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Araştırma Makalesi / Research Article

Pectin Based Edible Coating Application on Fresh-Cut Deveci Pears

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Abstract

The aim of this research was to apply pectin based edible coating for fresh-cut Deveci pears, and to investigate their quality changes during cold storage. For this aim, the coated (EC) and uncoated control samples (C) were stored at refrigerated (+ 4 °C) temperatures for 10 days. Samples were analyzed for their texture, color, weight loss, microbiological load and sensorial characteristics. Results showed that lightness values (L*) reduced during storage period of 10 days where the most browning occurred in the control (uncoated) group. Hardness values increased during storage for all samples. The weight loss of samples reached to 1.79 and 2.01 % at the end of 10 days for the coated and uncoated samples, respectively. The microbiological analyses indicated that microbial counts did not considerable increase during storage period. Also they were in acceptable level for all samples. Sensory analysis revealed that coated samples were considered as more attractive due to their shiny surface and took higher scores (> 4). However, overall acceptability scores considerable reduced especially after 7 days for all samples. Thus, pectin based edible coatings can be successfully applied for fresh-cut Deveci pears to prolong shelf life especially within 7 days of storage.

Keywords
Fresh-cut pear; Edible coating; Quality; Color

Pektin Bazlı Yenebilir Kaplamaların Taze Kesilmiş Deveci Armutlarına Uygulanması

Öz

Bu çalışmanın amacı, pectin bazlı yenilebilir film kaplamasının taze kesilmiş Deveci armutlarına uygulanması ve soğukta muhafaza sırasında meydana gelen kalite değişimlerinin incelenmesidir. Bu amaçla kaplanmış (EC) ve kaplanmamış kontrol örnekleri 10 gün boyunca soğukta muhafaza (+ 4 °C) edilmişlerdir. Örnekler tekstür, renk, ağırlık kaybı, mikrobiyolojik yük ve duyusal karakteristikleri açısından analizlenmişlerdir. Elde edilen sonuçlar, L* değerinin 10 günlük depolama süreci boyunca düştüğünü ve en fazla kararmanın kaplanmamış (kontrol) örneklerinde olduğu göstermiştir. Sertlik değerleri ise tüm örekler için depolama süreci boyunca artmıştır. 10 gün sonunda ağırlık kayıpları kaplanmış ve kaplanmamış örnekler için sırasıyla % 1.79 ve % 2.01 düzeyine ulaşmıştır. Mikrobiyolojik analizler ise, mikrobiyal sayının tüm analizlenen örnekler için kabul edilebilir ve uygun düzeyde olduğunu göstermiştir. Bu sayım ayrıca tüm numuneler için depolama boyunca hafifçe artmıştır. Duyusal analizler, kaplanmış örneklerin daha parlak dış yüzeye sahip olmalarından dolayı fazla beğenildiklerini ve daha yüksek puanlar (> 4) aldıklarını ortaya koymuştur. Bunula birlikte, genel beğeni skorları tüm örnekler için özellikle 7 gün sonrasında düşmüştür. Dolayısıyla pektin bazlı yenebilir filmler, taze kesilmiş Deveci armutlarının raf ömürlerinin uzatılması amacıyla 7 günlük depolama süreçlerinde başarıyla uygulanabilmektedir.

Anahtar kelimeler
Taze kesilmiş armut; Yenebilir kaplama;Kalite; Renk

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1. Introduction

Edible coating applications are environment friendly coatings which are used to preserve the quality of various foods where they do not show any harmful effect if they are consumed. They have been successfully used for various foods in the fresh-cut fruit and vegetable industry. In this industry, the

important perspective for the food quality preservation is that the reduction of the effects that cause the deterioration of fruit or vegetables due to the minimal processing (Garcia *et al.* 2014). The coating application will help for the extension of the fresh fruits shelf life by minimizing the moisture loss, as well as biochemical reactions such as migration of the solutes in tissue, the exchange of the gases due to the respiration process, oxidation reactions, and reduce some of the physiological disorders by the aid of coating (Duan *et al.* 2011; Kou *et al.* 2014).

In the scientific literature there are various researches implying the effective action of the edible coatings which contribute the extend shelf-life of fresh banana, fresh apples, fresh grapes and figs (Bico *et al.* 2008; Rojas-Graü *et al.*, 2010; Valverde *et al.* 2005; Allegra *et al.* 2017).

To prolong the shelf life of fresh-cut fruits, edible coatings contribute to improve the mechanical integrity or handling characteristics of the fruits to retard changes in moisture, oxygen, aromas, and solute transport (Silva de Moraes *et al.* 2012; Kou *et al*. 2014; Valdes *et al.* 2015). Edible coatings can be applied to fresh-cut commodities by different techniques such as spraying, dipping, brushing, and panning followed by drying (Bourtoom, 2008; Florez-López et al. 2016). Those coatings can be obtained from different types of materials usually as natural renewable sources like proteins, lipids, polysaccharides, and composites (Hassan et al. 2018). The commonly used edible coatings are made of polysaccharides. Kou *et al.* (2014) reported that polysaccharide based edible coatings acted as good oxygen barrier as low methoxylated pectin films. Therefore edible coating applications such as polysaccharide coatings for improvement of the fresh cut fruit's quality can be useful and contributes to prevent the surface oxidation of compounds in plant tissue (Garcia *et al.* 2014). The aim of this research was to analyze the quality changes of Deveci pears which were edible coated during storage period of 10 days at refrigeration conditions (+4 °C). Results of this research can be bases for fresh cuts commodities which are edible coated and can contribute the reduction of the surface deteriorations as oxidative browning, microbial growth, tissue softening, off-flavor formation or also weight losses occurred during storage which are important factors in food production in terms of economical point of view.

2. Materials and Methods

2.1 Materials

In this research, fresh mature pears (Deveci) were supplied from local markets (Afyonkarahisar, November, 2018). For the coating application, pectin (ABCR, food grade), calcium chloride (ACS), glycerol (Tekkim) were used. To determine the microbial loads potato dextrose agar (PDA) and plate count agar (PCA) were supplied from Merck (Germany). All other reagents used were analytical or technical grade.

2.2 Sample Preparation and Coating

Pears free of defects (bruised, immature, having some physical damages and having odd color) were washed under top water. Then surface was dried using paper towels and samples were sliced by the stainless steel knife to obtain slices with the 1cm thickness. Samples were exposured to pectin based edible coating which was described by Menezes and Athmaselvi, previously (2016). During application samples were immediately dipped in the pectin based coating solutions at solid to liquid ratio of 1:4 (w/w). The coated wedges were coded as (EC) and uncoated control samples were coded as (C). Coated wedges were then immediately drained and dried at ambient conditions for 1 h. Then coated pear wedges were packed using the polystyrene bags in ~300 g/pack, then they were sealed using the stretch film and put in refrigeration conditions of +4±1°C for the storage until the day of analyzes.

2.2 Methods

Samples were analyzed for their color, texture, weight loss, microbial loads and sensorial characteristic.

The L* (lightness) and a* (redness/greenness) b* (yellowness/blueness) and browning index (BI) for the color values indicating the browning of the samples (Akdeniz et al. 2012) were analyzed by Chromameter (Konica Minolta, Japan). Calculation of BI was performed using the following formula (Velickova *et al.* 2014):

$$BI = \frac{100}{0.17}\left(\frac{a* + 1.75\, b*}{5.645L* + a* - 3.012b*} - 0.31\right) \quad (1)$$

The weight losses were determined by gravimetrically.

Hardness values of the samples were determined by double compression test (Kavak and Akpunar, 2018) using TPA analyzer (TAXT texture analyzer, Godalming, UK).

The total mesopilic aerobic loads of pear wedges, and total mold and yeast counts were analyzed using pour plate method.

The sensorial characteristics of the fresh-cut samples were investigated using 5 scale hedonic sensory test (Altuğ, 1993), where 12 trained panelists were attained to the panel. At each time, cold stored samples served in white plates after they reached to room temperature of 21 °C.

All experiments were performed in two parallels and analyzes were conducted in triplicate. The results of the analyses were expressed as the average values of those measurements.

3. Results and Discussion

3.1 Color Results

In Table 1, the results of edible coating application on L* value of fresh-cut pear slices during storage were shown. Results showed that the L* value decreased but a* and BI values increased during storage period which indicated color changes such as increase in redness and browning for all fresh cut samples. When EC and control samples were compared, different than a* values, the significant difference in L* values indicated that edible coating application for the Deveci wedges was effective against surface browning. Since the L* value of Deveci samples indicates the lightness, the higher the L* value meant that the brighter the sample surface. Since the color is an important factor that affects the consumer's choice, results revealed that the brown color problem in fresh cut pears can be retarded by pectin based edible coating.

Table 1. The L*, a* and BI values of Deveci pears

	Sample	Day 0	Day 3	Day 7	Day 10
L*	C	74.57±1.93a	71.47±0.95a	69.90±0.36a	68.20±0.26a
	EC	77.03±1.58b	73.63±0.87b	72.03±0.76b	68.90±0.7a
a*	C	4.28±0.04c	4.42±0.05c	4.60±0.07c	5.13±0.05b
	EC	4.20±0.08c	4.35±0.06c	4.52±0.04c	5.01±0.08b
BI	C	26.12±0.91e	28.66±0.36e	31.84±0.42e	34.12±0.92e
	EC	25.14±1.01e	27.2±0.28f	29.74±0.53f	33.03±1.13e

a,b,c,d,e Different letter within columns show significant differences (Duncan test, $p < 0.05$)

Kou *et al.* (2014) reported that packaging materials, which were based on low methoxylated pectin, act as a good oxygen barrier due to their tightly packing property and good network structure of ordered hydrogen-bonding. Therefore the reduction in surface browning in EC samples can be due to this action. But after 7 days storage, the difference in L* values between coated and uncoated samples got reduced and difference between the BI values were not significant ($p > 0.05$). Those results indicated that edible coating can show a browning retarding action for 3-7 days storage periods ($p<0.05$), and especially at refrigeration conditions. In literature same low impact of coatings on color of fresh-cut commodities like fresh-cut apple, papaya were also reported in various studies (Raybaudi-Massilia *et al.* 2015; Oms-Oliu *et al.* 2008a). Therefore results revealed that edible coating for Deveci pears was less effective for storages longer than 7 days. To improve the color preservation for longer storage periods of Deveci pears, antibrowning agents such as ascorbic acid can be incorporated in coating formulations where it was reported that pectin based edible coatings including ascorbic acid for "Golden delicious" apples resulted delay in changes on color (Treviño-Garza *et al.* 2015).

3.2 Hardness and Weight Loss Results

The moisture loss can lead unwanted consequences which cause important economical losses due to high weight loss in mass commodities (Tesfay and Magwaza, 2017).

For the reduction of the detrimental effects weight loss and to preserve the textural quality, fresh-cut fruits samples can be coated. The results in Table 2 and 3 revealed that the hardness values in Table 2 increased with the increasing trend of the moisture loss. Edible coating was successful to preserve the

Table 2. Hardness loss values of the Deveci samples

	Hardness (N)			
Sample	Day 0	Day 3	Day 7	Day 10
C	1601.4±121a	2404.15±89a	2984.9±129a	3042.5±78a
EC	1589.1±204a	1901.2±153b	2667.4±135b	2902.3±173a

a,b, Different letter within columns show significant differences (Duncan test, $p < 0.05$)

Table 3. Weight losses in the Deveci pears

	Weight Loss (%)			
Sample	Day 0	Day 3	Day 7	Day 10
C	-*	0.35±0.09[a]	1.56±0.09a	2.01±0.1a
EC	-	0.28±0.08[a]	1.34±0.1b	1.79±0.1b

Table 4. Microbial count results of Deveci Samples (log10 cfu/g)

	Total mesophilic aerobic bacteria				*Total mold and yeast*			
Sample	*Day 0*	*Day 3*	*Day 7*	*Day 10*	*Day 0*	*Day 3*	*Day 7*	*Day 10*
C	*1.1a*	*2.3a*	*2.9a*	*3.2a*	*nd*	*2.6a*	*2.9a*	*3.5a*
EC	*nd b*	*2.3a*	*2.8a*	*2.9a*	*nd*	*1.9b*	*2.7a*	*3.1a*

which indicated the importance of coating in economical perspective. However, a 2.01 % moisture loss was obtained for uncoated Deveci pears at the end of the storage (day 10). Similar results were reported in literature (Allegra *et al.* 2017).

3.3 Microbial Analysis Results

In fresh cut fruits, water activity of the samples; storage conditions, as well as handling might promote conditions for the microorganisms to contaminate or growth on fresh-cut fruits, and results in a faster deterioration (Qadri *et al.* 2015).

The results of the microbial loads determined in Deveci Samples were tabulated in Table 4. Since the initial pH values and aw values of the fresh-cut pear samples were important, they were measured and found as 0.991 ±0.002 and 4.16 ±0.3, respectively. As in fresh fruits and vegetables, fresh-cut fruits have almost same water activity (aw) especially at the beginning of the samples preparations. But it is important to note that if fruits have low acidity, the growth of microorganisms was not facilitated (Parish *et al.* 2003). Therefore, due to the nature of fresh-cut pear and possibly due to the proper handling conditions low microbial counts were analyzed. Results showed that lower microbial counts were observed in all samples at initially. However, there was no significant difference ($p>0.05$) for the edible coated Deveci pears and uncoated samples in terms of microbial loads. These results were in good agreement with the literature. Since there was no antibacterial agent incorporated during film preparation, edible coating showed no significant effect to reduce the microbiological growth (Oms-Oliu *et al.* 2008b).

texture especially longer than 3 days storage ($p<0.05$). During preparation of edible films, adequate homogenization is required to improve the barrier functionality against the mass transfer of the film formed. The most common water mass barriers can be lipid based edible coatings. Therefore weight loss can be still a problem using pectin based edible films especially for fresh fruit and vegetables and may affect the texture of the samples.

Thus, weight loss was still in a considerable level in EC samples. Results were in good agreement with the literature where it was reported that pectin based edible films were not effective against moisture transfer through films by their hydrophilic nature (Ciolacu *et al.* 2014).

But, results indicated that edible coating of Deveci pears positively affected to preserve the hardness and resulted lower weight loss of 1.79 % at day 10,

3.4 Sensory Analysis Results

Sensory score graphs for the samples were given in Figures 1-2 for the +4 °C storage conditions for different time intervals.

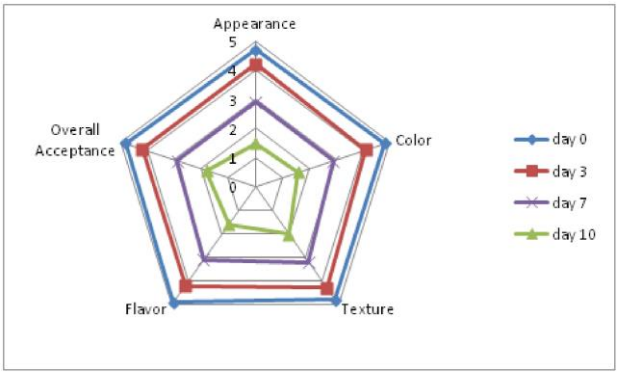

Figure 1. Sensory evaluation results of the uncoated samples (C) for the +4ºC storage

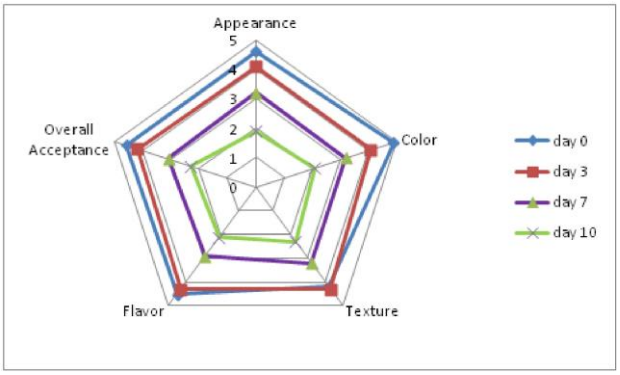

Figure 2. Sensory evaluation results of the coated samples (EC) for the +4ºC storage

Sensory evaluation is useful technique for having idea about the consumers' expectations (Beaulieu *et al.* 2004). By this way, the effects of fresh-cut application on sensorial characteristics, such as flavor, appearance, texture, and overall acceptance of Deveci samples could be investigated. Results of sensory analysis revealed that edible coatings of Deveci pears reduced the weight loss, thus it minimized the unwanted changes on the sensory characteristics (Allegra *et al.* 2017). Overall acceptance scores for EC samples were lower at the 0th days (immediately after coating) compared to uncoated samples. However, there was a comparable difference between the samples for longer storages ($p<0.05$). The storage resulted considerable decrease in sensory characteristics values such as overall acceptance of the all samples' scores but an important decrease was occurred for uncoated ones where their scores reduced under 2 for the 10th day ($p<0.05$). Results were in good agreement with the literature where it was reported that pectin based edible coating for the Pears (*Pyrus communis L.)* were successful for maintaining sensory attributes at 4 °C for 14 days (Oms-Oliu et al. 2008a). Results indicated that surface browning of Deveci pears was found to be important in terms of the sensorial characteristics of color where especially control got the lower scores (1.6) for 10 days of storage. The storage time negatively affected the overall scores of all samples however, higher scores were achieved for the Deveci pears that were coated since coating might have provided a shiny surface. Similar results were reported in literature (Barrett *et al.* 2010) which might be appreciated by the consumers or might protected the surface from browning.

4. Conclusion

Overall results in this study showed that edible coatings applied to Deveci pears was successful since these fresh-cut commodities are open to surface deteriorations. Unwanted quality losses; browning, weight loss, softening, and microbial growths are important in fresh-cut Deveci production in terms of economical point of view. The pectin based coating application to preserve quality and to prolong the Deveci pears shelf life especially within 7 days of storage may decrease the reliance for the cold temperatures usages without resulting considerable quality losses. Considering that the economical value of Deveci fruits or other fresh-cut commodities is determined on mass basis; edible coating can reduce the negative consequences the mass loss in fresh-cut Deveci pears which is important in terms of economical point of view.

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