1	ACCEPTED AKTICLE
2	
3	Effects of Aloe vera gel based active coating functionalized with lemon peel essential oil on
4	shelf life and quality attributes of cheese
5	Seyyed Sina Nejad Sajjadi ¹ , Ladan Mansouri Najand ² , Fatemeh Shahdadi ^{3*}
6	1- Graduated at Veterinary Medicine, Faculty of Veterinary Medecine, Shahid Bahonar University of
7	Kerman, sns1404@yahoo.com
8	2- Associate Professor, Food Hygene Department, Faculty of Veterinary Medecine, Shahid Bahonar
9	University of Kerman, mansouri39@uk.ac.ir
10	3- Assistant Professor, Department of Food Science and Technology, Faculty of Agriculture,
11	University of Jiroft, Jiroft, Iran, fatemeh.shahdadi@ujiroft.ac.ir
12	

A COEDTED A DTICLE

13 Abstract

In this study, the effect of an edible aloe vera gel-coating containing lemon peel essential oil (0, 14 100, and 150 ppm) on the qualitative characteristics of cheese samples was examined. Treatments 15 included 4 groups: control (without coating), aloe vera gel (AVG), AVG + 100 ppm lemon peel 16 essential oil (EO), and AVG + 150 ppm lemon peel EO. These treatments were evaluated for 60 17 days in terms of physicochemical, textural, sensory, and microbial counting properties. The 18 findings revealed that as storage duration increased, the acidity and salt increased while pH and 19 moisture content decreased. In evaluating the sensory properties, the effect of treatments on all 20 sensory properties except color scores was significant. Samples coated with AVG and 100 ppm 21 22 lemon peel EO received the highest flavor scores (4.97). As the storage time increased, the hardness, chewiness and springiness of the cheese samples increased. The samples' adhesiveness 23 24 was not affected by the storage duration. At the end of the storage time, the highest total microbial, mold and yeast counts were associated with the control cheese samples (5.37 and 4.62 log cfu/g, 25 26 respectively) and the lowest amount was related to the samples coated with AVG and 150 ppm of lemon peel EO (3.92 and 3.76 log cfu/g, respectively). In general, the use of edible coating 27 28 produced with AVG and lower concentrations of lemon peel EO (100 ppm and less) improved the appearance and the flavor of cheese samples during 60 days of storage. 29

Keywords: Aloe vera, Edible coating, Lemon peel essential oil, Cheese, Sensory evaluation,
 Textural properties.

33 Introduction

Nowadays, chemical preservatives have been proved to be harmful and consumers are more desired
to use foods without preservatives or containing natural preservatives (Sambu *et al.*, 2022). Cheese

is a nutrient-dense dairy food, providing protein, fats, and minerals (Yerlikaya and Ozer, 2014).
Cheese can be used as a main ingredient in meals, as a dessert and as a component of foods. The
rapid growth of cheese consumption in the world particularly in European countries is due to its
use in various foods (Gomes da Cruz *et al.*, 2009).

40 Due to its nutrients, cheese provides a favorable environment for the growth of several bacteria. Globally, there are a vast selection of different cheese varieties, and each one has a unique 41 42 microbiological profile. The high nutritional value of cheese has led to extensive studies to improve the quantitative and qualitative properties of this product and the production of more marketable 43 44 products (Trmčić et al., 2016). Mold growth during the ripening and manufacturing of cheese is one of the common issues faced by cheese makers. This problem is also seen for sellers and 45 46 consumers of this product during refrigeration. The use of herb materials has been considered for many years to prevent the growth of various microorganisms and molds. (Sengun et al., 2008). 47

Some natural and edible film-forming materials can be used to preserve foods such as cheese. One 48 49 of these natural ingredients is aloe vera gel (AVG). A clear and firm gel is extracted from the inner 50 parts of the leaves of the aloe vera (Aloe barbadensis Miller). AVG is odorless, non-sticky and has a high absorption strength. More than 98% of aloe vera gel is made up of water, followed by 51 polysaccharides (pectin, cellulose, hemicellulose, glucomannan, and acemannan), the acemannan 52 being considered as the main functional component of AVG (Bozzi et al., 2007). Aloe vera is also 53 an excellent source of antioxidants, Vitamin C, Vitamin A, Vitamin E, Beta-carotene, Folic acid, 54 Calcium, and Magnesium (Suriati, 2018). Aloe gel has high potential to be used in the food 55 industry, one of which as an edible coating material (Suriati et al., 2020). This gel is a 56 polysaccharide coating and can prevent moisture loss of the product. Due to the presence of 57 different chemicals including aloin, acemannan (Martinez-Romero et al., 2018)., anthraquinone, 58 59 saponins (Ergun and Satici, 2012) and phenolic compounds such as chatechin hydrate, caffeic acid, ferulic acid, ellagic acid, and quercetin (Sumi et al., 2019), AVG has antifungal and antimicrobial 60 characteristics and inhibits the growth and proliferation of fungus. 61

Essential oils (EO) are another herbal component that can be utilized in edible films and coatings. Citrus peel EO is a mixture of more than 100 compounds, which is divided into two volatile parts (99-85% of the total essential oil), and the non-volatile part (1-15%). The volatile parts include monoterpenes (such as limonene) and sesquiterpene hydrocarbons and oxygenated derivatives [aldehydes (such as citral), ketones and acids (along with linear aldehydes), alcohols (such as linalool)] and esters and the non-volatile parts include hydrocarbons, fatty acids, sterols,
carotenoids, waxes, coumarins, and flavonoids (Bennici and Tani, 2004). Limonene is the main
monoterpene compound of citrus essential oil and has antioxidant, antibacterial and antiviral
properties (Espina *et al.*, 2011; Roy *et al.*, 2007). In general, Citrus peel EOs have potent
antioxidant and antibacterial properties (Raspo *et al.*, 2020).

In a reported study, Shenbagam *et al.* (2023) investigated the effects of aloe vera gel-based edible coating (with or without incorporation of orange peel essential oil) on the postharvest shelf life and qualitative properties of button mushroom. The results showed that maximum concentration of orange peel essential oil (1500 μ L/L) incorporated in the 50% aloe vera gel significantly improved the postharvest quality attributes of mushrooms and helped extend the shelf life of mushrooms up to 4 days as compared to the control.

This study's objective was to determine the effect of an edible coating made of AVG and various
concentrations of lemon peel EO on physicochemical, sensory and textural properties as well as
microbial profile (total microbial count and total mold and yeast counts) of cheese.

81

89

97

82 Methods

83 Preparation of lemon peel essential oil

20 kg of Mexican lemon peel (*Citrus aurantifolia*) was dried at an ambient temperature (25-38°C)
and in the shade. The dried lemon peel was grounded and passed through a sieve (mesh 40). The
EO was extracted by steam distillation over a Clevenger system (Aria Exir, Iran) for 4h. The
obtained EO was dehydrated using sodium sulfate and stored at 4°C (Chanthaphon *et al.*, 2018).
Lemon peel EO was yellow in color and yield of extracted EOs was 1.1% (w/w).

90 Preparation of AVG

Aloe vera leaves were collected from University of Jiroft Research Farm. The leaves were washed and their jagged edges were cut with a knife. The top layer of the leaf was removed lengthwise and the gel was carefully separated from the leaf. The gel parts were blended thoroughly and put through a clean metal sieve (mesh 20) to form a homogeneous solution and the extract was finally pasteurized at 65°C for 15 min (Martinez-Romero *et al.*, 2018). In this study, Aloe vera extract at a 100% concentration was used.

98 Coating formulations and application

The cheese samples were prepared in Kerman Pegah milk factory. To produce cheese, milk was 99 pasteurized after fat standardization (3.5%) by HTST method and then concentrated at 50°C in 100 ultra-filtration system until reaching 34% dry matter. Starter inoculation was done at 32-35°C. 101 Then, rennet (12 ml per 400 g) was added and mixed well. The mixture was poured into containers 102 and after passing through the coagulation tunnel (30°C for 20 min), salt (3%) was added. After 103 that, it was sealed and placed in an incubator at 28°C until reaching a pH of 4.7. Then, it was 104 transferred to the cold room and kept at 4°C until the experiments (Khani and Roufegari Nejad, 105 2018). The cheese samples were cut into cubic specimens $(3 \times 3 \times 3 \text{ cm}^3)$ and coated by immersion 106 method. During this step, the cheese samples were immersed in the coating mixture (AVG with 107 various concentrations of lemon peel EO (0, 100 and 150 ppm which was homogenized by a 108 109 homogenizer at 1000 rpm) for 1 minute. The samples were incubated for about 8 hours under controlled temperature (12°C) and humidity (relative humidity of 85%) to dry all coatings 110 (Henriques et al., 2013). AVG and lemon peel EO created a colorless coating on the samples. The 111 samples were then placed in sealed polypropylene containers and stored in the refrigerator (4°C) 112 113 and evaluated at 15 days of intervals throughout 60 days of storage period.

114

115 Experimental methodology

Determination of acidity

117 The acidity of cheese samples was determined in terms of lactic acid and by titration with sodium

118 hydroxide (0.1 N) using the equation 1 (Iranian International Standard No2852:1995).

119 Equation 1: Acidity% = N. 0.009.100/M

In this equation, N is the amount of sodium hydroxide 0.1 N consumed (ml) and M is the weightof the sample.

122 123

126

3 pH measurement

A digital pH meter (Metrohm, model 827, Switzerland) was used to determine the samples' pH
levels (Iranian International Standard No2852:1995).

127 Measurement of moisture content

Cheese samples were placed in an oven at 102°C until they reached a constant weight (about 5 h).
The dried samples were weighed after cooling, and the amount of moisture loss was estimated
using the equation 2 (Roy *et al.*, 2007):

- 131 Equation 2: Moisture loss rate= Weight before drying Weight after drying / Weight before drying 132 $\times 100$
- 133

134 Measurement of salt content

- Mohr method was used to determine the amount of salt. Titration was performed using silvernitrate solution (0.1 N) until an orange precipitate appeared. The percentage of salt was calculated
- as equation 3 (Dorosti *et al.*, 2011).
- Equation 3: Amount of salt% = ml of consumed silver nitrate (ml) \times silver nitrate N \times 0.585
- 139

140 Sensory evaluation

Sensory properties of cheese samples were evaluated using a five-point hedonic test (very bad: 1 to very good: 5) in the first and sixtieth days of storage. The evaluators were 50 people who were selected from the experts working in Pegah Kerman factory and students familiar with the characteristics of cheese. Samples (100 g packages) were removed from the refrigerator before the test and after reaching the ambient temperature in 30 g pieces were given to the evaluators.

- 146 Samples were assessed for their characteristics including flavor, odor, color, texture and overall
- 147 acceptance. Mean data of the first and sixtieth days were reported (Beigomi *et al.*, 2013).
- 148

157

149 **Texture analysis test**

A texture analyzer equipment (model QTS25, FARNEL CNS, UK) and a cylindrical probe with a diameter of 36 mm were utilized for the texture profile analysis (TPA) test. The cheese samples were removed from the refrigerator before the test and after slicing $(20 \times 20 \times 20 \text{ mm})$ up to 50% of the initial height (10 mm depth) was compressed by the machine. Each test was performed in at least three replications. The measured traits were: hardness, cohesiveness, adhesiveness, chewiness, springiness, and gumminess. It should be noted that the TPA test is a two-step test and these traits were defined according to the standard TPA curve (Hosseini *et al.*, 2013).

158 Microbial tests

159 1- Total microbial count

160 The total microbial count was performed using a PCA (Plate Count Agar) at 37°C for 48 h. The

- number of bacteria in cheese samples was calculated as follows (Rezaei *et al.*, 2010).
- Microbial content /g of cheese = number of colonies \times inverse dilution coefficient \times 10

164 Mold and yeast count

165 YGC (Yeast Extract Glucose Chloramphenicol) medium was used for mold and yeast (fungi) count

- at 25° C for 48-72 h. After incubation, the obtained colonies were counted using the equation of the
- 167 previous section (Rezaei *et al.*, 2010).
- 168

169 Statistical analysis

170 The experiments were conducted in a factorial experiment based on completely randomized design

and the experimental data were analyzed with SPSS: 21 software. Factors included treatments (4

172 levels) and storage time (5 levels). The means were compared using the Duncan's multiple range

test with a 5% confidence level. All experiments were carried out in triplicate.

174

175 Results and Discussion

176 The effect of treatments on the pH

The findings in Table 1 demonstrate that the pH of cheese samples significantly reduced as storage time was increased. The lowest pH reduction was observed for cheese samples coated with AVG and 150 ppm of lemon peel EO. The pH of control treatment was found to be the lowest at the end of the maintenance time, whereas the other treatments were not significantly different (p> 0.05).

- 101
- 182

183

185

Table 1. The effect of treatments on the pH of samples.

		ne chiect of tieat	ments on the pr	i or samples.	
Treatments	Day 1	Day 15	Day 30	Day 45	Day 60
Control	5.50±0.1 ^{Ab}	5.43 ± 0.05^{ABb}	5.28±0.12 ^{Cb}	5.09 ± 0.1^{CDb}	$4.86 \pm 0.14^{\text{Ec}}$
AVG	5.86 ± 0.09^{Aa}	579 ± 0.1^{Aba}	5.57 ± 0.05^{Ca}	5.36±0.1 ^{Da}	5.10 ± 0.06^{Eab}
AVG + 100 ppm	$5.85{\pm}0.11^{Aa}$	5.75 ± 0.15^{Aba}	5.58 ± 0.2^{Ca}	5.35 ± 0.08^{Da}	5.16 ± 0.1^{Eab}
EO					
AVG + 150 ppm	$5.83{\pm}0.1^{Aa}$	5.75 ± 0.08^{Aba}	5.57 ± 0.05^{Ca}	5.57 ± 0.05^{CDa}	5.25 ± 0.12^{Da}
EO					
P value	0.013	0.004	0.003	0.004	0.049

* Mean values in each column that have different lower-case letters have a significant difference (p < 0.05).

* Numbers in each row that have different capital letters have a significant difference (p < 0.05).

186 The effect of the treatments on the acidity

Table 2 shows that the acidity of the cheese samples was significantly influenced by the type of coating used as well as the storage time. The treatment coated with AVG and 150 ppm EO and control had the greatest and lowest acidity, respectively, on the sixtieth day. The acidity of the treatments increased as storage duration increased, and this increase was significant in all

investigated treatments on all storage days. In cheese samples coated with AVG and 150 ppm of

Table 2. The effect of treatments on the acidity of samples.						
Treatments	Day 1	Day 15	Day 30	Day 45	Day 60	
Control	1.46 ± 0.05^{Ea}	1.77 ± 0.09^{Da}	2.11 ± 0.2^{Ca}	2.66 ± 0.09^{Ba}	3.26±0.1 ^{Aa}	
AVG	1.26 ± 0.1^{Eb}	$1.56 \pm 0.1^{\text{Db}}$	1.80 ± 0.18^{Cb}	2.16 ± 0.1^{Bb}	2.70 ± 0.05^{Ab}	
AVG + 100 ppm EO	1.23±0.08 ^{Eb}	$1.55 \pm 0.1^{\text{Db}}$	1.81±0.1 ^{Cb}	2.05 ± 0.06^{Bbc}	2.66±0.11 ^{Abc}	
AVG + 150 ppm EO	$1.26 \pm 0.08^{\text{Eb}}$	1.50 ± 0.1^{CDb}	1.67 ± 0.15^{Cb}	1.93±0.1 ^{Bc}	2.52±0.15 ^{Ac}	
P value	0.004	0.004	0.033	0.044	0.004	
		11.00 1		1.01 11.00		

192 lemon peel EO, minimal acidity changes were seen at the end of storage period.

194 * Mean values in each column that have different lower-case letters have a significant difference (p < 0.05).

195 * Numbers in each row that have different capital letters have a significant difference (p < 0.05).

196

193

197 By increasing the storage time, a reduction in pH values of all samples were observed which may be related to the activity of lactic acid bacteria species owing to the metabolization of lactose to 198 lactate and produce acid (Dermiki et al., 2008). Ramos et al. (2012) found that the pH of cheeses 199 coated with whey protein isolate, guar gum and antimicrobial substances decreased with increasing 200 storage time, and the coated cheeses had a higher pH than the control. Jamshidi et al. (2018), used 201 a coating of AVG and Persian gum in Iranian white cheese, and reported that during storage, the 202 203 pH decreased significantly while the acidity increased. Over time, the acidity of the various 204 treatments increased, indicating that an increase in lactic acid production by the bacteria may be the main reason for this trend, which is definitely consistent with the decreasing trend observed in 205 206 pH during storage.

El-Sisi *et al.* (2015) showed that the acidity of chitosan-coated cheeses increased during storage.
A study also revealed that the acidity of cheddar cheese samples coated with whey protein increased during ripening (Wagh *et al.*, 2013).

On the sixtieth day, the lowest amount of acidity was observed in cheese samples coated with AVG and lemon peel EO, which could indicate the lowest bioavailability of lactic acid bacteria (starter and non-starter) in these samples; Because more activity of lactic acid bacteria leads to more decomposition of lactate and production of organic acids such as lactic acid and acetic acid, and AVG and lemon peel EO probably due to antimicrobial activity decreased growth of these bacteria in cheese samples (Wagh *et al.*, 2013).

216

217 The effect of treatments on the salt content

218	According to results of Table 3, the control had the most salt content at all storage times, while the							
219	other treatments were not significantly different (p> 0.05). The salt content of the treatments							
220	enhanced with inc	creasing storag	ge period, althou	gh this rise was	not significant	in samples coated		
221	with AVG and 15	0 ppm lemon j	peel EO (p> 0.03	5).				
222								
223								
224								
225								
226								
227								
228								
229								
230								
231								
232	2 Table 3. The effect of treatments on the salt content (%) of cheese samples.							
	Treatments	Day 1	Day 15	Day 30	Day 45	Day 60		
	Control	3.26 ± 0.25^{Ba}	3.30 ± 0.2^{ABa}	3.41 ± 0.1^{ABa}	3.50 ± 0.2^{Aa}	3.57±0.1 ^{Aa}		
	AVG	2.76 ± 0.1^{Bb}	2.81 ± 0.5^{ABb}	2.86 ± 0.25^{Ab}	2.96±0.1 ^{Ab}	3.06 ± 0.15^{Ab}		
	AVG + 100 nnm	2 72+0 2Bb	2 80±0 5ABb	2 86±0 21Ab	2 03+0 00Ab	3.07 ± 0.15 Abc		

AVG AVG + 100 ppm	2.76±0.1 ^{Bb} 2.73±0.3 ^{Bb}	2.81±0.5 ^{ABb} 2.80±0.5 ^{ABb}	2.86±0.25 ^{Ab} 2.86±0.21 ^{Ab}	2.96±0.1 ^{Ab} 2.93±0.09 ^{Ab}	3.06±0.15 ^{Ab} 3.07±0.15 ^{Abc}
EO AVG + 150 ppm EO	2.73±0.17 ^{ABb}	2.80±0.44 ^{ABb}	2.87±0.23 ^{Ab}	$2.94{\pm}0.15^{Ab}$	2.98±0.17 ^{Ac}
P value	0.007	0.002	0.001	0.001	0.001

* Mean values in each column that have different lower-case letters have a significant difference (p < 0.05).

* Numbers in each row that have different capital letters have a significant difference (p < 0.05).

235

241

242

248 249

It can be seen that all the coated samples have less salt than control, which is consistent with the results of other researchers who have studied the effect of coating on the properties of cheese (Ramos *et al.*, 2012; Yilmaz and Dagdemir, 2012). On the other hand, during the 60 days of storage, the salt content of samples increased slightly as a result of weight loss due to the removal of moisture from the cheese texture.

The effect of treatments on the moisture content

The effect of the treatments on the moisture content of cheese samples is shown in Table 4. The results reveal that the coating treatments and storage period had a significant effect on the moisture content. As storage time increased, the moisture content of samples decreased. Cheese samples with coatings retained moisture significantly more than the control. There was no significant difference in the moisture content of all treatments on the first day of storage (p> 0.05).

Table 4. The effect of treatments on the moisture content (%) of samples.							
Treatments	Day 1	Day 15	Day 30	Day 45	Day 60		

Control AVG AVG + 100 ppm EQ	$\begin{array}{c} 63.30{\pm}4.2^{Aa} \\ 64.15{\pm}3.1^{Aa} \\ 64.60{\pm}4.0^{Aa} \end{array}$	$\begin{array}{c} 61.73{\pm}2.9^{Ab} \\ 64.66{\pm}4.3^{Aa} \\ 64.73{\pm}4.2^{Aa} \end{array}$	$\begin{array}{c} 60.76{\pm}2.1^{ABb} \\ 62.70{\pm}2.5^{ABab} \\ 63.00{\pm}2.1^{Aa} \end{array}$	$\begin{array}{c} 58.66{\pm}3.3^{Bb} \\ 61.67{\pm}3.1^{Ba} \\ 62.08{\pm}3.5^{ABa} \end{array}$	$\begin{array}{c} 58.73{\pm}4.1^{Bb} \\ 61.33{\pm}4.2^{Ba} \\ 61.40{\pm}3.8^{Ba} \end{array}$
AVG + 150 ppm EO	64.20±4.1 ^{Aa}	64.84±3.9 ^{Aa}	63.43±2.4 ^{ABa}	62.64±3.4 ^{Ba}	61.44±4.3 ^{Ba}
P value	0.006	0.032	0.007	0.000	0.033

* Mean values in each column that have different lower-case letters have a significant difference (p < 0.05).

* Numbers in each row that have different capital letters have a significant difference (p < 0.05).

The cheese samples' moisture gradually decreased during the storage period as a result of some 253 moisture being released from the texture of the cheese and the packaging to the outside. The 254 difference between the coated samples is probably due to the composition of the coating as well as 255 the kinetics of water influence and outflow into the various coatings (Pantaleão et al., 2007). 256 257 Jamshidi et al. (2018) reported that almost all cheeses coated with AVG and Persian gum showed higher moisture content than the control, which indicates the positive effect of coating on moisture 258 retention in cheese during storage. Coating with aloe vera gel had a barrier property for moisture 259 loss in several fruits such as peach (Mohammadi et al., 2020), plum (Martinez-Romero et al., 2018), 260 grapes, fresh cut papaya (Farina et al., 2020), and tomato fruit (Tzortzakis et al., 2019). 261

262

263 The effect of treatments on the sensory properties

264 Table 5 shows that with the exception of the color index, the effects of the tested treatments on the 265 sensory characteristics of samples are significant. The highest taste score was related to the 266 treatment coated with AVG and 100 ppm of lemon peel EO + the lowest taste score was related to the control and the AVG and 150 ppm of lemon peel EO treatments. The highest and lowest odor 267 scores were observed in AVG with 100 ppm of lemon peel EO treatment and control, respectively. 268 269 Samples coated with AVG and different concentrations of EO did not show significant differences in terms of texture (p > 0.05) and the lowest texture score was assigned to the control. In terms of 270 271 general acceptance, AVG with 100 ppm of lemon peel EO treatment received the highest score.

2	7	2
2	7	3

Tab	Table 5. The effect of treatments on the sensory properties of samples.							
Treatments	Taste	Odor	Color	Texture	General			
					acceptance			
Control	4.36±0.1°	4.45±0.05°	4.92±0.1	4.53±0.15°	4.42±0.08 ^{cd}			
AVG	4.59±0.05 ^b	4.63±0.1 ^b	4.96±0.1	4.67±0.1 ^b	4.78±0.12 ^b			
AVG + 100 ppm	4.97 ± 0.06^{a}	4.89 ± 0.12^{a}	4.96±0.15	4.91±0.05 ^{Aa}	4.95±0.06 ^a			
EO								
AVG + 150 ppm	4.36±0.05°	4.75±0.16 ^b	4.97±0.09	4.89±0.12 ^a	4.54±0.1°			
EO								
P value	0.001	0.001	0.56	0.000	0.003			

* Mean values in each column that have different lower-case letters have a significant difference (p < 0.05).

Most sensory panelists reported a bitter taste for cheeses containing 150 ppm of lemon peel essential oil. According to research of Yilmaz and Dagdemir (2012), there were no significant differences in the color of cheese samples coated in beeswax compared to the control, which is consistent with the findings of this investigation.

- Abbas et al. (2017) reported that adding 0.005 and 0.010 µl of basil essential oil to UF soft cheese 280 significantly improved the taste throughout the freshness of cheese and during the 60 days of 281 storage time. According to this report, the desirability of samples containing low concentration 282 $(0.005 \ \mu l \text{ per } 100 \ m l)$ was higher than the samples containing high concentration $(0.010 \ \mu l / 100 \ m l)$ 283 284 ml). Mohammadi et al. (2011) reported that 100 mg/kg of basil essential oil improved the odor, taste and acceptability of white cheese during the production and storage, however, the taste and 285 acceptability of the cheese samples were adversely affected by the essential oil concentrations of 286 150 and 200 mg/Kg. 287
- According to Otero *et al.* (2014), sheep cheese samples covered with edible films containing antimicrobial agents had improved sensory properties. The results of Pieretti *et al.* (2019) showed that cheese samples coated with alginate and low concentrations of oregano essential oil had better sensory acceptance than the control and higher concentrations of essential oil.
- 292

293 The effect of the treatments on the textural characteristics

The effect of the studied treatments on the textural characteristics of cheese samples is shown inFigure 1 (A-F).

296

297 1- Hardness

According to Fig. 1(A), the coating and storage duration both significantly affected hardness. The hardness of the samples increased with storage time. On 60th day, the AVG with 100 and 150 ppm of lemon peel EO had the lowest hardness while the control and AVG treatments had the highest hardness.





Figure 1. The effect of treatments on the hardness (A), Adhesiveness (B), cohesiveness (C), springiness (D), gumminess (E), and chewiness (F) of samples.

2- Adhesiveness

[Downloaded from jast.modares.ac.ir on 2024-05-08]

Fig. 1(B), shows that although numerically the adhesiveness of the samples increased during storage, the storage time had no significant effect on the adhesiveness of samples. At the end of storage, samples coated with AVG and 150 ppm of lemon peel EO showed the highest adhesiveness, which did not show a significant difference with the AVG and 100 ppm of lemon peel EO treatment (p> 0.05). The lowest adhesiveness was related to the control.

318

319 **3- Cohesiveness**

Fig. 1 (C), shows that the AVG treatment had the lowest cohesiveness at the end of the storage period, with no other treatments significantly different (p > 0.05).

322

323 4- Springiness

According to Fig. 1(D), No particular trend in the springiness of samples during storage time was seen in the control. In other treatments, springiness of samples increased with increasing storage time. On the sixtieth day, the highest springiness was related to AVG treatments with 100 and 150 ppm of lemon peel EO and the lowest amount of springiness was related to control.

328

329 **5-Gumminess**

According to Fig. 1 (E), it can be seen that at the end of the storage, the highest and lowest gumminess were observed in the treatment coated with AVG+150 ppm lemon peel EO and the control, respectively. The gumminess of samples significantly increased as the storage time rose.

333

334 6- Chewiness

Fig. 1(E) shows that the chewiness of samples increased as storage time increased. In the samples coated with AVG and AVG containing 100 and 150 ppm of lemon peel EO on the forty-fifth and sixtieth days, this enhancement was not significant (p> 0.05). On the sixtieth day, the lowest amount of chewiness was observed in the control and samples coated with AVG and the highest amount of chewiness was observed in the samples coated with AVG and 150 ppm of lemon peel EO.

According to the findings of the textural characteristics, the hardness of the samples increased with increasing storage time, which may be related to moisture loss during storage. Another factor contributing to the samples' increased hardness during storage is likely an increase in proteinprotein interactions (Bianchi *et al.*, 2021). It was also observed that the coated samples had less hardness than the control. It seems that more moisture in the coatings and more hydration may
reduce the hardness of the samples (Zhong *et al.*, 2014).

Pieretti *et al.* (2019) examined how rosemary and oregano EOs and alginate-based edible coatings
affected the textural characteristics of fresh cheese, and they found that at the end of the storage
period, the coated samples had less hardness than the control.

350 At the end of the storage time, the highest amount of adhesiveness was observed in the samples

- coated with AVG and 150 ppm lemon peel EO and the lowest amount of adhesiveness was related
 to the control. In the research of Wang *et al.* (2019), cheddar cheese samples coated with isolated
- 353 whey protein nanofibrils and carvacrol showed more adhesiveness than uncoated samples.
- The cohesiveness of the samples increased with increasing the storage time, and at the end of the storage, the treatment with the lowest cohesiveness was in the presence of AVG; the other treatments did not significantly differ from each other. In the study reported by Wang *et al.* (2019), the cohesiveness of coated cheese samples increased with increasing storage time, while no significant difference was observed in the other samples.
- With increasing storage period, the chewiness of samples increased. This is in line with the hardness and gumminess properties. On the sixtieth day, the highest amount of chewiness was related to the treatment coated with AVG and 150 ppm of lemon peel EO. From a sensory point of view, it is perceived that more energy is needed to chew the coated samples. It was found that the chewiness of cheese samples coated with starch and carvacrol increased with increasing storage, and the coated samples had more chewiness than the control (López-Córdoba, 2021).
- 365

366 The effect of treatments on microbial count of samples during storage

367 1- The total microbial count

Table 6 shows the effect of the treatments on the total microbial count of the samples. This table shows that the total microbial count was significantly affected by both storage times and coatings. The total microbial count increased with increasing storage time. The sample coated with AVG and 150 ppm of lemon peel EO had the lowest microbial count. In general, the coated treatments showed less microbial count than the control.

Table 6. The effect of treatments on the total microbial count (log cfu/g) of same	ples.
--	-------

					1
Treatments	Day 1	Day 15	Day 30	Day 45	Day 60
Control	4.87 ± 0.15^{Ca}	4.88±0.1 ^{Ca}	4.94±0.21 ^{Ba}	4.98±0.15 ^{Ba}	5.37±0.2 ^{Aa}
AVG	$3.64 \pm 0.1^{\text{Db}}$	3.73 ± 0.14^{Cb}	4.60 ± 0.15^{Bb}	4.64 ± 0.11^{Bb}	4.82 ± 0.1^{Ab}

373

AVG + 100 ppm	3.38 ± 0.22^{Dc}	3.55 ± 0.21^{Cc}	3.96 ± 0.25^{Bc}	4.30±0.1 ^{Ac}	4.31 ± 0.14^{Ac}
AVG + 150 ppm	$2.71{\pm}0.12^{\text{Ed}}$	$2.92{\pm}0.2^{\text{Dd}}$	3.73 ± 0.1^{Cd}	$3.81{\pm}0.25^{Bd}$	3.92 ± 0.21^{Ac}
EO					
P value	0.001	0.002	0.001	0.000	0.003

* Mean values in each column that have different lower-case letters have a significant difference (p < 0.05).

* Numbers in each row that have different capital letters have a significant difference (p < 0.05).

377

378 **2- The total mold and yeast count**

Table 7 shows that there is significant variation in the total number of mold and yeast in cheese samples depending on the various treatments and storage time. The total amount of mold and yeast increased with more storage time across all treatments, with the control having the highest levels. The lowest amounts of mold and yeast were found in samples that had been coated with AVG and EO.

384

Table 7. The effect of treatments on total mold and yeast count (log cfu/g) of cheese samples.

				<u> </u>	
Treatments	Day 1	Day 15	Day 30	Day 45	Day 60
Control	3.34 ± 0.2^{Ea}	3.82±0.13 ^{Da}	3.96±0.15 ^{Ca}	4.13±0.14 ^{Ba}	4.62±0.1 ^{Aa}
AVG	$3.17 \pm 0.15^{\text{Eb}}$	$3.45 \pm 0.21^{\text{Db}}$	3.81±0.11 ^{Cb}	4.01 ± 0.1^{Bb}	4.15 ± 0.2^{Ab}
AVG + 100 ppm	0.00^{Dc}	3.11±0.1 ^{Cc}	3.47 ± 0.22^{Bc}	3.76±0.1 ^{Ac}	3.92±0.21 ^{Ac}
EO					
AVG + 150 ppm	0.00^{Ec}	0.00^{Dd}	3.06±0.1 ^{Cd}	3.47 ± 0.12^{Bd}	3.76 ± 0.15^{Ad}
EO					
P value	0.001	0.002	0.003	0.001	0.002
	1 1 1	11.00 1	1	1.01 11.00	

* Mean values in each column that have different lower-case letters have a significant difference (p < 0.05).

387 * Numbers in each row that have different capital letters have a significant difference (p < 0.05).

388

In general, the coated treatments showed less microbial, mold and yeast counts than the control.

Numerous studies have focused on the antibacterial effects of AVG and lemon peel EO (Nielsen
and Rios, 2000; Irshad *et al.*, 2011; Roy *et al.*, 2007).

Aloin and aloe-emodin are the two main components of aloe vera gel. Several researchers have confirmed the antifungal and anti-bacterial properties with improved moisture and gas barrier properties of aloe vera gel based edible coating (Ortega-Toro *et al.*, 2017)

AVG as a coating can create a physical barrier against microorganisms and reduce the occurrence of microbial spoilage (Asghari and Khalili, 2014). AVG inhibits the germination and growth of fungal mycelium and the inhibitory effect of its compounds on the activity of enzymes of pathogenic fungi has been proven (Reynolds and Dweck, 1999). Saritha *et al.* (2010) reported that the antimicrobial activity of AVG against gram-positive bacteria was higher than gram-negative bacteria. Navarro *et al.* (2011) also reported that AVG controls the *Rhizopu stolonifer*, *Botrytis cinerea* and *Penicillium digitatum*. Leitgeb *et al.* (2021) investigated the effect of two aloe vera 402 cultivars gel on different bacteria and fungi and reported that both aloe vera cultivars gel inhibited 403 the growth of *Bacillus cereus, Staphylococcus aureus, E. coli, Pseudomonas aeruginosa, P.* 404 *fluorescens* and *Candida albicans*, representatives of Gram-positive bacteria, Gram-negative 405 bacteria, and fungi. The antibacterial properties of aloe vera are due to its constituents, which 406 include saponins, acemannan, and anthraquinone derivatives. Therefore, the presence of these 407 substances and antibacterial compounds in the AVG can reduce spread of germs in the treated 408 samples (Ramasubramanian *et al.*, 2010).

Essential oils have different mechanisms in destroying microorganisms. These compounds enter 409 410 the lipids of cell membranes and mitochondria, and this causes a difference in the structure of cells and their greater permeability, resulting in the release of ions and other cell contents. The release 411 412 of large amounts of cellular contents or the release of vital molecules and ions causes cell death (Pauli, 2006). There are several reports about the antimicrobial effect of citrus EOs and extracts 413 414 (Chanthaphon et al., 2018; Tan et al., 2011). Antimicrobial properties of lemon peel EO are related to its active ingredients. Limonene is the main monoterpene compound of lemon peel and other 415 416 citrus EOs, which has antibacterial and antiviral properties (Espina et al., 2011; Roy et al., 2007). Artiga-Artigas et al. (2017) studied the antimicrobial effect of edible coating containing different 417 concentrations of oregano EO on low-fat cheese. Their results showed that coatings containing 418 oregano EO significantly reduced the microbial population during storage. 419

420

428

430

431

432

433

421 Conclusion

The use of edible coating of AVG and lemon peel EO on cheese improved the appearance and prevented textural changes during storage. Lower concentrations (50 and 100 ppm) of lemon peel EO were suitable for obtaining cheeses with better sensory properties. The coatings maintained properties such as moisture, pH, hardness, etc. The lowest microbial, mold and yeast counts were observed in the treatments coated with AVG and 150 ppm of lemon peel EO. In general, the coated treatments showed less microbial, mold and yeast counts than the control.

429 **References**

- Abbas, H.M., Assem, F.M., Zaky, W.M., Kassem, J.M. and Omer, E.A. 2017. Antioxidant, rheological and sensorial properties of ultra-filtrated soft cheese supplemented with basil essential oil. *Int. J. Dairy Sci.*, **12(5)**: 301-309.
 - 2- Artigas, M.A., Acevedo-Fani, A. and Martín-Belloso, O. 2017. Improving the Shelf Life of

- 434 Low-Fat Cut Cheese using Nanoemulsion-Based Edible Coatings Containing Oregano
 435 Essential Oil and Mandarin Fiber. *Food Control.*, **76**: 1–12.
- Asghari, M.R. and Khalili, H. 2014. The effect of *aloe vera* gel on polyphenol oxidase
 activity, qualitative properties and shelf life of cherry fruit. *J. Horticl. Sci.*, 28 (3): 399-406.
- 4- Beigomi, M., Ghods Rohani, M., Mohammadifar, M.A., Hashemi, M., valizadeh, M. and
 Ghanati, K. 2013. Comparison of textural and sensory characteristics of ultrafiltrated white
 cheese produced by paneer bad (*Withania coagulans*) protease and fungal rennet. *Iran. J. Nutr. Sci. Food Technol.*, 8(1): 253-262.
- 442 5- Bennici, A. and Tani, C. 2004. Anatomical and ultrastructural study of the secretory cavity
 443 development of Citrus sinensis and Citrus limon: evaluation of schizolysigenous ontogeny.
 444 *Flora.*, **199**: 464 -475.
- 6- Bianchi, A., Mallmann, S., Gazoni, I., Cavalheiro, D. and Rigo, E. 2021. Effect of Acid
 Casein Freezing on the Industrial Production of Processed Cheese. *Int. Dairy J.*, **118**:
 105043
- 448 7- Bozzi, A., Perrin, C., Austin, S. and Arce Vera, F. 2007.Quality and authenticity of
 449 commercial *aloe vera* gel powders. *Food Chem.*, **103**(1): 22–30.
- 450 8- Chanthaphon, S., Chanthachum, S. and Hongpattarakere, T. 2018. Antimicrobial activities
 451 of essential oils and crude extract from tropical citrus spp. against food-related
 452 microorganism. *J Sci Technol.*, **30** (1): 125-131.
- 9- Dermiki, M., Ntzimani, A., Badeka, A., Savvaidis, I.N. and Kontominas, M.G. 2008. Shelflife extension and quality attributes of the whey cheese. *LWT-Food Sci. Techol.*, 41(2): 284294.
 - 10-Dorosti, S., Bazmi, A., Ghanbarzadeh, B. and Ayaseh, A. 2011. Effect of brine concentration on the physicochemical properties of Iranian White cheese. J. Food Sci. Technol., 8(30): 1-10.
 - 11-El-Sisi, A.S., Mohamed Gapr, E.S. and Kamaly, K.M. 2015. Use of Chitosan as an Edible Coating in RAS Cheese. *Biolife.*, **3**(2): 564-570.
 - 12-Espina, L., Somolinos, M., Loran, S., Conchello, P., Garcia, D. and Pagan, R. 2011. Chemical composition of commercial Citrus fruit essential oils and evaluation of their antimicrobial activity acting alone or in combined processes. *Food Control*, 22: 896-902.
 - 13-Farina, V., Passafiume, R., Tinebra, I., Scuderi, D., Saletta, F. and Gugliuzza, G. 2020.

457

458

459

460

461

462

463

- 465 Postharvest application of aloe vera gel-based edible coating to improve the quality and
 466 storage stability of fresh-cut papaya. *J. Food Qual.*, 200(1): 8303140
- 467 14- Gomes da Cruz, A., Buriti, F.C.A., Batista de Souza, C.H., Fonseca Faria, J.A. and Isay
 468 Saad, S.M. 2009. Probiotic cheese: health benefits, technological and stability aspects.
 469 *Trends Food Sci. Technol.*, 20(8): 344-354.
- 470 15- Henriques, M., Santos, G., Rodrigues, A., Gomes, D., Pereira, C. and Gil, M. 2013.
 471 Replacement of conventional cheese coatings by natural whey protein edible coatings with
 472 antimicrobial activity. *J. Hyg. Eng. Des.*, **3**: 34-47.
- 473 16- Hosseini, M., Habibi Najafi, M.B. and Mohebbi, M. 2013. Assessment of physico-chemical
 474 and sensory properties of imitation cheese containing whey protein concentrate and
 475 enzyme-modified Lighvan cheese. *Iran. J. Nutr. Sci. Food Ind.*, 8(2): 91-102.
- 476 17- Iranian International Standard. No2852:1995, 1st revision. Milk and milk
 477 productsDetermination of titrable acidity and value pH –Test method.
- 478 18- Irshad, S., Butt, M. and Younus, H. 2011. InVitro antibacterial activity of Aloe Barbadensis
 479 Miller (Aloe vera). *Pharma.*, 1(2): 59-64.
- 480 19- Jamshidi, F., Rahimi, S. and Fadaei Noghani, V. 2018. The Effect of Edible Aloe vera Gel481 Persian Gum Film on Iranian White Cheese Properties. *Iran. J. Nutr. Sci. Food Technol.*,
 482 13 (1): 63-74.
- 20- Leitgeb, M., Kupnik, K., Knez, Ž. and Primožič, M. 2021. Enzymatic and Antimicrobial
 Activity of Biologically Active Samples from *Aloe arborescens* and *Aloe barbadensis*. J. *Biol.*, 10(8): 765-771.
- 486 21- Khani, A. and Roufegari Nejad, L. 2018. Low fat UF-feta cheese production containing
 487 xanthan gum. *J. Food Ind. Res.*, 29(1): 155-167.
 - 22- López-Córdoba, A. 2021. Feasibility of Using Carvacrol/Starch Edible Coatings to Improve the Quality of Paipa Cheese. *Polym.*, **13(15)**: 1-11.
 - 23- Martinez-Romero, D., Paladines, D., Valverde, M., Guillén, F., Zapata, P. J. and Valero, D.
 2018. Rosehip oil added to aloe vera gel as postharvest coating of 'Songría' plums and 'President' prunes. *Acta Hortic.*, **1194(4)**: 321–325..
 - 24- Mohammadi, K., Karim, G., Hanifian, Sh., Tarinejad, A. and Gasemnezhad, R. 2011.
 Antimicrobial effect of *Zataria multiflora* Boiss. Essential oil on *Escherichia coli* O157:H7
 during manufacture and ripening of white brined cheese. *J. Food Hyg.*, 1(2): 69-78.

489

490

491

492

493

494

- 496 25- Mohammadi, L., Hassanzadeh Khankahdani, H. andTanaka, F. 2020. Effect of aloe vera
 497 gel combined with basil (*Ocimum basilicum* L.) essential oil as a natural coating on
 498 maintaining post-harvest quality of peach (*Prunus persica* L.) during storage. IOP
 499 Conference Series: Earth and Environmental Science, **594**(1): 012008
- 26- Navarro, D., Díaz-Mula, H.M., Guillén, F., Zapata, P.J., Castillo, S., Serrano, M., Valero,
 D. and Martínez-Romero, D. 2011. Reduction of nectarine decay caused by *Rhizopus stolonifer*, *Botrytis cinerea* and *Penicillium digitatum* with Aloe vera gel alone or with the
 addition of thymol. *Int. J. Food Microbiol.*, **151**: 241–246.
- 504 27- Nielsen, V. and Rios, R. 2000. Inhibition of fungal growth on bread by volatile components
 505 from spices and herbs and the possible application in active packaging with special
 506 emphasis on mustard essential oil. *J. Food Microbiol.*, **60 (2-3)**: 219-29.
- 507 28- Otero, V., Raquel, B., Santosa, J., odríguez-Calleja, M.R., Nerín, C. and García-Lópeza,
 508 M. 2014. Evaluation of two antimicrobial packaging films against *Escherichia coli*509 O157:H7 strains in vitro and during storage of a Spanish ripened sheep cheese (Zamorano).
 510 *Food Control.*, **42**: 296-302.
- 511 29- Ortega-Toro, R., Collazo-Bigliardi, S., Roselló, J., Santamarina, P. and Chiralt, A. 2017.
 512 Antifungal starch-based edible films containing aloe vera. *Food Hydrocoll.*, 72(2): 1–10
- 30- Pantaleão, I., Pintado, M.E. and Poças, M.F. 2007. Evaluation of two packaging systems
 for regional cheese. *Food Chem.*, **102** (2): 481–487.
- 31- Pauli, A. 2006. α-Bisabolol from chamomile-A specific ergostrol biosynthesis inhibitor. *J. Aromathe.*, 16:5-21.
 - 32- Pieretti, G.G., Pinheiro, M.P., Scapim, M.R.D.S., Mikcha, J.M.G. and Madrona, G.S. 2019. Effect of an Edible Alginate Coating with Essential Oil to Improve the Quality of a Fresh Cheese. *Acta. Sci. Technol.*, **41**: 36402.

33-Ramasubramanian, T.S., Sivakumar, V.T. and Thirumalai, A.V. 2010. Antimicrobial activity of *Aloe vera* (L.) Burm. against pathogenic microorganisms. *J. Bio. Sci. Res.*, 4(2): 251–258.

- 34- Ramos, O.L., Pereira, J.O., Silva, S.I., Fernandes, J.C., Franco, M.I., Lopes-da-Silva, J.A., et al. 2012. Evaluation of antimicrobial edible coatings from a whey protein isolate base to improve the shelf life of cheese. *J. Dairy Sci.*, **95**(11): 6282-92.
- 35-Raspo, M.A., Vignola, M.B., Andreatta, A.E. and Juliani, H.R. 2020. Antioxidant and

517

518

519

520

521

522

523

524

525

527	antimicrobial activities of citrus essential oils from Argentina and the United States. Food
528	Biosci., 36(3): 27-38.
529	36- Rezaei, M., Yahyaei, M., Parviz, M. and Khodaei motlagh, M. 2010. A Survey of microbial
530	contamination in Traditional Cheese distributed in Markazi Province in. Iran. J. Health
531	Environ., 7(1): 115-121.
532	37-Reynolds, T. and Dweck, A.C. 1999. Aloe vera leaf gel. A review updatr. J.
533	<i>Ethnopharmacol.</i> , 21 : 68- 89.
534	38-Roy, B.C., Hoshino, M., Ueno, H., Sasaki, M. and Goto, M. 2007. Supercritical Carbon
535	Dioxide Extraction of the Volatiles from the Peel of Japanese Citrus Fruits. J. Essent. Oil
536	<i>Res.</i> , 19 : 78-84.
537	39-Sambu, S., Hemaram, U., Murugan, R. and Alsofi, A.A. 2022. Toxicological and
538	Teratogenic Effect of Various Food Additives: An Updated Review. Biomed. Res. Int.,
539	24(1) : 1-11.
540	40- Saritha, V., Anilakumar, K.R. and Khanum, F. 2010. Antioxidant and antibacterial activity
541	of Aloe vera gel extracts. Int. J. Pharm. Biol. Sci., 1: 376-384.
542	41- Sengun, I., Yaman, D. and Gonul, S. 2008. Mycotoxins and mould contamination in cheese:
543	a review. World Mycotoxin J., 1(3) : 291 – 298
544	42-Shenbagam A., Kumar, N., Rahul, K., Upadhyay, A., Gniewosz, M. and Kieliszek, M.
545	2023. Characterization of Aloe Vera Gel-Based Edible Coating with Orange Peel Essential
546	Oil and Its Preservation Effects on Button Mushroom (Agaricus bisporus). Food Bioproc.
547	<i>Tech.</i> , 131 (4): 1-22.
548	43- Sumi, F.A., Sikder, B., Rahman, M.M., Lubna, S.R., Ulla, A., Hossain, M.H., Jahan, I.A.,
549	Alam, M.A., and Subhan, N. 2019. Phenolic Content Analysis of Aloe vera Gel and
550	Evaluation of the Effect of Aloe Gel Supplementation on Oxidative Stress and Fibrosis in
551	Isoprenaline-Administered Cardiac Damage in Rats. Prev. Nutr. Food. Sci., 24(3): 254-
552	264.
553	44- Suriati, L., Utama, I.M.S., Harjosuwono, B.A. and Gunam, B.W. 2020. Stability Aloe Vera
554	Gel as Edible Coating. Earth Environ. Sci., 411(2): 1-6.
555	45-Suriati, L. 2018. Studies the Resistance to Oxidation and the Changes Phases against the
556	Characteristics of Physicochemical Aloe vera Gel. J. Bio. Chem. Research., 35(2): 670-
557	679.

558	46- Tan, Q., Ai, M. and Minh, N. 2011. Volatile constituents of essential oil from citrus sinensis
559	grown in tine giant province, Vietnam. Asian J. Food Agro. Ind., 4(3): 183-186
560	47- Trmčić, K., Chauhan, A., Kent, D.J., Ralyea, R.D., Martin, N.H., Boor, K.J. and Wiedmann,
561	M. 2016. Coliform detection in cheese is associated with specific cheese characteristics,
562	but no association was found with pathogen detection. J. Dairy Sci., 99(8): 6105-6120.
563	48-Tzortzakis, N., Xylia, P. and Chrysargyris, A. 2019. Sage essential oil improves the
564	effectiveness of aloe vera gel on postharvest quality of tomato fruit. Agron., 9(10): 635-
565	643.
566	49-Wagh, Y.R., Pushpadass, H.A., Magdaline Eljeeva Emerald, F. and Surendra Nath, B.
567	2013. Preparation and characterization of milk protein films and their application for
568	packaging of Cheddar cheese. Food Sci. Technol., 51(12): 3767-3775.
569	50-Wang, Q., Yu, H., Tian, B., Jiang, B., Xu, J., Li, D., Feng, Z. and Liu, C. 2019. Novel
570	Edible Coating with Antioxidant and Antimicrobial Activities Based on Whey Protein
571	Isolate Nanofibrils and Carvacrol and Its Application on Fresh-Cut Cheese. J. Coat, 9(9):
572	583-591.
573	51-Yerlikaya, O. and Ozer, E. 2014. Production of probiotic fresh white cheese using co-
574	culture with Streptococcus thermophilus. Food Sci. Technol., 34(3): 1-10.
575	52-Yilmaz, F. and Dagdemir, E. 2012. The effects of beeswax coating on quality of Kashar
576	cheese during ripening. Int. J. Food Sci. Tech., 47: 2582-2589.
577	53-Zhong, Y., Cavender, G. and Zhao, Y. 2014. Investigation of different coating application
578	methods on the performance of edible coatings on Mozzarella cheese. LWT Food Sci.
579	<i>Technol.</i> , 56 : 1–8
580	
581	تاثیر پوشش فعال مبتنی بر ژل آلوئه ورا با اسانس پوست لیمو بر ماندگاری و ویژگی های کیفی پنیر
582	سید سینا نژاد سجادی ¹ ، لادن منصوری نژند ² ، فاطمه شهدادی ³ *
583	1-فارغ التحصيل دامپزشکی، دانشکده دامپزشکی، دانشگاه شهيد باهنر کرمان، sns1404@yahoo.com
584	2-دانشیار گروه بهداشت مواد غذایی، دانشکده دامپزشکی، دانشگاه شهید باهنر کرمان، .mansouri39@uk.ac.ir
585	3– استادیار، گروه علوم و صنایع غذایی، دانشکده کشاورزی، دانشگاه جیرفت، جیرفت، ایران،
586	fatemeh.shahdadi@ujiroft.ac.ir

588	در این مطالعه تأثیر پوشش خوراکی ژل آلوئه ورا حاوی اسانس پوست لیمو (0، 100 و 150 پی پی ام) بر ویژگی های کیفی نمونه های
589	پنیر مورد بررسی قرار گرفت. تیمارها شامل 4 گروه کنترل (بدون پوشش)، ژل آلوئه ورا، ژل آلوئه ورا و 100 پی پی ام اسانس پوست
590	ليمو و ژل آلوئه ورا و 150 پی پی ام اسانس پوست ليمو بود. اين تيمارها به مدت 60 روز از نظر خواص فيزيكوشيميايي، بافتي، حسي و
591	شمارش میکروبی مورد ارزیابی قرار گرفتند. یافتهها نشان داد که با افزایش مدت نگهداری، اسیدیته و نمک افزایش و pH و رطوبت
592	کاهش یافت. در ارزیابی ویژگیهای حسی، تأثیر تیمارها بر تمامی ویژگیهای حسی به جز امتیاز رنگ معنیدار بود. نمونه های پوشش
593	داده شده با ژل آلوئه ورا و 100 پی پی ام پوست لیمو بالاترین امتیاز طعم (4/97) را دریافت کردند. با افزایش زمان نگهداری، سختی،
594	قابلیت جویدن و فنری بودن نمونه های پنیر افزایش یافت. چسبندگی نمونه ها تحت تاثیر مدت زمان نگهداری قرار نگرفت. در پایان زمان
595	نگهداری، بیشترین شمارش کل میکرویی، کپک و مخمر مربوط به نمونه های پنیر شاهد (به ترتیب 5/37 و log cfu/g4/62) و
596	کمترین مقدار مربوط به نمونه های پوشش داده شده با ژل آلوئه ورا و 100 پی پی ام پوست لیمو (به ترتیب 3/92 و log 3/76
597	cfu/g) .به طور کلی استفاده از پوشش خوراکی تهیه شده با یل آلوئه ورا و غلظت های کمتر اسانس پوست لیمو (100 پی پی ام و
598	کمتر) باعث بهبود ظاهر و طعم نمونه های پنیر طی 60 روز نگهداری گردید.

واژگان كليدى: آلوئه ورا، پوشش خوراكى، اسانس پوست ليمو، پنير، خواص بافتى، ارزيابى حسى.

600