Turkish Journal of Agriculture - Food Science and Technology, 6(5): 561-569, 2018

Turkish Journal of Agriculture - Food Science and Technology

Available online, ISSN: 2148-127X
www.agrifoodscience.com,
Turkish Science and Technology

The Usage of Edible Films Extracted from Cherry and Apricot Tree Gums for Coating of Strawberry (*Fragaria ananassa*) and Loquat (*Eriobotrya japonica*) Fruits

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A R T I C L E I N F O

Research Articles

Received 22 December 2017
Accepted 03 April 2018

Keywords:
Gum
Edible coating
Strawberry
Loquat
Shelf life

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A B S T R A C T

The gum exudates leaking from cherry and apricot trees were used as edible coating material in this study. Some chemical properties of these gums were analysed whether they are proper as edible coating or not. Carbon, hydrogen, nitrogen and sulfur percentages were determined by elemental analysis. Both two gums were found rich in phenolic content and their antioxidant capacities were detected high as a result of the analysis. The behaviours against the heat and losses of weight of the films extracted from gums were determined by thermal analysis. According to these analysis, films were found heat tolerant up to 400°C. It was observed that the surface images of the films taken by SEM were homogeneous and a regular structure. Afterwards, strawberry and loquat fruits were coated with film solutions extracted from gums. The coated/uncoated fruits stored in refrigerator at 4±1°C were compared in respect of shelf life, organoleptic and microbiologic properties. It was seen that the films extended shelf life of the coated fruits. The total bacteria, yeast-mould and coliform bacteria levels of the uncoated samples were highest level at the end of the storage. Also, coatings affected positively organoleptic properties of the fruits. According to the sensory analysis test, the coated fruits had higher points from the uncoated fruits. The cherry and apricot tree gums are suitable materials to use as edible coating.

Türk Tarım – Gıda Bilim ve Teknoloji Dergisi, 6(5): 561-569, 2018

Kiraz ve Kayısı Ağacı Reçinelerinden Elde Edilen Yenilebilir Filmlerin Çilek (Fragaria ananassa) ve Yenidünya (Eriobotrya japonica) Meyvelerinin Kaplanmasında Kullanımları

M A K A L E B İ L G İ S İ

AraştırmaMakalesi

Geliş 22 Aralık 2017
Kabul 03 Nisan 2018

Anahtar Kelimeler:
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Ö Z E T

Bu çalışmada kiraz ve kayısı ağaçlarından sızan reçineler yenilebilir kaplama materyali olarak kullanıldı. Reçinelerin yenilebilir kaplama olarak uygun olup olmadıkları bazı kimyasal özellikleriyle incelendi. Karbon, hidrojen, azot ve kükürt yüzdeleri elementel analiz ile belirlendi. Yapılan analizler sonucunda her iki reçinenin de fenolik madde bakımından zengin olduğu bulundu ve antioksidan kapasitelerinin yüksek olduğu tespit edildi. Termal analizlerle reçinelerden elde edilen filmlerin ısıya karşı davranışları ve ağırlık kayıpları belirlendi. Bu analizlere göre, filmlerin 400°C'ye kadar ısıya dayanıklı oldukları bulundu. Filmlerin SEM ile elde edilen yüzey görüntülerinin homojen ve düzgün bir yapıda oldukları görüldü. Daha sonra, reçinelerden elde edilen film çözeltileriyle çilek ve yenidünya meyveleri kaplandı. 4±1°C'de buzdolabında muhafaza edilen kaplamalı/kaplamasız meyveler; raf ömrü, organoleptik ve mikrobiyolojik özellikler bakımından karşılaştırıldı. Filmlerin kaplanmış meyvelerin raf ömrünü uzattığı görüldü. Depolama sonunda kaplamasız örneklerin toplam bakteri, maya-küf ve koliform bakteri düzeyleri en yüksek seviyedeydi. Ayrıca, kaplamalar meyvelerin organoleptik özelliklerini olumlu etkiledi. Duyusal analiz testine göre kaplamalı meyveler, kaplamasız meyvelerden daha yüksek puanlara sahip oldular. Kiraz ve kayısı ağacı reçineleri yenilebilir kaplama olarak kullanıma uygun materyallerdir.

DOI: https://doi.org/10.24925/turjaf.v6i5.561-569.1768

Introduction

Gum exudates are natural sticky substances leaking from trunk or branches of some trees. They can occur naturally or for curing wounds on trees as due to microbial infection or injuries, including water stress, against to insect attack (Simas-Tosin et al., 2010). *Leguminosae, Meliaceae, Rutaceae, Anacardiaceae, Rosaceae* are some of the families producing gum. *Rosaceae* family trees such as cherry, apricot, peach, sour cherry, plum and almond produce copious quantities of gum (Olien and Bukovac, 1982). Gum arabic leaking from acacia, gum tragacanth, gum karaya are also important natural gums. Plant gums are hydrophilic carbohydrates. They are advantageous of being non-toxicity, non-irritancy, easy availability, eco-friendly, biodegradability, biocompatibility and low cost (Philips and Williams, 2001; Kulkarni et al., 2005; Bouaziz et al., 2016a). Industrial usages of tree gums are quite wide and they are used in textile, pharmacy, paper, cosmetic, food and beverage industries (Vinod et al., 2008). Food industries like beverage, confectionary, dairy, bakery make use of gums as emulsifying, coating, stabilising, thickening, bulking agents (Valdez, 2012).

Tree gums are being used in food sector as edible coating also they are used in several fields. They are being used in textile and paper industry due to its sticky nature. In pharmacy sector gums are used as binder agent for medicine tablets. Besides, they are used in cosmetic sector as hair conditioner, hair gel and toothpastes (Lopez-Franco et al., 2012). Apricot tree, widely growing in Turkey, produces arabinogalactan-type gum. Arabinogalactan is a colorless, odorless, tasteless and water-soluble polysaccharide. Apricot tree gum was used in drug industry as a binder in tablet manufacturing and as an emulsifier in food industry. Moreover apricot gum used as antidote, expectorant and antihelmintic agent (Şensoy, 2002; Khan et al., 2012). The apricot gum exudates have been used as medicinal remedies in Iran. In chemical composition of this gum, potassium, calcium, magnesium contents were found high. And the harmful elements (lead, mercury, cadmium, arsenic) were below the method detection limits (Fathi et al., 2016). Similarly, peach tree gum is also arabinogalactan-type polysaccharide and used as thickener and gelling in food industry (Simas-Tosin et al., 2010). Gums are permitted in food industry for a number of uses in Canada. They can use as emulsifier in salads, thickening agent in jams and sauces, stabilizer agent in ice creams (Bouaziz et al., 2016b). Gum arabic (Acacia (sen) SUPERGUM^{TM}) has been adopted by European Union and Codex Alimentarius for food applications. This gum has also beneficial effects on blood pressure, diabetes mellitus and cholesterol (Phillips and Phillips, 2011; Glover et al., 2009). Hamdani et al. (2018) investigated the characterization of some exudate gums and they have reported that gums had high antioxidant potential. The apricot gum exhibited the higher antioxidant potential from acacia and karaya gums. The antinutritional factors (terpenoids, saponins, alkaloids) were absent in these gums.

Storing of the foods after harvest is an important factor in agriculture sector. Fresh fruits and vegetables decay easily unless they are stored properly after harvest (Salunkhe et al., 1991; Danalache et al., 2016). Decompositions such as decaying, moulding, shrivelling and sourness reduce the nutritional value of food and cause the shelf life to shorten (Cerqueire et al., 2011). Furthermore, they cause to infectious diseases and food poisoning for the people consuming those foods (Kayaardı, 2005). In order to avoid these problems, fresh fruits and vegetables should be stored in a cold environment, presented without delay and effective packaging methods should be used. Many packaging method is used to protect the foods. The packaging materials such as plastic, glass, metal, wood, paper and cardboard can be a big problem in terms of environmental pollution (Petersen et al., 1999). And also plastic packages carry cancer risk (Dursun and Erkan, 2009). In recent years there has been a growing interest in edible films and coatings, which have been developed as an alternative to these packaging types (Appendini and Hotchkiss, 2002; Bosquez-Molina et al., 2003). Edible films consist of a film-forming polymer, a solvent and a plasticizer. They are applied on to food surface as a thin layer and consumed together with food. The fruit and vegetable surfaces, meat products, some dairy products and seafood can be coating with edible films/coatings. Edible films also improve organoleptic, sensory, microbiological properties of foods with prolonging their shelf life. They prevent oxidation and delay browning (Campos et al., 2010; Falguera et al., 2011).

Strawberry (*Fragaria ananassa)* is a member of *Rosaceae* family. Strawberry is a delicate fruit and has short shelf life. The shelf life of strawberry is generally less than 5 days at 0-4°C. It is rich in calcium, vitamin C, vitamin E, folic acid and has anticarcinogenic effects (Xu et al., 2001; Debeaufort et al., 1998; Han et al., 2004).

Loquat *(Eriobotrya japonica)* is also a member of *Rosaceae* family. If loquat, sensitive to water loss, is keep long after harvest; weight loss, shrivelling and browning may occur (Shao and Tu, 2014). Vitamin A, potassium and calcium rate is quite high in the fruit. Besides, it contains minerals such as magnesium, phosphor and iron (Topuz, 1998).

In this study, edible coatings were obtained from the gums collected from cherry and apricot trees. Some physicochemical properties of the gums were investigated. The strawberry and loquat fruits coated with the coating solutions obtained from these gums. The effects of the coatings to the microbiological decomposition and organoleptic properties of the fruits were investigated.

Materials and Methods

Materials

The gum exudate samples used in the study were collected cutting from the trunk of the cherry and apricot trees in Senirkent district of Isparta (Turkey). Strawberry and loquat fruits were purchased from a local supermarket in Afyon (Turkey). Folin-Ciocalteu reagent, DPPH reagent, sodium carbonate, sorbitol and ethyl alcohol were purchased from Merck (Merck, Germany). Gallic acid and acetone were supplied by Sigma (Sigma Chemical, USA) and peptone was supplied by Oxoid (Oxoid, Germany). Distilled water was used in all experiments.

Preparation of Coating Solutions

Firstly, gum samples were washed with distilled water and dried at 40°C in incubator. They were crushed in a porcelain mortar to get a very fine powder, so they could pass through 250 µm sieve (Vinod et al., 2008).

Preliminary experiments were made to determine the optimum concentration for coating solutions and films to use in the study. 2, 3, 4, 5, 6 grams from cherry and apricot tree gums were taken and dissolved with 100 mL distilled water. While a dilute solution is obtained in 2, 3 and 4 grams; dissolution was extremely difficult in 6 grams. So, 5 grams of gums and 100 mL distilled water were used to prepare coating solutions.

Similarly, the content of the sorbitol using as a plasticizer was determined with preliminary experiments. It was tried to minimize the amount of chemicals in the study. For this, different quantities of sorbitol were added to film solutions and the fragilities of the films (dried in petri plates) were examined. Films had flexible structures with 0.02 grams of plasticizer (Cerqueira et al., 2009).

The solutions (5 grams gum+100 mL water+0.02 grams sorbitol) were hold at 70 °C for half an hour. After the solutions cool down a bit, they were homogenized for 3 minutes by homogenizer at 12000 speed (Aydınlı et al., 2004). These solutions were used for coating strawberry and loquat fruits.

Preparation of Films

The films from cherry and apricot tree gums were prepared with their solutions. 50 mL were taken from these solutions and were poured into petri plates. Films were dried for 3 days at room temperature (21±2). The films were used for elemental analyses, total phenolic content, antioxidant capacity, thermal analysis and surface images.

Elemental Analysis

C, H, N, S percentage levels were determined by elemental analysis. For this, elemental analyser (LECO CHNS, Germany) was used. Samples were placed in the silver capsules and burned. The combustion gas was transferred to thermal conductivity detector. The elemental percentages of the samples were determined with the aid of gas electrical signals (Anonymous, 2014).

Total Phenolic Content

Total phenolic content of the gums was determined according to Folin-Ciocalteu spectrophotometric method. One gram from the gum samples was taken for sample extraction and one mL 80% acetone solution was added over. The samples were placed in an ultrasonic bath at 50±5ºC for 5 minutes (Bandelin Sonorex RK100, Germany). 30 µL of the samples passed through the filter paper were taken to the test tubes. 2370 µL distilled water and 150 µL Folin-Ciocalteu reagents were added over them. Mixtures were hold for a while after vortex. Later on, 450 µL sodium carbonate was added and left to stand in dark environment for 30 minutes. Absorbance at 750 nm was measured by UV-Vis spectrophotometer (Thermo Labsystems, 1500, Finland). Standard calibration curve was obtained by preparing gallic acid solutions in different concentrations. The results were given as gallic acid equivalent (GAE) (Karaaslan et al, 2014).

Antioxidant Capacity

DPPH (2,2-diphenyl 1-pikrilhidrazil hydrate) method was used to determine antioxidant capacity of the gums (Blois, 1958). Dilutions of gum extracts at different concentrations were prepared with ethanol. 0.1 mL was taken from these and 2.9 mL DPPH solution was added. It was left to incubation for half an hour and then their absorbance was read at 517 nm on UV-Vis spectrophotometer (Thermo Labsystems, 1500, Finland). The DPPH radical scavenging effect was calculated with equation 1. EC_{50} values (median effective dose) were found from the calibration curves (Karaaslan et al., 2014).

$$DPPH\ (\%) = (Ac\text{-}As) / (Ac\text{-}100) \qquad (1)$$

Ac: absorbance of control sample
As: absorbance of sample

Thermal Analysis

The thermal analysis of films prepared from cherry and apricot tree gums investigated in terms of behaviours against heat, thermal stability, decomposing temperatures, weight changes and reaction type. The films were heated up to 500°C at 20°K/min heating rate at TG-DSC (Netzsch STA 449 F1, Germany) and their thermal behaviours were evaluated (Sudhamani et al., 2003).

Surface Images

Scanning electron microscope (LEO 1430 VP, Germany) was used to take surface images of the films. Film images were taken at 15 kV voltages coating them with gold under high vacuum (Liu et al., 2013).

Coating Strawberry and Loquat Fruits with Coating Solutions

After the leaves of the strawberries were removed, the strawberry and loquat fruits were first washed with tap water and then with distilled water. The washed fruits were placed on a paper towel and let to dry at room temperature for two hours. The coating process was performed with immersion method. The fruits were immersed in coating solutions three times for ten seconds with intervals of ten seconds. Fruits were hanged to tripod stand as hooked from their stem. In this way, they were dried at room temperature (22±1°C) for 3-4 hours. The strawberry and loquat samples such as uncoated (A), coated with cherry tree gum (B), coated with apricot tree gum (C) were placed in the refrigerator at 4±1°C in seperate rings. Strawberry samples were stored for 6 days and loquat samples were stored for 12 days. A total of 237 strawberries and 237 loquat fruits were used for weight losses, microbiological and sensory analyses.

Weight Losses

For the determination of weight losses, all uncoated and coated samples were weighed at electronic scale (Precisa 205A SCS, Swiss) at intervals of 24 hours. According to the obtained results, the percent weight loss values in the fruits were calculated. Experiments were performed in triplicate.

Microbiologic Analyses

Microbiologic properties of the uncoated and coated samples were analysed in terms of total bacteria, yeast-mould and coliform bacteria levels. One gram of each uncoated and coated samples was put into sterile stomacher bags for microbiologic analysis. 9 mL peptone water was added to them and homogenised in stomacher for 1 second. 1 mL of those homogenates was transferred to test tubes containing 9 mL peptone water. Once test tubes were mixed by vortex (IKA MS2 Minishaker), dilution series were prepared up to 10^{-4} (Gürgün and Halkman, 1988).

Spread plate method was applied as microbiologic counting method. Total bacteria count was determined by Plate Count Agar (PCA) medium (Salubris, Poznan). Planted petri plates were incubated 48 hours at 30±2°C. After incubation, all colonies composed in medium were counted and logarithmically calculated (Nortje, 1990).

For yeast and mould counts in strawberry and loquat fruits, Potato Dextrose Agar (PDA) medium was planted. It was incubated 4-5 days at 25±1°C (Anonymous, 1987).

Violet Red Bile Agar (VRB) medium was used in counting of coliform group bacteria in the samples. Planted petri plates were left to incubation 24 hours at 30±1°C (ISO, 1991). The colonies composed at mediums after incubation were counted and the results were given as log cfu/g (colony forming units). All of the microbiologic analyses were performed as three repetitions and at each repetition three times planted.

Sensory Analysis

Hedonic test (pleasure-likeness) was performed to panellist group (n=8) to analyse the effects of the coatings obtained from gums to the sensory properties of the fruits. The information about samples was not given to the panellists and they were asked to score the samples in terms of appearance, texture and taste according to 9 point hedonic scale (1: extremely bad 5: neither good nor bad 9: excellent) The panellists scored the samples as per their surface flatness, surface gloss, surface colour, texture, aroma and overall acceptability. Sensory analysis was performed as two repetitions (Chien et al., 2007; Çalıkoğlu, 2008).

Statistical Analysis

The results of the statistical analysis obtained from the experiments were done by using SPSS statistics package program (IBM SPSS Statistics 18.0). The data were evaluated by applying the variance analysis (ANOVA) on randomized blocks test order. In the differential groups, the level of the differences was determined by Duncan test. Data obtained from findings were shown in the tables as average±standard deviation (SD).

Results and Discussion

Elemental Analysis

Elemental analysis is used in the physicochemical characterization of compounds. Carbon, hydrogen, nitrogen, sulphur, oxygen and some other elements, minerals can be determined by this way. It is also determined by elemental analysis whether the compounds are in carbohydrate, protein or lipid structure.

C, H, N, S quantities of the gums were determined by elemental analysis in this study. The percentages of these elements in gums are shown in Table 1. Considering to elemental analysis results, cherry and apricot tree gums are chemically similar. As there are no impurities in the gums, the remaining 60% part is oxygen.

Edible coatings can be polysaccharide, protein or lipid based. Tree gums are known as polysaccharide compounds. Especially, *Prunus* species tree gums are arabinogalactan-type polysaccharides (Fathi et al., 2016). And for this reason the nitrogen content in gums is expected to be low or absent. The characterization of kondagogu tree gum, contents were determined as 34.97% C, 5.58% H, 0.229% N, 0.128% S (Vinod et al., 2008). These values are closer to our results. Containing N and S in cherry, apricot and kondagogu tree gums in these studies, may be due to presence of S-containing amino acids (Janaki and Sashidhar, 1998). Aydınlı (1997) found the locust bean gum elements as 43.24% C, 6.40% H and 49.49% O and indicated that the locust bean gum is in the structure of polysaccharide.

Total Phenolic Content

In recent years, studies about the positive effects of phenolic substances on health have increased. Phenolic rich foods have also high antioxidant capacity. Whit this aspect, they can prevent many diseases including cancer (Nakilcioğlu and Hışıl, 2013; Uyar et al., 2013). The phenolic contents of the tree gums were investigated in the study. The phenolic contents of cherry and apricot tree gums were found as 781.94 mg GAE/kg and 180.71 mg GAE/kg. The phenolic content of the cherry tree gum is higher than the apricot tree gum. In a study, blueberry fruits were coated with chitosan-based films and total phenolic content of the coated fruits was found as 4.02 g GAE/kg (4020 mg GAE/kg). Here, the high amount of phenolic material is due to the fact that the coating and the fruit work together (Duan et al., 2011).

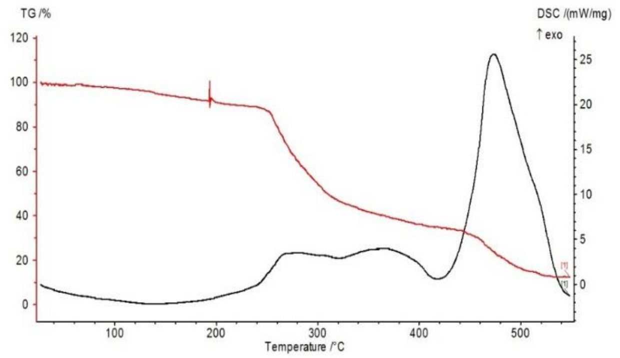
Antioxidant Capacity

DPPH method was used to determine the antioxidant capacities of gums. According to this method, EC_{50} value was calculated. The smaller the EC_{50} value, the greater the antioxidant capacity. In the study, EC_{50} value of cherry tree gum was calculated as 1.659 g/L, and apricot tree gum was calculated as 6.880 g/L. In this case, the antioxidant capacity of the cherry tree gum, which has a low EC_{50} value, is higher than the other.

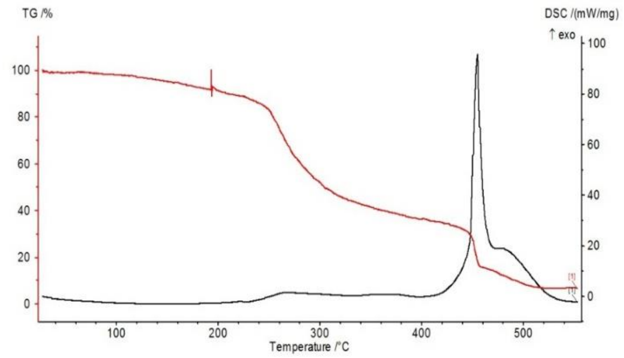
The 10% arabic gum coating was applied to tomato fruits. Comparing to the uncoated samples, antioxidant capacity and total phenolics were increased in coated fruits (Ali et al., 2013). Duan et al. (2011) have coated blueberry fruits with five different edible coatings. At those fruits coated with chitosan-based, EC_{50} (antioxidant capacity) value was 2.81 g/kg. Its antioxidant capacity is less than cherry tree gum, but more than apricot tree gum. There is a positive correlation between phenolic content and antioxidant capacity. Similarly, cherry tree gum has higher phenolic content and antioxidant capacity in our study. The antioxidant capacities of some *Rosaceae* gum exudates were investigated in a study (Bouaziz et al., 2016a). The EC_{50} values of peach, almond and *Prunus cerasoides* (wild Himalayan cherries) gums were found as 50, 6.6 and 0.98 g/L (Yao et al., 2013a; Bouaziz et al., 2015c; Malsawmtluangi et al., 2014).

Table 1 C, H, N, S quantities of gums (%)

Tree gum	Element (%)			
	Carbon	Hydrogen	Nitrogen	Sulfur
Cherry	37.880	7.094	0.119	0.044
Apricot	36.220	6.951	0.386	0.036



(a)



(b)

Figure 1 DSC and weight loss curves of the cherry(a) and apricot(b) tree gum films

Thermal Analysis

DSC curves and weight changes on films heated up to 500°C are shown in Figure 1. According to the DSC curve of cherry tree gum film, initial degradation heat is 279.9°C and last degradation heat is 472.7°C. Accordingly, film is heat tolerant up to 400ºC. It has been determined that there is very little weight loss in the film with heat effect up to 250°C. This loss, which is below 10%, is due to the content of moisture in the film (Figure 1.a).

Initial degradation heat of the apricot tree gum film is 267.5°C and last degradation heat is 455°C. Apricot tree gum film was also found heat tolerant up to 400°C. The weight loss curve of the film is linear up to 250°C, severe losses occur after 300°C. Our findings show that both films can also be used in baked food products (Figure 1.b).

Sudhamani et al. (2003) have determined initial degradation heat of the film prepared with gellan and polyvinyl alcohol as 115.5°C. This film is not proper for the baked products. Aydınlı et al. (2004) have remarked according to thermal analysis that locust bean gum polymer is heat tolerant up to 300°C and severe weight losses occur after 330°C.

Surface Images

The images of the films in the scanning electron microscope are shown in Figure 2. Accordingly, the films had homogeneous and smooth structure. Irregularity or porous structure could not be observed. It was seen that the sorbitol (plasticizer) didn’t cause irregularities in the structure of the films. These features have important role in food coating and packaging.

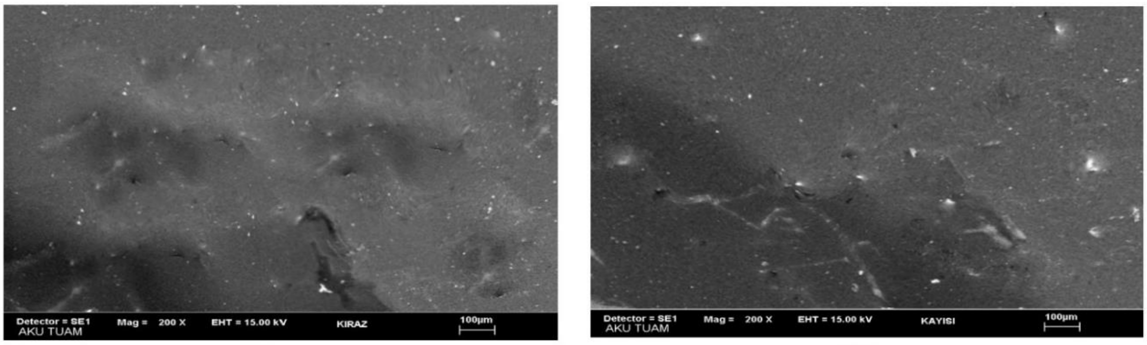
Chen et al. (2009) have informed that starch based film has also proper surface image. Liu et al. (2013) have analysed the effect of the plasticizer (sorbitol) used in chitosan films to the film image. The plasticizer did not affect the surface image of the film negatively. Al-Hassan and Norziah (2012) used glycerol and sorbitol as plasticizer in starch-gelatin edible films and examined their images in SEM. To this, uneven surfaces were seen in glycerol films. The sorbitol films showed more compact and homogeneous surfaces. It was found a relationship between coatings surface morphology and their moisture barrier properties. An edible coating based mesquite tree gum-candelilla wax was used for Persian limes. The MCB (mesquite gum+candelilla wax+beeswax) coating had the poorest water vapor permeability. In relation to this, SEM image of the coating presented a melted-like undefined flat fat surface. On the other hand, the MCO coating (Mesquite gum+candelilla wax+oleic acid) showed more spherical and smaller globules and crater-like holes. So the barrier properties were not good either (Bosquez-Molina et al., 2003).

Weight Losses

The strawberry and loquat samples (uncoated/coated with coating solutions) were weighed at intervals of 24 hours to determine the weight losses daily. The samples were weighed till the day the first one decayed. In this case, strawberry fruits were weighed until 6th day and loquat fruits until 12th day.

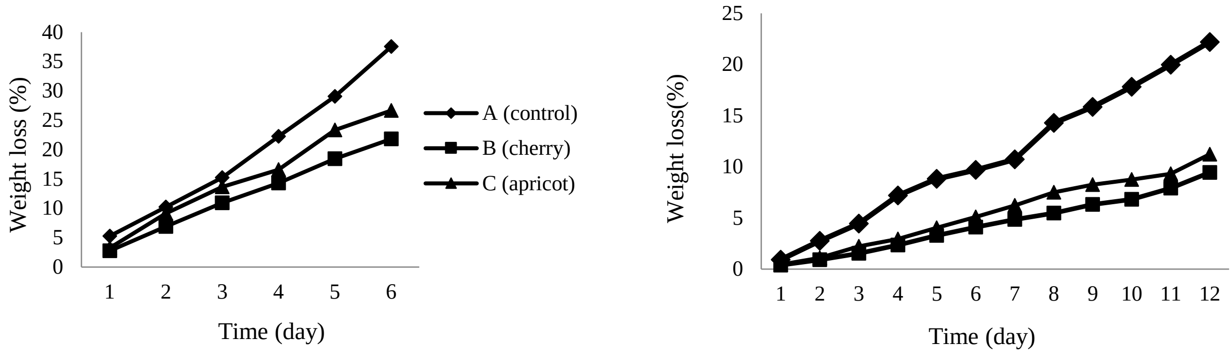
The uncoated strawberry fruits stored at 4±1°C decayed at 6th day and the coated ones with both films decayed at 12th day. It was seen that the coatings doubled the shelf life of the strawberry fruits. At the end of the 6th day, loss of weight in uncoated strawberry fruits (A) was 37.51%; 21.8% in strawberries coated with cherry tree gum film (B) and 26.65% in strawberries coated with apricot tree gum film (C) (Figure 3.a).

The uncoated loquat fruits stored at 4±1°C decayed at 12th day, the coated ones with cherry tree gum film at 21st day and coated ones with apricot tree gum film at 19th day. The highest loss of weight in loquat fruits was seen in uncoated samples (A) with 22.19% at the end of the 12th day. This rate was 9.43% in the samples coated with cherry tree gum film (B) and 11.21% in the samples coated with apricot tree gum film (C) (Figure 3.b). As shown, the weight losses in both fruits coated with cherry tree gum were less. It can be said that the cherry tree gum film is more effective in preventing weight losses.



(a) (b)

Figure 2 SEM images of cherry(a) and apricot(b) tree gum films



(a) (b)

Figure 3 Weight losses of strawberry(a) and loquat(b) samples at 4±1°C

Del-Valle et al. (2005), have observed shelf life of the strawberry fruits by coating them with cactus mucilage and storing at 5±0.5°C in refrigerator. They informed that coated fruits kept their colour and firmness along 9 days. In another study, pineapple slices were coated with antimicrobial edible film and stored at 4°C. Normally, pineapples that can be stored in the refrigerator for 5-7 days were stored freshly along 15 days with impact of the films (Mantilla et al., 2013). The use of almond gum as coating agent of tomato *(Solanum lycopersicum)* fruits was investigated in a study. According to the results of this study, the coated fruits with almond gum had a significant effect on delaying the weight loss compared to uncoated controls (Mahfoudhi et al., 2014). Pompa et al. (2009) coated avocado fruits with candelilla gum and compared losses of weight with uncoated samples in their study. Loss of weight in coated avocados that are stored for 6 weeks at 5°C was 5%, in uncoated ones was almost 25%. Similar results were obtained in strawberry, mango, blueberry fruits with coated chitosan based films (Han et al., 2004; Chien et al., 2007; Duan et al., 2011).

Microbiologic Analyses

Rosaceae gum exudates are known with their antimicrobial activities and used in the medicinal field ever since (Khan et al., 2012). With this property, they extend the shelf life of the coated food and prevent their decaying. In the study, the effect of the coatings to the microbiologic quality of strawberry and loquat fruits was researched. For this reason, total bacteria, yeast-mould and coliform bacteria levels were determined in the uncoated and coated samples. The microbiologic counting was performed for strawberry fruits on the 0, 2, 4 and 6th days and for loquat fruits on the 0, 4, 8 and 12th days. It was observed that the count of total bacteria, yeast-mould and coliform bacteria was increased in uncoated and coated samples over time. However, at the end of the storage, the highest increase on microorganism count was in the uncoated samples. The coatings affected the microbiological properties of the fruits positively and prevented the decaying of them. Besides, the analyses showed that the cherry tree gum coating was more effective to protect microbiologic properties of the fruits.

In Table 2, total bacteria, yeast-mould and coliform bacteria levels of the strawberry samples were shown until the end of the storage. While on the 0th day, coated and uncoated samples had approximate values, it was seen that the total bacteria, yeast-mould and coliform bacteria levels were at the highest values in uncoated ones on 6th day.

Total bacteria, yeast-mould and coliform bacteria levels of the loquat samples on 0, 4, 8 and 12th day were given in Table 3. Once again, the uncoated samples had the highest values at the end of the storage. Similarly, Mantilla et al. (2013) found aerobic bacteria level in pineapple fruits with edible coating as 2.7 log cfu/g and 5 log cfu/g in uncoated fruits. In another study, it was reported that the chitosan based coating prevented to grow *Listeria monocytogenes* in coated food (Roberts and Greenwood, 2003). In a study using peach gum for coating white shrimp samples, it was seen that the samples coated with peach gum polysaccharides delayed the bacterial growth (Yao et al., 2015b). Chiu and Lai (2010) investigated the antimicrobial activities of tapioca starch/hsian-tsao leaf gum coating containing green tea extracts. This coating could inhibit the growth of aerobic mesophilic bacteria, yeast-mold and phychrotrophic bacteria in applied foods.

Sensory Analysis

The coated strawberry and loquat fruits were compared with the uncoated ones in sensory side. Accordingly, in all applications sensory points were better in the coated samples than the uncoated samples. In the early days of storage, features except surface glass and colour received approximate points in the coated and uncoated samples. The coated samples seemed brighter and charmed the consumer. The loss of texture occurred in all samples over time but the most of it was in uncoated samples. Having samples approximate points in terms of aroma in the early days of storage indicated that the films did not affect the taste of the fruits positively or negatively. According to the overall acceptability situation, uncoated samples received the lowest points at the end of the storage (Tabele 4).

Mahfoudhi et al. (2014) evaluated tomato fruits uncoated and coated with almond gum at the end of the storage (20 days) between 0-9 points. The panellists were asked to point samples in terms of pulp colour, flavour, texture and overall acceptability parameters. The control samples had 2 points and coated samples had 8.20 points by the panellists. They indicated that the uncoated fruits had the lower points for all parameters evaluated and they were not acceptable to the panel of experts.

Edible coatings besides improving the sensory properties of foods, they enhance nutritional qualities of them. In a study, almond gum was used in coating of fried potato chips. The coating decreased the oil absorption of potato chips by 34% and increased the moisture by 29.5%. Almond gum coating also improved sensorial properties (color, appearance, crispiness, taste, odor, appetence) of the potato chips. The coated chips had an overall acceptability better than the uncoated chips (Bouaziz et al., 2016b).

Table 2 Microbiologic levels of strawberry samples at 4±1 ℃ (Log cfu/g)*

D	Strawberry/total bacteria			Strawberry/total yeast-mould			Strawberry/total coliform bacteria		
	A	B	C	A	B	C	A	B	C
0	3.02±0.24^{d}	2.84±0.51^{c}	2.90±0.26^{c}	2.62±0.15^{d}	2.68±0.17^{d}	2.56±0.24^{d}	1.69±1.46^{c}	1.53±1.32^{b}	2.36±0.10^{d}
2	3.70±0.12^{c}	3.56±0.13^{bc}	3.56±0.07^{bc}	3.38±0.22^{c}	3.15±0.16^{c}	3.22±0.24^{c}	3.44±0.04^{b}	3.15±0.04^{a}	3.13±0.12^{c}
4	5.82±0.04^{b}	4.18±0.37^{ab}	4.23±0.36^{ab}	5.58±0.37^{b}	4.22±0.21^{b}	4.38±0.11^{b}	4.34±0.47^{b}	4.00±0.29^{a}	4.05±0.21^{b}
6	6.61±0.55^{a}	4.72±0.56^{a}	4.73±0.58^{a}	7.01±0.05^{a}	5.22±0.25^{a}	5.28±0.23^{a}	6.17±0.06^{a}	4.35±0.14^{a}	4.39±0.12^{a}

D: Day, * ^{abcd} (↓) The difference between averages bearing same letters is not important statistically. (P<0.05). A: uncoated sample (control) B: coated sample with cherry tree gum film C: coated sample with apricot tree gum film

Tablo 3 Microbiologic levels of loquat samples at 4±1 ℃ (Log cfu/g)*

D	Loquat/total bacteria			Loquat/total yeast-mould			Loquat/total coliform bacteria		
	A	B	C	A	B	C	A	B	C
0	2.46±0.15^{d}	2.34±0.24^{d}	2.69±0.09^{d}	2.62±0.15^{d}	2.59±0.11^{c}	1.82±1.58^{b}	1.65±1.43^{c}	2.53±0.20^{c}	2.65±0.15^{b}
4	3.41±0.20^{c}	3.14±0.17^{c}	3.20±0.08^{c}	3.46±0.16^{c}	3.21±0.17^{b}	3.20±0.26^{ab}	3.48±0.13^{b}	3.36±0.24^{b}	3.37±0.32^{a}
8	4.24±0.13^{b}	3.60±0.04^{b}	3.66±0.05^{b}	4.64±0.45^{b}	3.91±0.04^{a}	3.90±0.02^{a}	4.14±0.12^{ab}	3.66±0.18^{ab}	3.61±0.11^{a}
12	6.65±0.03^{a}	4.31±0.23^{a}	4.47±0.13^{a}	6.27±0.60^{a}	3.97±0.14^{a}	4.05±0.19^{a}	5.37±0.23^{a}	3.92±0.07^{a}	3.79±0.51^{a}

D: Day, * ^{abcd} (↓) The difference between averages bearing same letters is not important statistically. (P<0.05). A: uncoated sample (control) B: coated sample with cherry tree gum film C: coated sample with apricot tree gum film

Table 4 Overall acceptability points of strawberry and loquat samples at 4±1°C*

D	Strawberry			D	Loquat		
	A	B	C		A	B	C
0	7.23±0.14a	8.34±0.12a	7.47±0.12a	0	8.28±0.14a	8.57±0.08a	8.63±0.16a
2	6.60±0.14b	7.42±0.11b	7.21±0.04a	4	6.61±0.15b	8.23±0.14b	7.29±0.12b
4	5.47±0.12c	7.15±0.13b	6.89±0.14b	8	5.34±0.12c	7.22±0.04c	6.80±0.11c
6	3.63±0.16d	6.32±0.09c	6.28±0.04c	12	3.59±0.22d	6.78±0.04d	6.43±0.20c

D: Day, * ^{abcd} (↓) The difference between averages bearing same letters is not important statistically. (P<0.05). A: uncoated sample (control) B: coated sample with cherry tree gum film C: coated sample with apricot tree gum film

Conclusions

In this study, cherry and apricot tree gums which are characterized with edible film properties were found as effective materials in food coating. These organic products have many advantages such as being harmless to health, high phenolic content and antioxidant capacity, resistant to high temperatures. When they also used as an edible coating, extend the shelf life of the coated food. It was seen in the study that the coatings prepared with cherry and apricot tree gums prevented microbiological decay of strawberry and loquat fruits and improved their organoleptic properties. The coatings doubled the shelf life of the strawberries.

To compare the gums, cherry tree gum was found to have better edible film properties than the other. The phenolic content and antioxidant capacity were higher of the cherry tree gum. It provided that the weight losses in the coated fruits to be less. The cherry tree gum was also more effective to protect microbiological properties of the samples.

It is considered that positive results will be obtained when the both films prepared with these gums are applied to different foods. Further investigations should be done about these and other natural tree gums and should be increased their uses in food applications.

Acknowledgements

This study is supported with project number 12.SAĞ.BİL.17 by Afyon Kocatepe University Scientific Research Projects Commission.

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