±0.72^{Aa}
QSMF 0.5%	41.89±1.88^{Eab}	57.55±1.35^{Dab}	65.96±1.50^{Ca}	70.15±0.21^{Ba}	70.56±0.47^{Aa}	70.98±0.45^{Aa}	71.19±0.45^{Aa}	71.29±0.60^{Aa}
QSMF 1%	42.58±2.63^{Dab}	59.55±1.40^{Cab}	67.45±1.39^{Ba}	68.73±0.48^{Ba}	69.32±0.56^{Aa}	69.61±0.44^{Aa}	69.81±0.45^{Aa}	69.90±0.33^{Aa}
QSMF 1.5%	35.79±6.22^{Db}	51.88±7.97^{Cb}	62.12±8.64^{Ba}	64.03±9.74^{Ba}	67.26±6.34^{Aa}	67.64±6.08^{Aa}	67.84±6.10^{Aa}	68.03±5.84^{Aa}

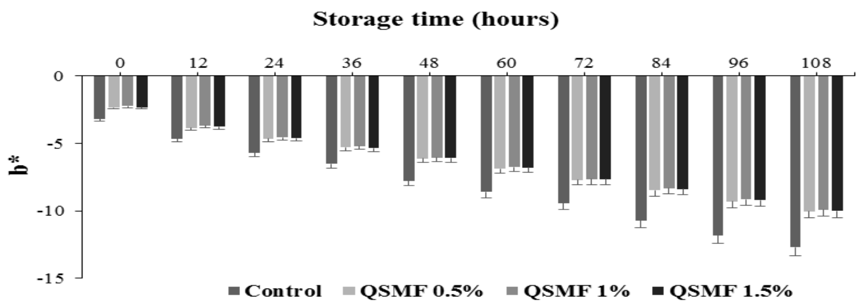
* Means followed by the same capital letter is in line and the same lower case letter in the columns, do not differ statistically at P>0.05.

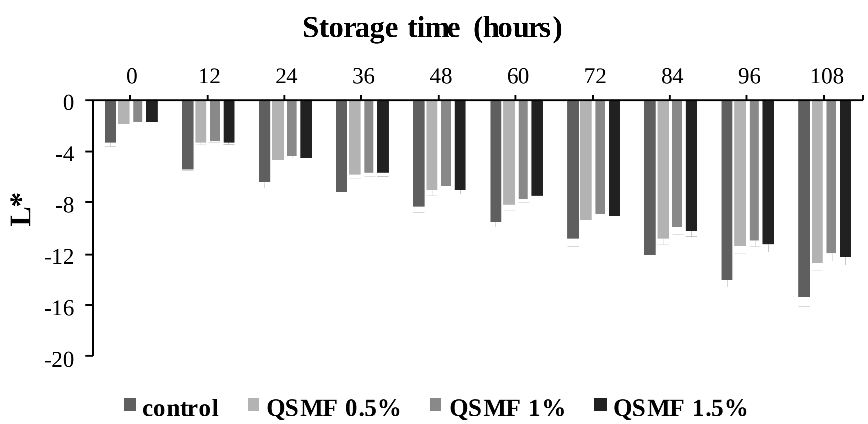
In similar research de Aquino, Blank, and de Aquino Santana (2015) exhibited that an edible chitosan coating blending guavas coated with edible coating containing 2.0% cassava starch, 2.0% chitosan and 3.0% Lippia gracilis Schauer genotype mixtures had more effect in preventing the browning of during storage than no coating. As a* value changes was shown, an increase of a* means a higher browning index (Rojas-Graü, Sobrino-López, Soledad Tapia, & Martín-Belloso, 2006). Control samples exhibit forceful increase in a* values that associate to changes in the browning index, whiles for the treated samples with quince seed gum showed significant difference ($p > 0.05$). So, coating have the best effective property against changes a* increase for 1% QSMF with 8.67 at 4°C after 120 hours of storage time and 13.02 in 40°C after 84 hours of storage time. Rojas-Graü et al. (2008) express that higher a* value is pointing to increasing browning index in apples during storage. As a consequence, this study is recommended that coating with quince seed gum (1%) could be used to reduce the surface fresh-cut banana browning. This affection is most probably ascribed to a decrease in oxygen accessible (Zambrano-Zaragoza, Mercado-Silva, Gutiérrez-Cortez, Castaño-Tostado, & Quintanar-Guerrero, 2011).

Conclusion

This study showed that several physicochemical quality changes of stored banana slice were dependent on the storage conditions (time and temperature) and used concentration of coating. Most changes were accelerated at higher temperatures, and hence, lower temperatures suggested better choices for storage. Quince seed gum has beneficial effects on maintain quality and extend the shelf life. Samples of coated with gum reduced the weight loss and shrinkage during storage. In addition, the results of this study is recommend that coating with quince seed gum (1%) could be used to reduce the surface fresh-cut banana browning.







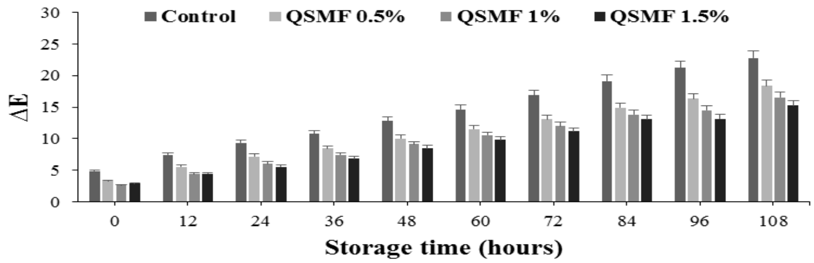
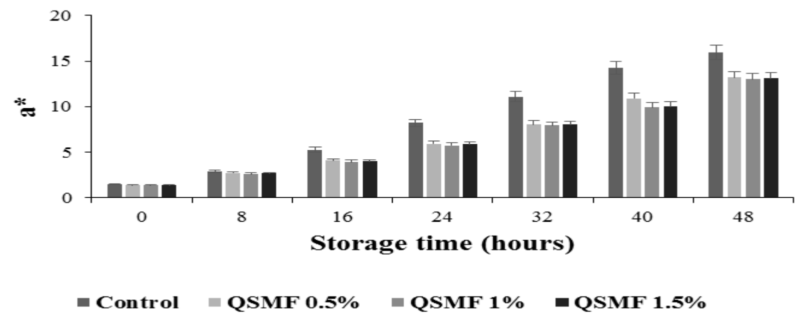
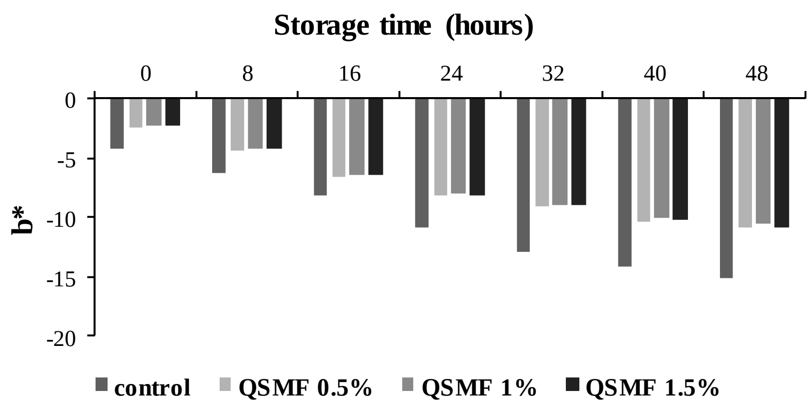
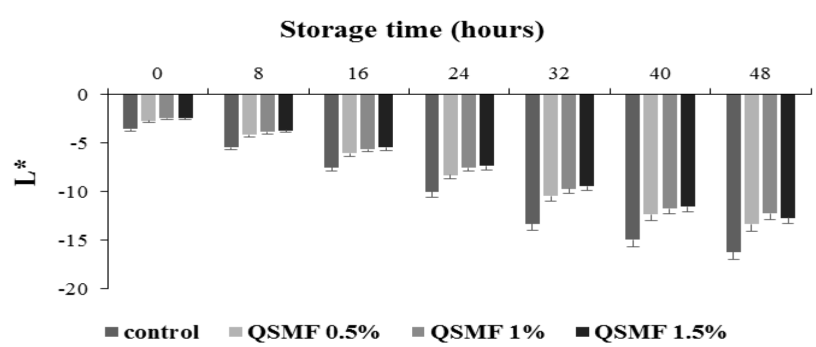


Fig. 1. Effect of coating treatment and storage time on changes of color parameters at 4°C.







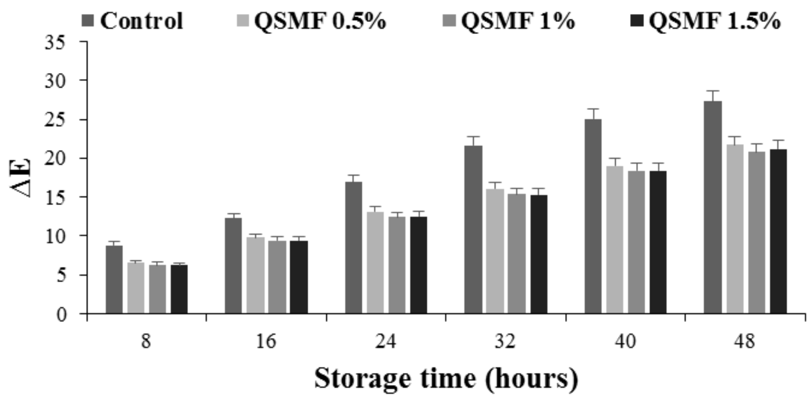


Fig. 2. Effect of coating treatment and storage time on changes of color parameters at 40°C.

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کیفیت برش‌های موز پوشش داده شده با صمغ به: اثر غلظت، دما و مدت انبارداری

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چکیده

پذیرش مصرف‌کننده در طی انبارداری میوه‌های برش یافته به شدت کاهش می‌یابد. پوشش‌های خوراکی یکی از جدیدترین روش‌ها برای حفظ کیفیت و افزایش دوره ماندگاری میوه‌ها و سبزی‌های تازه است. هدف از این مطالعه ارزیابی میزان مناسب بودن صمغ دانه "به" در غلظت‌های مختلف (0/5، 1 و 1/5 درصد) به‌عنوان پوشش‌های خوراکی برای برش‌های موز و تعیین تاثیرات آنها بر تغییرات خصوصیات فیزیکوشیمیایی طی انبارداری در 4 و 40 درجه سانتی‌گراد بود. داده‌های چروکیدگی، افت وزن و رنگ جمع‌آوری شد و مورد آنالیز آماری قرار گرفت. برگه‌های موز پوشش داده شده با 1% صمغ "به" و نگهداری شده در دمای 4 ºC خصوصیات فیزیکوشیمیایی بهتری نشان دادند. افزایش دما منجر به تغییرات سریع‌تر در خصوصیات کیفی شد. از طرف دیگر، نمونه‌های پوشش داده شده با صمغ میزان افت وزن و چروکیدگی را طی انبار داری کاهش دادند. توصیه می‌شود که غلظت 1% صمغ "به" می‌تواند برای کاهش قهوه‌ای شدن سطح برش‌های موز مورد استفاده قرار گیرد.

واژه‌های کلیدی: موز، پوشش، کیفیت، صمغ دانه به

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