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Evaluation of the Effect of the Film Prepared on the Basis of Polylactic Acid Tragacanth Gum Containing *Origanum Vulgare* Essential Oil on the Shelf Life and Characteristics of Feta Cheese

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ABSTRACT

Introduction: Chemical preservatives are widely used to increase the shelf life of food products. But due to their disadvantages, today the main research is in the field of using natural preservatives. This study was carried out to prepare a film based on polylactic acid and tragacanth gum containing *Origanum vulgare* essential oil (OVEO) on the microbial, chemical and sensorial properties of feta cheese.

Method: OVEO was extracted by steam distillation and its composition was determined by gas chromatography-mass spectrometry (GC-MS). The most important parameters of PLA films were determined as thickness, turbidity and humidity. The antibacterial effects of films were evaluated against four common pathogenic bacteria (*Staphylococcus aureus*, *Listeria monocytogenes*, *Salmonella typhimurium* and *Escherichia coli* O_{157}:H_7) by disk diffusion method.

Results: The results of physical properties showed no significant difference in film turbidity when adding different OVEO concentrations ($p>0.05$). In terms of moisture and turbidity, there was a significant difference between films containing different concentration of OVEO and pure film ($p<0.05$). The results of the antimicrobial activity showed that the *Staphylococcus aureus* (10 mm), *E. coli* (6 mm), Listeria and Salmonella (1 mm), were the most sensitive organisms, respectively. The most sensitive and largest diameter of the inhibition zone was in Aspergillus (13 mm).

Conclusion: Based on these findings, the film based on polylactic acid and tragacanth gum containing OVEO can be an effective natural preservative with the least adverse effects on the properties of different products and may have a wide application in food industry.

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Introduction

Cheese is a dairy product that plays an important role in human nutrition and because of its high nutritional value; it has a special place in the diet of many countries [1]. One of the most consumed salt water cheeses in the world is Feta cheese; Feta is a soft, ripe white cheese made from whole sheep's milk or a mixture of sheep's and goat's milk and kept sliced in salted water, it is universally accepted that, in order to produce good quality feta cheese, the acidity of the milk should be less than (23%) in terms of lactic acid, and its pH should be more than the roots of feta cheese go back to Greece, where it has been traditionally produced since the time of the Homeric period. Today, Denmark is the largest producer of feta cheese. Feta is prepared in two traditional and industrial ways [1]. Dairy products, such as cheese are prone to mold and yeast contamination due to their physical and chemical properties, as well as being rich in nutrients [2].

Recently, the use of edible films and coatings has increased and they have become a common option for packaging various food products [3]. Active packaging is one of the most commonly methods of packaging .The use of antimicrobial materials in this packaging prevents the growth

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of microorganism that increases the shelf life of food products, and enhances food quality [4]. The use of polymers is one of the materials used in active food packaging .one of the polymers used in active packaging is poly lactic acid that is polymer with a linear chain obtained from renewable sources. It has high mechanical strength transparency and is suitable for human consumption [4-5].

Gums are made of different types of polysaccharides used in food packaging and are safe for human consumption [6]. Gums are macromolecules with a high molecular weight used to increase consistency, gel formation, emulsion stabilization and foaming, prevent the growth of ice-crystals, and also create a favorable sense in food products [7]. One of the gums used in the tropical industry is tragacanth; tragacanth is colorless and tasteless gum. This plant grows predominantly in the southwestern part of Asia, particularly in the arid and mountainous areas of Iran and Turkey. The world's biggest manufacturer and exporter of tragacanth gum is Iran [8-9].

Today, plant essential oils are used to increase the shelf life of food due to their antimicrobial, antiviral and antioxidant properties [10]. One of the essential oils used in the industry is *Origanum vulgare* essential oil; Origanum is a native plant of southwestern Eurasia and the Mediterranean region, which is a member of the lamiaceae family. Origanum is perennial plant. The most used part of this plant is leaves, whose taste varies from subtly bitter to mildly sweet [11]. The two main compounds in *Origanum vulgare* essential oil are thymol and carvacrol. Carvacrol is the main component of *Origanum vulgare* essential oil, and its antimicrobial and antifungal effects have been seen on various microorganisms [12].

Considering the importance of food health and safety, economic efficiency and ways of keeping fresh food longer using natural compounds instead of chemical compounds, the present study aims to investigate the effect of a film prepared based on polylactic acid and tragacanth gum containing *Origanum vulgare* essential oil on the shelf life and characteristics of feta cheese.

Materials and Methods

Preparation and Analysis of OVEO

The Department of Botany sciences Research institute confirmed the OVEO. After milling the dried parts, the essential oil was extracted for 3 hours using the Clevenger (Ambala, India) apparatus by hydro-distillation method. After dehydration using water-free sodium sulfate, it was kept in dark glass containers at refrigerator temperature, the prepared samples were injected into a gas chromatograph machine, and the most suitable separation of essential oil compounds was obtained. A mass spectrometer-mounted (GC-MS) device (Biobase, China) was used to analyze essential oils. Columns were maintained at 265 degrees per minute for (30 minutes), with a temperature program of (50-265 °C), a progressive increase of 2.5 degrees per minute, and a length of 30 meters, along with an inner diameter of 250 µm and an inner layer's thickness of 0.25 µm. the injection chamber temperature was 250 ºF and the helium gas was obtained at a speed of 1.5 mm. the El had an ionization energy of 70 ev and ionization temperature of 250 ºF. Alkane was utilized to determine the retention index [13-14].

Preparing Polylactic Acid Film with Tragacanth Gum

Preparing of polylactic acid films was done using modeling method and based on the study of Liana et al., (2019) [12]. The method involved dissolving 1 g of polylactic acid (Merck, Germany) in 50 ml of chloroform and 1% glycerol. The polylactic acid granules were fully dissolved after 8 hours at room temperature when a magnetic stirrer was used. Then, in separate containers, a 2% gum solution was dissolved in 100 ml of sterile distilled water (2% v/v) and stirred at 65 ºC for 30 minutes with the help of a magnetic stirrer at 150 revolutions per minute. Finally, the prepared solutions were mixed in equal proportions Rezaeigolestani et al., (2017). Different concentrations of OVEO were added to prepared solution in proportions of 0, 0.5, 1 and 1.5 [15]. The resulting solutions were homogenized well the help of a homogenizer at 12000 revolutions per minute. Afterward, the solutions were transferred to sterile glass plates with a depth of 15 mm and a diameter of 8 mm, and the solvent was evaporated under chemical hood for 24 hours. After chloroform was vaporized the films created in sanitary conditions were separated from the plates. Finally, the films were placed in desiccator that contained silica gel until testing.

Measuring the Thickness, Turbidity and Humidity of the Film

The thickness of polylactic acid films was measured using a caliper. Each sample had 10 measurement points calculated and their average was calculated [16]. The turbidity was measured by cutting the film samples into squares and placing them on the inner side of the spectrophotometer. The absorption spectrum (200-800 nm) for each sample was recorded using a spectrophotometer, and the turbidity of the film was calculated using; [17].

Film thickness (mm) = film turbidity/absorption at a wavelength of 600 nm

The amount of moisture was measured by cutting pieces of film with dimensions of 3×3 mm and the weight each one. The final dry weight was obtained by placing the film pieces in a 90 ºC oven [16].

Preparation of Cheese, Treatment and Packaging

The feta cheese was bought from a trusted brand without any preservatives. Then, to produce the treatments, a sheet of prepared film was placed on the bottom of a sterile glass plate and cheese was placed on it, so that the thickness of the cheese was the same in all treatments. Then a second film was placed on the cheese and it was stored under sterile conditions inside sterile bags and at a refrigerator temperature for testing [15].

Microbial Properties of Samples

The microbial test of cheese samples was conducted to evaluate the presence of live cells on days 0, 3, 6, 9 and 12th at 4 ºC. The bag mixer was used to separate and weight 10 g of the sample under sterile conditions. Then, 90 ml of a (0.1% peptone water) solution from (Merck, Germany) was mixed and homogenized by a stomacher device. Then, (1 ml) of the dilution prepared under sterile conditions and using a sterile sampler was added to tubes containing (9 ml) of a (0.1% peptone water sterile) solution was added and mixed well. Different dilutions were prepared by transferring it to the next tubes. Duplicate and three consecutive dilutions were used to culture all the tests. *Staphylococcus aureus* on Baird parker agar was cultured using surface cultured method at 37 ºC for 48 hours, coliform was cultured using violet red bile agar culture medium at 37 ºC, they were incubated for 5th day [15, 16].

Preparation of Bacteria

Four common pathogenic bacteria found in food were used to investigate the antibacterial effects of the films, including two gram-positive bacteria, *Staphylococcus aureus* (ATCC 65218) and *Listeria monocytogenes* (ATCC 19117), and two gram -negative bacteria, *Salmonella typhimurium* (ATCC 14028) and *Escherichia coli* O_{157}:H_7 (ATCC 25922). All the mentioned strains were obtained from the Department of the Faculty of Veterinary Medicine at Amol university. The lyophilized culture and primary strains of bacteria were transferred to heart-brain broth (BHI) (Merck, Germany). The amount of inoculation was prepared by incubating the bacterial cells for 18 hours at 35 ºC, after three the successive cultures were transferred to sterile cuvette tubes containing heart-brain broth medium. Using a spectrophotometer, an optical absorption measurement of 0.1 was taken for the resulting suspension inside sterile cuvette tube. The wavelength measured was 600 nm.

Antibacterial Activity

The antibacterial activity of the films in laboratory conditions was evaluated using diffusion method from disc diffusion to agar. The discs of the films prepared in the previous step were placed on Mueller Hinton Agar culture medium (Merck, Germany). Disks of the prepared film containing the desired concentration of OVEO with diameter of 10 mm were placed in the center of the plate; it was incubated for 24 hours at 37 ºC. The diameter of the non-growing halo around the film was measured with calipers and software. In this study, the standard gentamicin antibiotic disc was employed as a positive control [15].

pH

A pH meter (Janco, Taiwan) was used to measure the cheese's pH 10 g of the sample was completely homogenized with 90 ml of distilled water for 1 minute.

Peroxide Value

To measure the peroxide value, the sample was crushed and 3 g of n-hexane solution was added as a solvent. After 24 hours, the samples were filtered with Whatman paper N.1, filter paper was transferred to a weighed Erlenmeyer glass. After the solvent evaporated, 25 ml of acetic acid-

chloroform solution was added to Erlene in a ratio of 2 to 3. Then, 30 ml of distilled water was added. Additionally, 0.5 mL of a 1% starch glue solution was added. The solution was titrated with thiosulfate solution until it became colorless. The amount of peroxide in mill equivalents per 1000 g (meq.kg) of fat calculated by;

$$POV = V.N.1000/W$$

Fat weight in grams (W) - normality of thiosulfate (N) - ml of thiosulfate for titration(V).

Sensory Evaluation

The sensory properties of cheese samples, including texture, taste, appearance, and overall acceptance, were determined by 9 employees of the Faculty of Food Science and Engineering of Azad university of Karaj using a 5-point hedonic method (with 5 indicating favorable quality and 1 indicating unfavorable quality). They used water to rinse their mouths between samples [18].

Statistical Analysis

SPSS software was used for statistical analysis. The Leven's test was used to evaluate the homogeneity of data variance. The Kolmogorov-Smirnov test was used to check the normality of the data. ANOVA test was used to compare the average number of bacteria.

Results

Chemical composition of OVEO

As shown in table 1, the analysis of the chemical composition of OVEO showed that its main components are Pulegone (19.08%), Piperitenone oxide (29.22%), and Piperitenone (10.32%).

Table 1. Analysis results of the studied OVEO using GC/MS method

Number	Compounds	Relative percentage of compounds
1	Pulegone	**19.08**
2	Piperitenone oxide	**29.22**
3	α – pinene	**0.31**
4	2- β- Pinene	**1.07**
5	Caryophyllene oxide	**3.36**
6	P- Menth- 3- En- 8- ol	**7.49**
7	Spathulenol	**0.38**
8	1,8- Cineole	**8.91**
9	Cis- Iso Pulegone	**6.16**
10	Menthofuran	**4.11**
11	Cyclohexan- 1- one	**1.10**
12	Iso pentyl 2- Menthyl Butanoate	**1.05**
13	P- Mentha- 3,8- Diene	**0.96**
14	(Neo- Iso) Dihydrocarveol	**0.73**
15	Borneol	**5.06**
16	Piperitenone	**10.32**
17	1- Decene	**0.77**
18	Cis- piperitenone	**5.62**
Total	-	**96.70**

Physical and Mechanical Properties of Film

Figure 1 shows the results of the mechanical properties, including humidity, turbidity, and thickness of the films. In relation to the turbidity feature, there was no significant difference between the films containing different percentages of OVEO and the pure film ($p>0.05$). In relation to the humidity feature, it was found that there was a significant difference between the treatments with different concentrations of OVEO and the film prepared alone ($p<0.05$). However, the treatments containing different concentrations of OVEO did not have significant difference ($p>0.05$). When examining the thickness of the films, it was also found that treatment containing 1% of OVEO was significantly different from the other treatments ($p<0.05$).

Antimicrobial Activity

Figure 2 shows the results of evaluating the antimicrobial activity of polylactic acid and tragacanth gum films containing different concentrations of OVEO. As is clear from the results, the antimicrobial activity of the films increased as the concentration of OVEO increased. Among the studied bacteria, the film containing 1.5% OVEO showed the most antimicrobial activity against *Staphylococcus aureus*, with a halo diameter of non-growth measuring 10 mm. For *Escherichia coli* O_{157}:H_7, the film with 1.5% OVEO showed a non-growth halo diameter of 6 mm, making it the most sensitive bacteria. The diameters of non-growth for Listeria and Salmonella bacteria were approximately the same. Aspergillus showed the most inhibitory growth halo. Overall, the results suggest that the film containing 1.5% OVEO has significant antimicrobial activity.

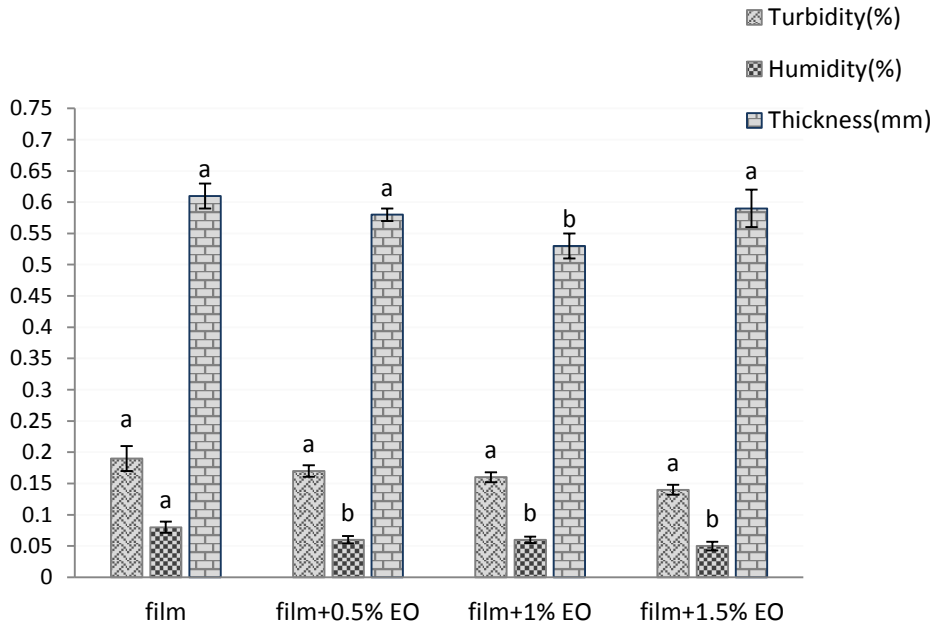

Figure 1. The results of the mechanical properties of the films

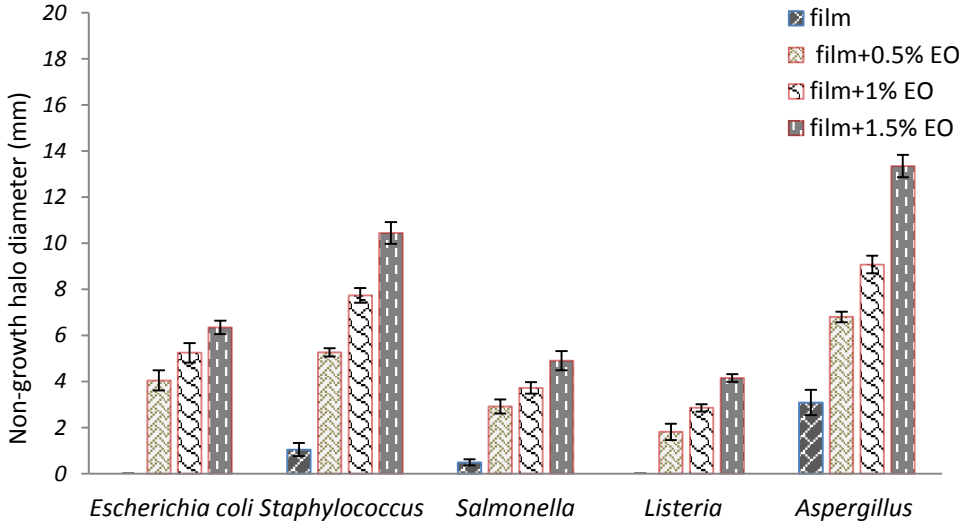

Figure 2. The results of the non-growth halo diameter of the films

Enumeration of Coliform Bacteria and Staphylococcus Aureus

The results of counting coliform bacteria and *staphylococcus aureus* can be seen in figure 3 and 4. As it is clear from the results, the process of counting coliforms in all treatments was increasing during the study. In the control group, the count of coliforms increased from 2.13 log cfu/g on day 0 to 5.20 log cfu/g on day 12. The control group had a significant difference with pure film treatment alone from day 6 and with other treatments from day 2 (P<0.05). Also, by adding OVEO to the film compared to the pure film, the growth of coliforms decreased and by increasing the concentration of the OVEO, the control of the growth of bacteria improved, so that on the last day, all the treatments had a significant difference (P<0.05) and the lowest growth rate in the treatment containing 1.5% OVEO was (3.06 log cfu/g).

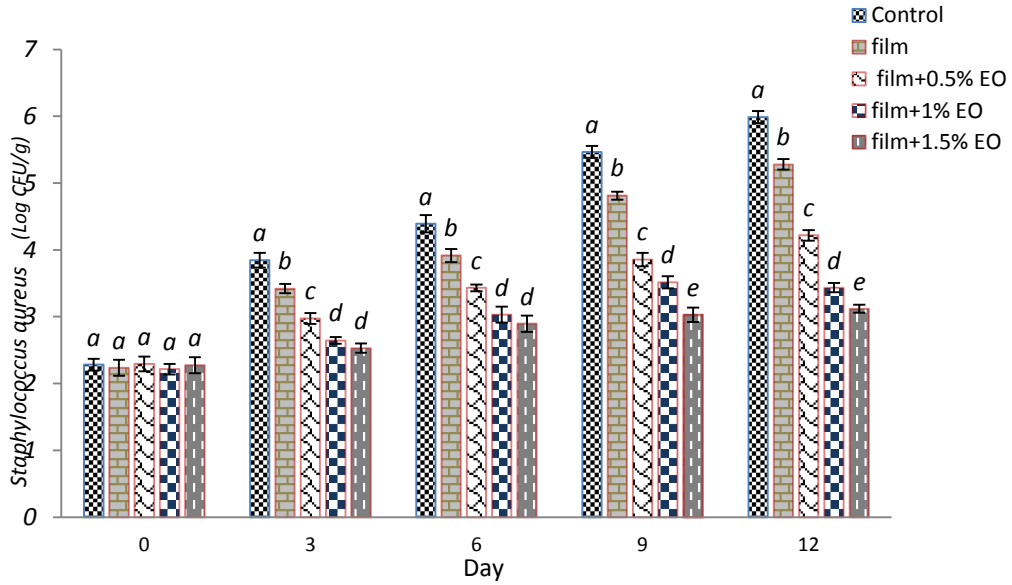

Figure 3. The count of *Staphylococcus aureus* in different treatments during storage (Mean ± SD). Non-similar lower case English letters indicate significant differences between treatments in the same day (P<0.05).

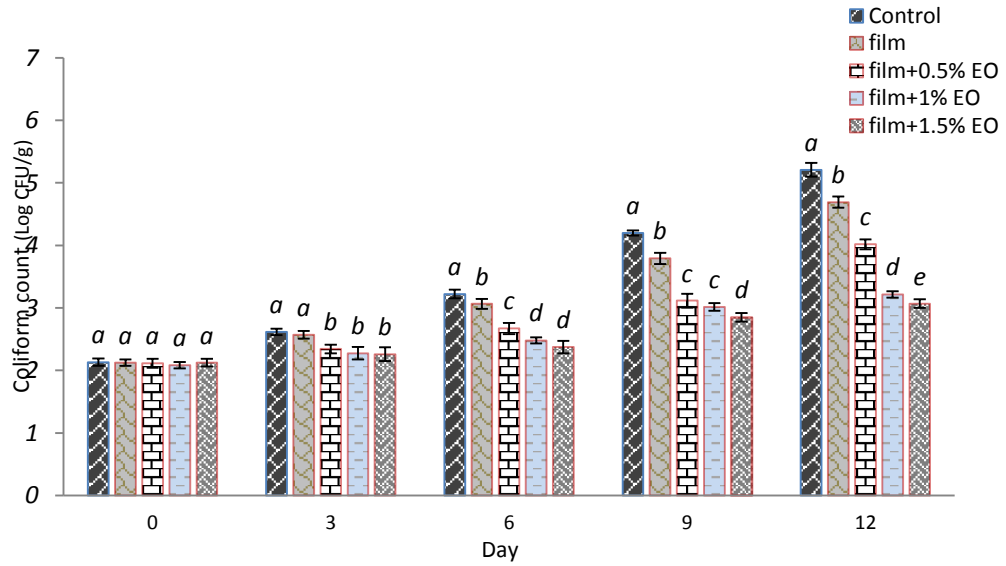

Figure 4. The results of the coliform count in different treatments during storage (Mean ± SD). Non-similar lower case English letters indicate significant differences between treatments in the same day (P<0.05).

In the count of *Staphylococcus aureus*, the control group reached from 2.28 log cfu/g on zero days to 5.98 log cfu/g on 12th day. From the third day of the study, there was a significant difference between the control group, the pure film, and the film containing OVEO ($P<0.05$), and from the 9th day to the end of the study, there was a significant difference between all the study treatments ($P<0.05$). By increasing the concentration of OVEO, the growth control of *Staphylococcus aureus* improved so that on the 12th day, the lowest amount was observed in the treatment containing 1.5% OVEO (3.11 log cfu/g).

pH

The results of evaluating the pH of cheese samples packed with film alone and containing different concentrations of OVEO during 12th day of storage at refrigerator temperature are shown in Table 2. As can be seen in the results, the pH of the control group was 5.0 on the zero days, and it reaches 6.01 on the last day of the study. On the last day of the study, there was no significant difference between the control group and treatment of polylactic acid film and tragacanth gum ($p>0.05$). There was a significant difference between the treatments with different concentrations of OVEO, as well as between the treatments containing the OVEO ($p<0.05$). The lowest pH was observed in the samples kept with polylactic acid film and tragacanth gum containing 1.5% OVEO (4.82%).

Table 2. Average pH changes in different treatments (Mean ± SD)

Treatment	Day				
	0	3	6	9	12
Con	$0.06^{a} \pm 57.5$	$0.08^{a} \pm 63.5$	$0.07^{a} \pm 81.5$	$0.02^{a} \pm 93.5$	$0.06^{a} \pm 01.6$
Film	$0.01^{a} \pm 50.5$	$0.08^{a} \pm 60.5$	$0.06^{a} \pm 63.5$	$0.06^{b} \pm 81.5$	$0.07^{a} \pm 92.5$
Film+0.5% EO	$0.08^{a} \pm 56.5$	$0.06^{a} \pm 51.5$	$0.08^{b} \pm 41.5$	$0.11^{c} \pm 32.5$	$0.01^{b} \pm 24.5$
Film+1% EO	$0.12^{a} \pm 51.5$	$0.07^{a} \pm 47.5$	$0.05^{b} \pm 33.5$	$0.04^{c} \pm 23.5$	$0.06^{c} \pm 01.5$
Film+1.5% EO	$0.08^{a} \pm 55.5$	$0.04^{b} \pm 35.5$	$0.03^{c} \pm 20.5$	$0.01^{d} \pm 01.5$	$0.01^{d} \pm 82.4$

Non-similar lower case English letters indicate significant differences between treatments in the same day ($P<0.05$).

Table 3. Average PV changes in different treatments (Mean ± SD)

Treatment	Day				
	0	3	6	9	12
Con	$0.02^{a} \pm 0.57$	$0.01^{a} \pm 0.65$	$0.02^{a} \pm 0.70$	$0.03^{a} \pm 0.79$	$0.01^{a} \pm 0.88$
Film	$0.01^{a} \pm 0.55$	$0.02^{a} \pm 0.64$	$0.01^{a} \pm 0.68$	$0.02^{a} \pm 0.76$	$0.03^{b} \pm 0.83$
Film+0.5% EO	$0.03^{a} \pm 0.58$	$0.03^{a} \pm 0.62$	$0.01^{b} \pm 0.65$	$0.02^{b} \pm 0.70$	$0.02^{c} \pm 0.74$
Film+1% EO	$0.00^{a} \pm 0.56$	$0.00^{a} \pm 0.60$	$0.01^{c} \pm 0.62$	$0.01^{c} \pm 0.65$	$0.01^{d} \pm 0.66$
Film+1.5% EO	$0.02^{a} \pm 0.55$	$0.02^{a} \pm 0.60$	$0.00^{c} \pm 0.61$	$0.02^{c} \pm 0.64$	$0.01^{d} \pm 0.65$

Non-similar lower case English letters indicate significant differences between treatments in the same day ($P<0.05$).

Peroxide Value (PV)

The results of the measurement of the amount of peroxide in the treatments of pure film-wrapped cheese and films containing different percentages of OVEO during storage at refrigerator temperature for 12th day, along with the control treatment, are presented in table 3. As is clear from the results, the general trend in all treatments is upward. The control group was 0.57 (meq.kg) at the beginning of the study, and it increased to 0.88 (meq.kg) on the last day. There was a significant difference with the pure film treatment, which reached 0.83 on the last day of the study ($p<0.05$). The peroxide number of the control and the pure film treatment were significantly different from the treatments containing different percentages of OVEO ($p<0.05$). The peroxide number in the treatments wrapped with film containing different percentages of OVEO from zero day to the end of the study was significantly ($p<0.05$) lower than control group.

Sensory

The changes in sensory characteristics, including taste, texture, appearance and overall acceptance, are presented in Figure 5. The results showed that no adverse effects were observed in the sensory characteristics of the cheese samples. The overall evaluation was positive and no adverse feelings were reported. The highest score was related to the films containing 1% and 1.5% OVEO. The control group reported the highest score in the taste attribute. The control group and the pure film received the highest score in the appearance attribute. The control group and the films containing 1% and 1.5%

OVEO received the highest score. However, in general, there was no significant difference in sensory properties among the samples stored with films containing different percentages of OVEO (p>0.05).

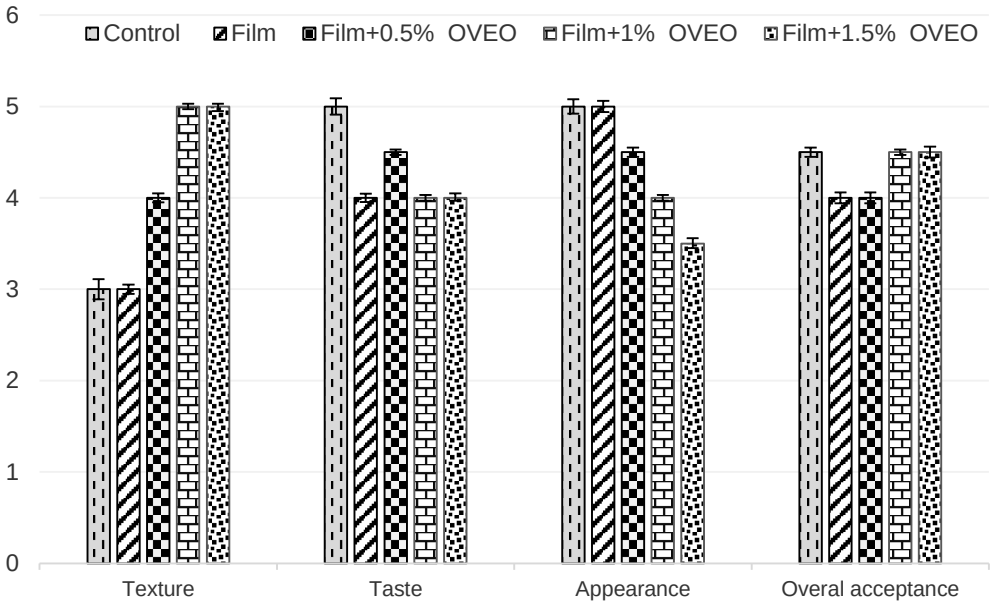

Figure 5. Sensory evaluation results of samples in different treatments

Discussion

The evaluation of the chemical composition of OVEO showed that the main components included Peritenone oxide (29.22%), pulegone (19.08%) and Piperitenone (10.32%) respectively. Hajlaoui et al., (2008) [18] evaluated the chemical composition areas (ecotypes) of *longifolia* essential oil against several types of pathogenic microorganisms. According to the results, 34 compounds were isolated from OVEO, and menthone was the most obtained compound with about 27%, which is consistent with the results of this study [19]. Comparing present study with the previous studies reveals cases of conformity or non-conformity in the type and number of major compounds, which can be caused by various factors such as genetics, place of growth, different parts of the plant, harvest time, and how to apply essential oil [20]. The results of mechanical properties, including humidity, turbidity, and film thickness, are reported in graph 1. It shows that there is no significant difference between the turbidity of films containing different percentages of OVEO and pure film (p>0.05). The moisture characteristic was also found to be significantly less in treatments with different concentrations of OVEO compared to the edible film prepared alone (p<0.05), but there was no significant difference between treatments containing different concentrations of essential oils(p>0.05). In the investigation of film thickness, it was also determined that the treatment contained 1% an edible bioactive Nano-composite made from Mentha longifolia gum, polyvinyl alcohol, Nano-particles (ZnO), and ascorbic acid. The treatment was prepared for food packaging using glycerol and citric acid as a crosslinker prepared for food packaging. In examining the physicochemical and mechanical properties of the prepared addible film, the results showed that the thickness increased with the increase of tragacanth Azadi et al., (2023) [21] prepared an edible film based on three polysaccharides; chitosan, tragacanth gum and polyvinyl alcohol containing different concentrations of *cinnamon* essential oil. Then, the physic-mechanical properties were evaluated. According to the results, it was found that adding essential oil to the prepared edible film caused an increase in its thickness. They also found that *cinnamon* essential oil Nano-emulsion can be included in the studied composite films and used successfully as active and environmentally friendly packaging, which is

consistent with the results of this study [22]. In another study Azadi et al., (2023) prepared an edible film based on three polysaccharides; chitosan, tragacanth gum and polyvinyl alcohol containing different concentrations of *cinnamon* essential oil. *Cinnamon* emulsion has antimicrobial properties, but this activity is more pronounced against Gram-positive bacteria (*Bacillus cereus* and *Staphylococcus aureus*) than Gram-negative types (*Escherichia coli* O_{157}:H_7 and *Salmonella Typhimurium*). *Cinnamon* essential oil emulsion can be included in the composite films of the study and can be successfully used as active and environmentally friendly packaging, which is consistent with the results of this study [21]. In Talebi et al., (2017) research, the integration of spice essential oil into the polylactic acid film matrix was done with the aim of increasing the microbiological shelf life of ground beef. It was found that essential oil derived from plants generally have a high potential to increase the shelf life of meat and meat products. Based on the microbiological analysis of the samples, it showed effective antibacterial activity against all tested microorganisms. In terms of the total number of bacteria, a combination of higher concentrations of both essential oils (1%) in the initial active film formula increased the durability of the product (from 4 to 7th day) compared to the control sample. This result is consistent with the findings of the study [23]. Also, in a study conducted by Ranjbar et al., (2016), the effect of OVEO on the shelf life of hamburgers was investigated. In this study, OVEO was used as an antimicrobial compound with different concentrations of 0, 0.25, 0.5, 1 and 2%. The formulation of 100 gr hamburger samples produced were kept in the refrigerator at 4 ºC for 10 days and then subjected to microbial tests on days 0, 4, 7 and 10th. According to the results, treatments containing 2% OVEO had the fewest number of microorganisms compared to other treatments, which is consistent with the results of this study [24]. In the study of Khanjari et al., (2019), they investigated the antimicrobial activity of different concentrations of the *Pimpinella animus* essential oil against the growth of some food pathogenic microorganisms. The finding indicated that the halo diameter of the growth of all bacteria increases with increasing the concentration of the essential oil, which is consistent with the results of this study. Additionally, Gram positive bacteria are more sensitive to polylactic acid films containing essential oil than Gram- negative bacteria, which is consistent with the results of this study. It was also reported that *Staphylococcus aureus* bacteria were more sensitive to the treatment of edible film containing 1.5% OVEO with a diameter of 10 mm non-growth halo than *Escherichia coli* O_{157}:H_7 bacteria with a diameter of 6 mm non-growth halo [25]. Ranjbar et al., (2016), investigated the effect of *oregano* essential oil on the sensory characteristics of hamburgers [24], in this study; OVEO was used as an antimicrobial compound with different concentrations of 0, 0.25, 0.5, 1 and 2% OVEO had the most appropriate sensory characteristics compared to the other treatments.

Conclusion

In this study, a film based on polylactic acid and tragacanth gum containing OVEO was prepared. The effect of this film on microbial characteristics, sensory characteristics, and some chemical characteristics of feta cheese was evaluated during storage at refrigerator temperature for 12th day. The study included the control group, treatment with pure polylactic acid film and tragacanth gum, and poly lactic acid film tragacanth gum containing OVEO in three different concentrations: 0.5%, 1%, and 1.5%. Various microbial, chemical, and sensory tests were performed on different days. The results indicated that packing feta cheese with the film based on polylactic acid and tragacanth gum improved its properties. Additionally, the increase in the concentration of OVEO added to this film further improved its properties. Overall, the results suggest that the film based on polylactic acid and tragacanth gum containing OVEO has positive effects on the properties of feta cheese. Of course, it's suggested to evaluate and compare the performance of other polysaccharides, other essential oils, and aqueous extracts, and to consider the possible effect of essential oils on the organoleptic characteristics of the product.

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