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Biochemical content of cherry laurel (*Prunus laurocerasus* L.) fruits with edible coatings based on caseinat, Semperfresh and lecithin

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Abstract: Cherry laurel is one of the most important cherry species and naturally grown in Black sea region in Turkey. Its fruits are sold at high price in local markets in northern parts of Turkey. Cherry laurel fruits are very perishable with a limited shelf life due to a high metabolic activity and susceptibility to mechanical damage and microbial attack. The effect of edible coatings (EC) based on caseinat, Semperfresh and lecithin on the fruit quality, bioactive content and antioxidant activity of cherry laurel fruits stored at 4 ± 1 °C for 15 days was evaluated. The EC fruits compared with uncoated fruits in terms of weight loss, brix, color, pH, titratable acidity, reducing sugar, total sugar, sucrose, total phenolic content, DPPH-IC_{50}, ABTS-IC_{50}, total yeast-mold count, number of total mesophilic aerobic bacteria and ascorbic acid (Vitamin C). Results showed that Semperfresh coating was more promising on titratable acidity (0.26%), pH (4.63), invert sugar (11.77 g/100 g), total sugar (11.96 g/100 g) and sucrose (0.13 g/100 g), caseinat coating was found more promising for count of total yeast-mold count (2.93 log kob/g) and total mesophilic aerobic bacteria (3.44 log kob/g) and lecithin coating was more promising in terms of weight loss (6.77%). For radical scavenging activity and total phenolic content, Semperfresh was found more useful. Thus, caseinat, Semperfresh and lecithin showed to be a promising alternative in prolonging shelf life and preserving the quality of cherry laurel.

Key words: Edible coating, forgotten fruits, cherry laurel, Shelf life, quality

1. Introduction

Forgotten, less known or wild edible horticultural plants particularly fruit species including cherry laurel are gained more popularity in recent two decade throughout the world. They not only have a high morphological diversity but also have high content of nonnutritive, nutritive, and human health promoting substances such as anthocyanins, flavonoids, phenolics, phenolic acids. These fruits are rich in nutraceuticals including specific sugars, organic acids, essential oils, carotenoids, vitamins, and minerals. Those fruit species have also distinct flavor and taste, excellent medicinal value and health care functions (Halilova and Ercisli, 2010; Dogan et al., 2014; Gecer et al., 2020; Bolaric et al., 2021; Grygorieva et al., 2021).

The Black Sea region of Turkey is main diversity center of cherry laurel in the world and along with Black Sea area cherry laurel trees are abundant with high morphological diversity (Celik et al., 2011; Halasz et al., 2021). Cherry laurel fruits are known locally as taflan or laz cherry in the region (Gunal, 2002; Islam, 2002; Akbulut et al., 2007). In fact, the distribution area of this fruit is limited and can be found in general as solitary trees in mainly Southeast Europe, Northern Iran, the Balkans, Northern Anatolia, the Taurus Mountains in Southern Anatolia, the north and east of the Marmara region, and the eastern regions of the Black Sea (Islam, 2002; Akbulut et al., 2007; Yazici et al.,2011) and trees of this species bearing attractive variable red colored fruits with bitter taste (Islam, 2002; Celik et al., 2011; Sayinci et al., 2015).

Cherry laurel fruits are a good source of monosaccharides, vitamin C, dietary fibers, minerals, and phenolics (chlorogenic, caffeic, vanillic, and benzoic acids) and reported with high antioxidant activity (Demir et al., 2017; Erguney et al., 2017). Traditionally cherry laurel has been used to treat eczema, sore throat, cough, asthma, stomachache, and hemorrhoids for centuries. Cherry laurel components have also been found to have antiinflammatory, antinociceptive, antioxidant, antiatherosclerotic, and antidiabetic properties (Demir et al.,2017). It is used as a flavor and sweetener in pickles, jams, molasses, marmalade, cake and in fruit juice. It can be also consumed as fresh or dried (Orhan et al., 2015; Esringu et al., 2016; Temiz and Tarakçı, 2017; Ozturk et al., 2017). Fruits of cherry laurel are highly perishable due to

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their high respiration rate, which makes them susceptible to postharvest mechanical damage and microbial attack. More recently effective technological alternatives to keep quality of fresh fruits have been developed and those including cold storage, UV irradiation, ozonation, and modified environment packaging. Packaging materials such as paper, glass, cardboard, aluminum, cardboard, and other plastics can be used to retain food quality and ensure food safety between manufacturing and consumption (Hecer, 2012; Oksuztepe and Beyazgul, 2015). Many of these substances cause a food migration that is hazardous for human health (Oksuztepe and Beyazgul, 2015). Synthetic packages are often made of petrochemicals; while they are good at safeguarding products and are widely used in the business, decreasing their use owing to environmental pollution and migration issues is on the table (Luchese et al., 2017). In this context, the development of edible coatings (EC) has been proposed. EC form a thin layer of natural, edible, and biodegradable polymeric matrix directly on a food surface and can lower fruit respiration rate and maintain quality characteristics (e.g., color, texture, aroma, and nutritional content) (Yousuf et al., 2018; Ali et al., 2019; Saleem et al., 2020; Vieira et al., 2021).

Semperfresh, a sucrose ester coating widely used in the fresh fruit and vegetable industry for consumers to reduce storage spoilage, weight loss, and preserve green color and fruit pressure without delaying normal ripening processes, is one of the materials used in the production of edible films and coatings (Otoni et al., 2017; Ghidelli and Perez-Gago, 2018). The hydrophobic fatty acid components in Semperfresh greatly improve the coating material's moisture barrier properties (Pavinatto et al., 2020). Casein is another coating substance. Phosphoproteins are the major component of casein, which possesses a water-soluble structure. When fruits with a modest water content are covered with casein, adding lipid increases the permeability of the casein film to water vapor, reducing water loss from the fruit (Khan et al., 2021). Natural product lecithin is used as a surfactant in food. Many foods include modest levels of lecithin, which is plentiful in soy and eggs. Commercially, it is mostly obtained as a byproduct during the production of soy flour and oil (Vieria et al., 2020).

The aim of this study is to reveal the physical and chemical properties of the cherry laurel fruit by covering it with different materials in order to preserve in the best way. As a part of this study, cherry laurel fruit was collected and covered with 3 different coating material. As a result of 15 days of storage, microbiological, physical, and chemical analyses were performed on cherry laurel fruit and the results were evaluated.

2. Materials and methods

2.1. Material

Fruits of cherry laurel (*Prunus laurocerasus*) were collected at full maturation stage from Tonya district of Trabzon Province and after harvesting, fruits were selected with uniform size, shape, weight, and color, without physical damage and apparent infection by microorganisms. Harvested cherry laurel fruit samples were kept at 15 ºC and brought to the laboratory. For edible coating solutions, lecithin in powder form is supplied from Baltek (İstanbul) Company, caseinate in powder form from Unsan Chemistry (İstanbul) and Semperfresh was supplied from England AgriCoat NatureSeal Ltd in liquid forms.

2.2. Methods

Harvested cherry laurel fruits samples were kept at 15°C and quickly brought to the laboratory. Semperfresh, sodium caseinate and lecithin materials, which used as an edible coating material, were prepared by pure water heated up to 100 °C and cooled to 40 °C. The temperature of the coating solution prepared at a concentration of 3% (w/v) was kept constant at 40 °C and mixed in a magnetic mixer for 30 min without forming foam on its surface. The prepared solution was kept at room temperature for 6 hours in order to remove the air bubbles. Fruits dipped in solution for 4 min were taken with a metal strainer and dried for 30 min in a fan dryer. Samples were placed in each container with a sterile spatula to be 200 ± 5 g and stored at 4 ±1 C° for 0, 5, 10, and 15 days of storage. As a result of different storage periods, microbiological, physical, and chemical analyses were performed on cherry laurel fruits and the results were evaluated.

The pH, titratable acidity % (expressed as malic acid) and soluble solid content (SSC) of cherry laurel samples were carried out. SSC content was determined by digital refractometer (Abbe-Way-2S model, Atago Co LTD Sayitama, Japan) and expressed as Brix. The sugar determination in the study was made by volumetric Lane-Eynon method (Keles, 1983; Cemeroglu, 2010), ABTS and DPPH radical scavenging activity determined by Sahin (2014) and total phenolic content was determined by according to Singleton and Rossi (1965). The titratable acidity was determined by Cemeroglu (2010), and the findings were expressed in malic acid as a percentage. pH values were determined by pH meter (Mettler Toledo Columbus, OH, USA). The pH meter was standardized with 4.00 and 7.00 pH buffer solution and then measures were made (Cemeroglu, 2010). Color coordinates (L, a and b) of fruit skin were determined by a Konica-Minolta CR-400 colorimeter (Konica-Minolta Inc., Tokyo, Japan) at four different positions around the equator of fruits (Ozturk et al., 2009).

Before coating process, 30 fruit samples were taken for each repeat. Fruit samples that were put in the previously weighted package boxes were weighed in the 0, 5, 10, and 15th days with 0.0001 g accuracy digital balance (Ohaus Corporation, NJ, USA) and their weight losses were calculated (Vieira et al., 2016). The prepared coating solutions were poured into petri boxes with an inner diameter of 85 mm to be 30 mL. Films were dried by holding for 3 days under ambient conditions. Samples of coatings cut in 4 × 4 mm sizes were coated with gold in a high vacuum, and surface images of coatings at a voltage of 10 kV were obtained by scanning electron microscopy (Kibar, 2010). Statistical analyses were performed in the SPSS 20.0 package program according to the 2-factor trial plan depending on the full chance. The data obtained were subjected to variance analysis and the averages were compared with Duncan's multiple comparison test.

3. Result and discussion

Table shows weight loss, SSC, pH, titratable acidity, reduced sugar, total sugar, sucrose, total phenolic content, DPPH IC_{50} and ABTS IC_{50} and color parameters (*L, a* and *b* values).

In terms of weight loss, considering average of 0, 5, 10, and 15 days of storage periods, edible coated cherry laurel fruits showed lower weight losses compared to the control group. There were statistically significant differences among control and treatments and between treatments as well ($p < 0.01$). Overall, the fruits coated with lecithin showed the lowest weight loss (6.774%), and followed by those coated with Semperfresh (7.301%), casein (9.825%) and control (10.508%), respectively (Table). According to different storage periods (0, 5, 10, and 15 days), weight loss was increased with increasing storage period and reached maximum for all edible coating treatments at the end of the 15th day of storage and among treatments caseinate-coated samples had a greater weight loss while the lecithin-coated samples had the least (Table).

Edible films can be used to manage or limit moisture in foods. Lipids and other hydrophobic materials are commonly utilized to increase barrier characteristics (Morillon et al., 2002). Hydrophobic lecithin and Semperfresh materials performed better in this study than hydrophilic caseinate films. To prevent weight loss, fatty materials should be added to the coating solution. When weight loss was considered during storage, it was discovered that the weight loss increased with storage time increasing (Table). Previously cherry laurel fruits stored at 0 °C for 60 days lost an average of 2.39% of their weight (Karan, 2015). Fruits of cherry laurel were preserved at 2°C in PET containers with perforated coatings. Weight loss was reported to be 11.11% after 21 days storage (Ozturk et al., 2017). The weight loss values in our study were higher compared to above studies because we stored cherry laurel fruits at a higher temperature.

As shown in Table, an increase in SSC ratio was observed in general for all treatments and control treatment compared to the beginning of storage (Table). The highest SSC content was observed on the control fruits (18.700%) and followed by caseinate treatment (18.446%). However, there was no statistically differences between control and caseinate treatment ($p < 0.001$). Those groups statistically differed from Semperfresh (17.363%), and lecithin treatments (17.725%). Semperfresh and lecithin treatments also showed no statistical differences from each other ($p < 0.001$). Overall Semperfresh treatment presented the lowest SSC ratio and the samples coated with Semperfresh had the SSC amount closest to the initial value at the end of the 15-day period. Thus, among edible coating treatments, samples treated with caseinate were the most effective treatments to obtain the highest SSC content in cherry laurel fruits. Previously Certel et al. (2004) found that the amount of SSC in the fruits they studied increased with storage period. The impact of storage on SSC varied depending on the application. The SSC content of cherry laurel fruits collected during the optimum harvest period was reported to be between 10.0% and 25.0% in the literature (Akbulut et al., 2007; Celik et al., 2011; Orhan et al., 2015; Esringu et al., 2016; Temiz and Tarakçı, 2017; Ozturk et al., 2017). SSC value of cherry laurel fruits stored at 2 °C for 21 days varied between 17.30% and 19.10% (Ozturk et al., 2017). In fruits, acid metabolism continues after harvest maturity, with the conversion of starch and acid to sugar. Total acidity, pH, and SSC change according to this process (Duan et al., 2011).

Based on average values of four storage periods (0, 5, 10, and 15 days), the highest pH value was obtained almost equally from lecithin (4.729) and caseinate (4.725) treatments and followed by control (4.647) and Semperfresh treatment (4.627). The pH levels of caseinate and lecithin treatments were not statistically differed from each other at $p < 0.001$ level. Uncoated and Semperfresh coated samples had slightly lower pH values than the caseinate and lecithin coated samples. Based on treatments average, pH level reached at maximum at 10 or 15 days of storage periods and there were no statistically differences between 10 and 15 days of storage periods ($p < 0.01$). pH level of lecithin and control rose on the 5th day of storage and the control's pH decreased on the 10th day and increased again on the 15th day of storage. The pH value of caseinate-coated samples showed fluctuation decreased on the 5th day, increased on the 10th day, and then decreased again on the 15th day. The pH of the uncoated samples was highest on the 15th day. pH values of our cherry laurel samples were found similar with previous studies (Beyhan, 2010; Celik et al., 2011).

Organic acids are an important component of fruits and vegetables and there were differences among species in

Table. Some physical and chemical properties and antioxidant capacities of different edible coatings of cherry laurel

	Applications	Storage time (day) 0	5	10	15	Mean (X ± Sx)		Applications	Storage time (day) 0	5	10	15	Mean (X ± Sx)
Weight loss (%)	**Control**	0.000d	7.074c	14.411b	20.548a	10.508a	Total sugar (g/100 g)	**Control**	10.667c	11.000c	12.000b	12.500a	11.54b
	Semperfresh	0.000d	5.341c	9.764b	14.099a	7.301c		**Semperfresh**	11.000c	11.833b	12.167b	12.833a	11.96a
	Caseinate	0.000d	6.169c	13.165b	19.966a	9.825b		**Caseinate**	10.667d	11.000c	12.000b	13.000a	11.67b
	Lecithin	0.000d	4.370c	9.087b	13.639a	6.774d		**Lecithin**	10.167c	11.000b	11.000b	12.000a	11.04c
	Mean (X ± Sx)	0.000d	5.738c	11.607b	17.063a			**Mean (X ± Sx)**	10.63d	11.21c	11.79b	12.58a	
SSC (%)	**Control**	16.367d	18.033c	19.000b	21.400a	18.700a	Sucrose (g/100 g)	**Control**	0.067d	0.082c	0.092b	0.098a	0.085b
	Semperfresh	15.383d	16.683c	18.283b	19.100a	17.363b		**Semperfresh**	0.100d	0.126c	0.141b	0.157a	0.131a
	Caseinate	15.250d	17.983c	19.200b	21.350a	18.446a		**Caseinate**	0.063d	0.076c	0.091b	0.102a	0.083b
	Lecithin	15.217d	16.967c	17.900b	20.817a	17.725b		**Lecithin**	0.046d	0.075c	0.087b	0.099a	0.077c
	Mean (X ± Sx)	15.554d	17.417c	18.596b	20.667a			**Mean (X ± Sx)**	0.069d	0.089c	0.102b	0.113a	
pH	**Control**	4.465d	4.657b	4.573c	4.893a	4.647b	Total phenolic substance (mg GAE/100 g)	**Control**	1699c	2191a	2020b	1724c	1908a
	Semperfresh	4.533c	4.558c	4.812a	4.603b	4.627c		**Semperfresh**	1648d	1716c	1835b	1968a	1792b
	Caseinate	4.697c	4.520d	4.888a	4.797b	4.725a		**Caseinate**	1612c	1614c	1725b	1801a	1688c
	Lecithin	4.468d	4.730c	4.885a	4.833b	4.729a		**Lecithin**	1635c	2064a	1724b	1327d	1667c
	Mean (X ± Sx)	4.541c	4.616b	4.790a	4.782a			**Mean (X ± Sx)**	1648d	1896a	1826b	1705c	
Titratable acidity (g/100 g)	**Control**	0.255b	0.212c	0.288a	0.237b	0.248b	DPPH IC_{50} (µg/mL)	**Control**	0.172b	0.103d	0.150c	0.222a	0.162c
	Semperfresh	0.243b	0.258ab	0.272a	0.265a	0.260a		**Semperfresh**	0.170c	0.172c	0.185b	0.199a	0.181b
	Caseinate	0.192b	0.238a	0.242a	0.197b	0.217c		**Caseinate**	0.199a	0.193b	0.176c	0.167d	0.184b
	Lecithin	0.277a	0.213b	0.278a	0.210b	0.245b		**Lecithin**	0.261b	0.131d	0.185c	1.105a	0.421a
	Mean (X ± Sx)	0.242b	0.230c	0.270a	0.227c			**Mean (X ± Sx)**	0.150d	0.174c	0.200b	0.423a	
Reduced sugar (g/100 g)	**Control**	10.530d	10.929c	11.706b	12.393a	11.389c	ABTS IC_{50} (µg/mL)	**Control**	7.272b	4.693d	5.370c	8.471a	6.452d
	Semperfresh	10.985d	11.411c	12.160b	12.527a	11.771a		**Semperfresh**	7.721a	6.874b	6.487c	6.294d	6.844c
	Caseinate	10.508d	11.071c	12.070b	12.764a	11.603b		**Caseinate**	8.606b	9.523a	7.523c	5.883d	7.884b
	Lecithin	10.257d	10.910c	11.167b	12.003a	11.084d		**Lecithin**	8.836c	7.827d	9.968b	12.348a	9.745a
	Mean (X ± Sx)	10.570d	11.080c	11.776b	12.422a			**Mean (X ± Sx)**	8.109b	7.229d	7.337c	8.249a	

Table. (Continued).

	Applications	Storage time (day)				Mean		Applications	Storage time (day)				Mean
		0	5	10	15	**(X ± Sx)**			0	5	10	15	**(X ± Sx)**
L	**Control**	24.148c	31.717a	29.892a	27.397b	28.288b	b	**Control**	2.203a	0.278bc	–0.200c	0.768b	0.762a
	Semperfresh	31.223a	31.223a	30.845a	31.510a	31.110a		**Semperfresh**	–0.067a	0.055a	–0.717a	0.255a	–0.118b
	Caseinate	24.738b	29.417a	29.038a	29.110a	28.075b		**Caseinate**	1.547a	0.993ab	0.145b	0.035b	0.680a
	Lecihtin	30.078b	32.400a	32.985a	29.672b	31.283a		**Lecihtin**	0.155ab	–0.332ab	–0.553b	0.690a	–0.010b
	Mean (X ± Sx)	27.547d	31.189a	30.630b	29.422c			**Mean (X ± Sx)**	0.960a	0.249b	–0.331c	0.437b	
a	**Control**	9.192a	5.957c	7.335b	5.808c	7.027a							
	Semperfresh	7.092a	5.567b	6.067b	6.050b	6.193b							
	Caseinate	9.258a	5.688c	6.830b	5.732c	6.877a							
	Lecihtin	6.613a	5.930b	6.483a	5.438b	6.116b							
	Mean (X ± Sx)	8.038a	5.785c	6.668b	5.757c								

Means in the same lines followed by the different letters are significantly different according to Duncan's multiple range test ($p \le 0.01$).

terms of organic acid forms and amount. The lower sugar/acid ratio in fruits indicates sour flavor and higher ratio shows sweet flavor (Karatas, 2014). Sugars and organic acids in fruits and their products affect not only flavor but also stability, acceptance and quality maintenance (Esringu et al.,2016). There was a substantial change in the quantity of titratable acidity of the cherry laurel fruit during the applied edible coatings and storage period. Based on four storage periods, fruits coated with Semperfresh had the highest titratable acidity (0.260 mg/100 g), whereas samples coated with caseinate (0.217 mg/100 g) had the lowest one. The control samples and lecithin treated samples showed very similar titratable acid value and were placed in the same statistical group. The influence of storage time on the titration acidity values of cherry laurel fruits has been determined to be substantial. Considering the average of treatments, the maximum titration acidity was found on the 10th day of storage (0.270 mg/100 g), while the lowest value was found on the 15th day of storage (0.227 mg/100g). On the 5th day, the titration acidity values of lecithin and control treatments were decreased, then increased on the 10th day, and then decreased again at the end of the 15th day. The values of the caseinate and Semperfresh coated samples increased up to the 10th day, then decreased. At the end of the 15th day, caseinate had the lowest titration acidity value (0.917 mg/100 g) (Table). Other studies also showed fluctuations on organic acids during storage periods (Sallan, 2010; Certel et al., 2014). Ozturk et al. (2017) conducted a 21-day storage experiment with cherry laurel fruit and discovered that while the titration acidity value did not change significantly in the first 7 days of storage, the changes occurred on the 14th and 21st days of storage periods. The titration acidity of cherry laurel has been determined to be 0.12–0.70 g malic acid/100 mL in previous studies (Celik et al.,2011; Sulusoglu, 2011; Islam and Deligoz, 2012; Sahan et al., 2012).

The amount of invert (reduced) sugar was found to be statistically significant among treatments ($p < 0.01$) (Table). Semperfresh coatings had the highest inverted sugar (11.771 g/100 g), followed by caseinate (11.603 g/100 g), control (11.389 g/100 g) and lecithin (11.084%), respectively. The influence of storage time on the inverted sugar levels of cherry laurel was shown to be considerable. The amount of inverted sugar increased as the number of days in storage increased. Based on all treatments average, on the 15th day of storage, the highest value (12.422 g/100 g) was discovered. At the end of the 15th day, the highest amount was observed in the samples coated with caseinate (12.764 g/100 g) and the least in the samples coated with lecithin (12.003 g/100 g).

According to the coatings treatments, the total sugar values were found between 11.04 g/100 g (lecithin) and 11.96 g/100 g (Semperfresh) treatments. The treatments differed from each other for total sugar content statistically at $p < 0.01$ level (Table). Caseinate and control fruits displayed a similar trend and differed from the other treatments. It was found that storage period significantly affected total sugar content of cherry laurel fruits. As the number of days increased during storage, total sugar was also increased based on treatments. The highest total sugar was seen at the end of the 15th day for all treatments. The amount of total sugar, as well as the amount of inverted sugar, increased during the storage period.

The greatest sucrose level was found in Semperfresh treatment (0.131 g/100 g), and followed by control (0.085 g/100 g), caseinate (0.083 g/100 g) and lecithin (0.077 g/100 g). Results clearly indicated that the sucrose content of cherry laurel fruits was significantly affected by treatments and also storage period ($p <0.01$). The amount of sucrose in coated and uncoated fruits increased after the 5th day of storage. The maximum sucrose value was found in the Semperfresh coating on the 15th day of storage period whereas the lowest value was found in the control group. Semperfresh coatings had the largest quantity of sugar from baseline. Cherry laurel has a high sugar content, which increases as the fruit ripening period (Ozturk et al., 2017). Fructose was the most common sugar in Cherry laurel fruits, with amounts ranging from 6.93–8.03 g per 100 g, and glucose amounts ranging from 1.89 g/100 g to 2.22 g/100 g. Although cherry laurel contains a lot of sugar, its bitter taste is thought to be caused by the high level of hydroxyacids in its fruits (Karan, 2015). According to Esringu et al. (2016), the glucose, fructose, and sorbitol content in fruits of 12 distinct cherry laurel genotypes ranged from 4.83 to 5.74, 4.66 to 5.53, and 1.50 to 3.22 mg/100 g, respectively.

Cherry laurel fruits rich for phenolic content (Celik et al., 2011). We found statistically significant differences among treatments on total phenolic content at $p < 0.01$ (Table). Uncoated samples have the highest phenolic concentration (1908 mg GAE/100 g), followed by Semperfresh-coated samples (1792 mg GAE/100 g). Caseinate and lecithin had statistically similar values (1688 and 1667 mg GAE/100 g). There were fluctuations for total phenolic content on cherry laurel fruits considering storage periods and total phenolic substance levels of cherry laurel fruits increased on the 5th and 10th days of storage while decreasing on the 15th day according to the Duncan's multiple comparison data. In comparison to the coatings, the effect of storage duration on the phenolic material was different. On the 15th day, the level of phenolic content was determined to be the lowest, especially with lecithin coating. Semperfresh and caseinate coated samples, on the other hand, showed a small increase from the first to the 15th day. At the end of the 15th day, the phenolic content of the Semperfresh coating was the highest, followed by caseinate, control, and lecithin coatings. Total phenolics are affected by postharvest circumstances and ripening degree. Enzymatic reactions that occur during the ripening, softening, and aging stages cause declines in total phenolic compounds. In addition to these characteristics, phenolic chemicals are affected by environmental and genetic factors (Dogan et al., 2014; Ersoy et al., 2018; Gecer et al., 2020). In a study conducted to determine the total phenolic content of cherry laurel fruit was found between 45.3 and 48.1 mg gallic acid/g dry extract (Karabegović et al., 2014). In the study conducted by Ozturk et al. (2017), the total phenolic content of cherry laurel fruit was 943 mg GAE/100 g fresh weight at the beginning of storage, while this value was determined as 702 mg GAE/100 g fresh weight after 21 days of storage.

The difference between the DPPH-IC_{50} values was statistically significant ($p < 0.01$) depending on the coating substances (Table). Overall, the control group had the lowest DPPH value (0.162 µg/mL) which indicates highest antioxidant activity, followed by samples coated with Semperfresh (0.181 µg/mL), caseinate (0.184 µg/mL) and lecithin (0.421 µg/mL) (Table). DPPH-IC_{50} values decreased as storage time increased, with the lowest value found on day 0. On the 15th day, the greatest value was discovered. In comparison to coatings, storage has a different effect on DPPH-IC_{50} values. While all groups except the Semperfresh group experienced a decrease in radical scavenging activity until the 5th day. On the 15th day, the sample coated with lecithin showed a significant increase. Ozturk et al. (2017) found that antioxidant activity of cherry laurel fruits decreased during the storage. The antioxidant activity levels were determined to be DPPH (43.54–30.85 mol TE/g wet weight) from the first day of storage to the 21st day of storage.

The statistically significant differences were evident among coating materials ($p < 0.01$). The coatings with lecithin had the highest ABTS IC_{50} value (9.745 µg/mL), followed by caseinate (7.884 µg/mL), Semperfresh (6.844 µg/mL) and control groups (6.452 µg/mL). All four treatment were placed in different statistical group. The influence of storage time on ABTS value of cherry laurel fruits was substantial ($p < 0.01$) (Table). While the ABTS value was high on the first day, it fell on the 5th and 10th days before increasing again. In comparison to coatings, storage has a different effect on ABTS-IC_{50} values. Apart from caseinate, ABTS values decreased in the other coatings and uncoated samples for the first 5 days, before increasing in lecithin and uncoated samples until the 15th day. The caseinate-coated sample increased until the 5th day, then decreased until the 15th day. On the 15th day, the highest ABTS IC_{50}value was found in lecithin, whereas the lowest value was found in caseinate-coated samples.

The most important attribute of the appearance of any food is its color, especially when it is directly associated with other food-quality attribute. Table presents *L*, *a* and *b* peel (skin) color coordinates of coated and uncoated cherry laurel fruits in different storage periods. The peel color results of storage periods and treatments indicated statistically significantly differences at $p < 0.05$ for *L*, *a* and *b* values.

The highest *L* values were obtained from lecithin (31.283) and Semperfresh (31.110) but these two treatments were placed in the same statistical group. The control (28.288) and caseinate (28.075) showed lower values but there were no statistical differences between control and caseinate ($p < 0.01$) (Table). The influence of storage time on cherry laurel fruits *L* values was found to be significant ($p < 0.01$) (Table). There were fluctuations among storage periods in terms of *L* value. At the beginning of storage period, the value was 27.547 and increased to the highest value 31.189 at the 5th day, then decreased to 30.630 at the 10th day storage and 29.422 at the 15th day of storage. Considering coatings substances, storage had a different influence on *L* values. Up to the 5th day, caseinate, control, and lecithin all increased, while the Semperfresh value (31.223) stayed the same. On the 10th day of storage, Semperfresh decreased (30.845) and increased on the 15th day (31.510). Lecithin levels increased until the 10th day, then decrease (29.672). After the 5th day, the values of the uncoated samples always decreased. Halilova and Ercisli (2010) studied a number of cherry laurel genotypes and reported *L* values of skin of cherry laurel fruits between 18.43 and 23.62, which in agreement with our result.

The *a* values of coated fruits differed each other statistically significant level ($p < 0.01$) (Table). The control had the highest *a* value (7.027), whereas the lecithin coating had the lowest (6.116). Statistically control, caseinate, Semperfresh, and lecithin formed the same statistical group. The influence of storage time on cherry laurel *a* values is observed to be substantial ($p < 0.01$) (Table). The *a* value that was higher on the at the beginning of storage (8.038) based on average of treatments than decreased on the 5th day (5.785), increased again on the 10th day (6.668), and decreased again on the 15th day (5.757). Halilova and Ercisli (2010) studied a number of cherry laurel genotypes and reported *a* value of skin of cherry laurel fruits between 0.81 and 20.61 which supports our findings.

The difference between *b* values was considerable ($p < 0.01$) depending on the applied coatings and storage periods. The *b* value according to average of storage periods was in descending order control (0.762) > caseinate (0.680) > lecithin (–0.010) > Semperfresh (–0.118), respectively. The noncoated samples had the highest *b* value at the beginning of storage period (0.960) and decreased at the 5th day and finally reached 0.436 at the 15th day of storage.

(Table). Halilova and Ercisli (2010) studied a number of cherry laurel genotypes and reported *b* value of skin of cherry laurel fruits between 0.28 and 6.26 which supports our findings.

3.1. Scanning electron microscope image

Information about the surface homogeneity of films can be obtained with scanning electron microscopy. A homogeneous surface is perceived as a sign of structural integrity, and coatings with such a surface are also expected to have good mechanical properties. Additionally, surface homogeneity also affects the opacity value of coatings. It is possible to relate the mechanical properties of the prepared coatings to the obtained micrograph results. It is expected that the tensile strength of coatings with homogeneous surfaces is high, and the elongation values of coatings with rough surfaces, i.e. their flexibility, are lower. It is thought that the water vapor permeability of coatings will be negatively affected by porous structures (Kibar, 2010). Surface micrographs obtained by scanning electron microscopy of coating samples are given in Figures 1 and 2 (sodium caseinate), Figures 3 and 4 (Lecithin), Figures 5 and 6 (Semperfresh). The caseinate and lecithin coatings have a homogenous surface, as seen in the surface micrographs. There were no pinholes or air bubbles in either of these two coatings. However, the surface roughness of the Semperfresh-prepared coating is higher than that of other coatings. It has a porous structure and a spongy structure. The loss of structural integrity

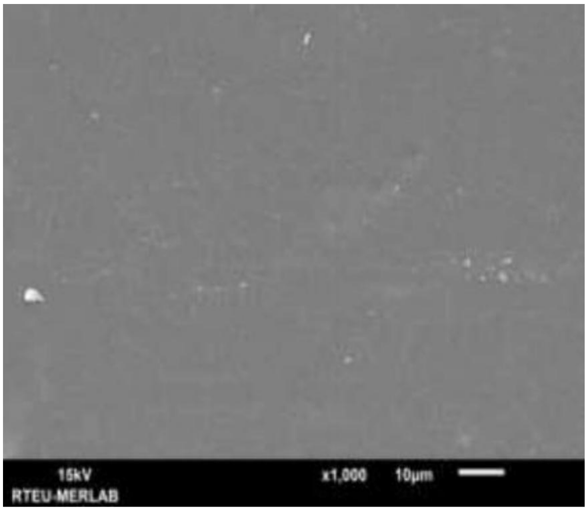

Figure 1. Surface micrograph of coating prepared with sodium caseinate (1000×).

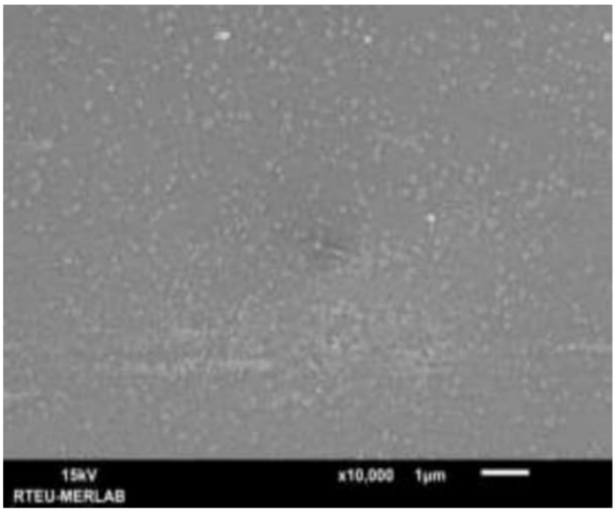

Figure 2. Surface micrograph of coating prepared with sodium caseinate (10,000×).

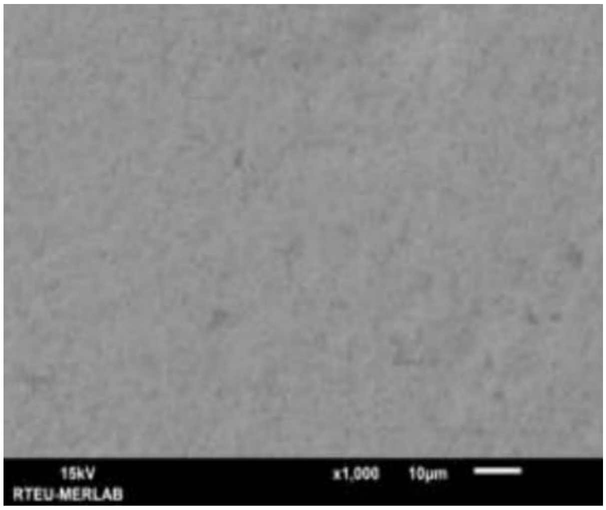

Figure 3. Surface micrograph of coating prepared with Lecithin (1000×).

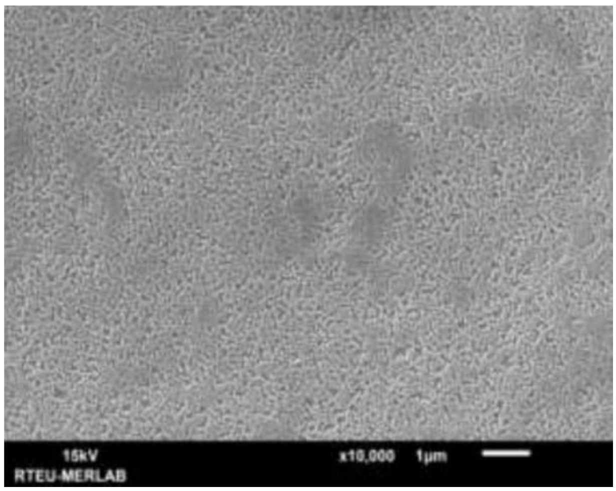

Figure 4. Surface micrograph of coating prepared with Lecithin (10,000×).

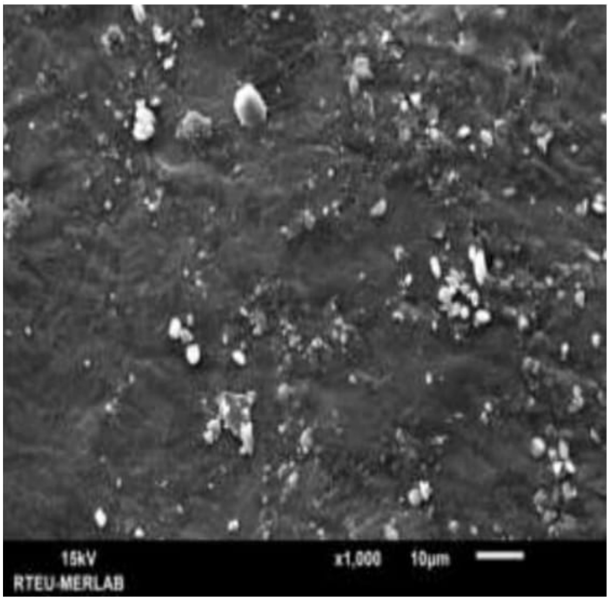

Figure 5. Surface micrograph of coating prepared with Semperfresh (1000×).

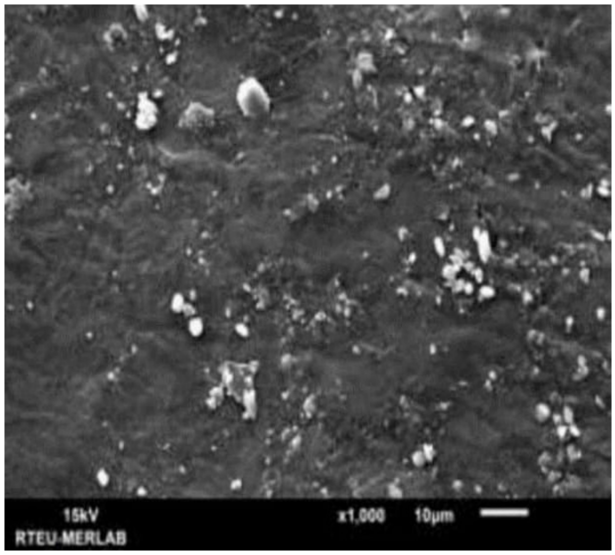

Figure 6. Surface micrograph of coating prepared with Semperfresh (10,000×).

implies phase separation between the Semperfresh material's components.

4. Conclusion

Weight loss, titration acidity, SSC, pH, total sugar, reducing sugar, sucrose, phenolic substance and antioxidant activity of cherry laurel fruit coated with different edible coatings, which are directly proportional to shelf life, at different storage times, were all investigated in this study. The best coating was obtained from the samples coated with Semperfresh in terms of weight loss, titration acidity, pH, total sugar, decreasing sugar, and sucrose values. While the uncoated samples provided the best results in terms of phenolic content, ABTS-IC_{50} and DPPH-IC_{50} values. As a result, we believe that using coating materials alone is insufficient and that elements with varied benefits should be combined. The Semperfresh coating has been found to preserve the qualitative attributes of cherry laurel fruit until the 10th day of storage.

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