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The effect of gelatin coating containing aqueous extract of *Citrus sinensis* peel on increasing shelf life of rainbow trout fillet during refrigeration

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ABSTRACT

Today, the use of active packaging containing natural antimicrobial compounds such as essential oils and plant extracts has increased to increase the shelf-life of food products. The purpose of this study is to investigate the effect of gelatin coating containing *Citrus sinensis* peel extract on increasing the shelf life of rainbow trout meat. Gelatin (4%) coating was prepared with different levels of *Citrus sinensis* peel extract (2% and 4%). After preparing the pieces of rainbow trout meat, all the pieces were coated and examined for chemical properties (pH, TVB-N, TBARS), microbial (TVCs and TPCs) and sensory properties (odor, color, texture and overall acceptance) were evaluated for 16 days at 4°C with a 4-day interval (0, 4, 8, 12, 16). The results of the investigation of the antimicrobial effect showed that in the samples coated with 2% and 4% levels of *Citrus sinensis* peel extract, the average count of mentioned bacteria was significantly lower than the control and gelatin alone ($p < 0.05$). The results of examining the chemical properties of the samples showed that pH, TVB-N and TBARS increased during the period, but this increase occurred at a slower rate in the samples coated with different levels of *Citrus sinensis* peel extract. In the evaluation of sensory characteristics, at the beginning of the study, all the samples had the highest acceptance limit, and with the passage of time and the appearance of signs of spoil, the scores decreased, especially in the control. Generally, the results showed that gelatin coating along with different levels of *Citrus sinensis* peel extract has a positive effect on increasing the shelf life of fish meat and these compounds can be used together to increase the shelf life of protein foods.

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1- Introduction

Seafood, including fish meat, is an important food source for humans. Marine products rich in compounds such as zinc, iron, phosphorus and vitamins includingA AndD and help to improve the immune system and brain and nervous function. One of the important concerns related to fish and marine products is the high rate of spoilage and quality reduction of these products during storage.[1]. In order to prevent the loss of quality and also to postpone spoilage due to microbial and chemical destructive factors, they use different methods such as low temperature and suitable and efficient packaging [2].

Active packaging is a new way to increase the shelf life of seafood by delaying the oxidation of lipids and the growth of bacteria in marine products. Currently, packaging based on natural polymers such as carbohydrates, proteins and lipids are used as biological materials. Degradable is used for active packaging and production of edible coatings [3]. Among natural biodegradable polymers, fish gelatin obtained from collagen hydrolysis is a good alternative to mammalian-derived gelatin for the production of edible films and coatings. Fish gelatin is economically obtained from fish by-products. Fish gelatin is tasteless and colorless, has good film-forming and mechanical properties, and is a biodegradable compound [4]. Gelatin is also a suitable material to combine with essential oils and plant extracts and phenolic compounds, and with the combined use of these compounds, it is possible to produce suitable antioxidant and antimicrobial coatings and films [7,6,5]. In this regard, gelatin-based edible films and coatings for food preservation including salmon fillet [8], cheese [9], shrimp [10], bread [11] and beef [12] in order to They are used to increase the duration of their storage.

Various pharmaceutical, health, cosmetic and food industries have paid special attention to these compounds to improve the quality and durability of their products due to the strong antimicrobial and antioxidant activities of essential oils and plant extracts [13]. Essential oils and plant extracts are mixtures of 20-100 different plant secondary metabolites with considerable chemical diversity [14]. This chemical diversity is due to the different ecological and geographical conditions of plant age, harvest time and extraction methods. Changes in the chemical profile of essential oils and plant extracts may affect their biological activity [15]. Several plant essential oils, including citrus essential oils such as orange, have been recognized by the FDA as a GRAS compound. Orange plant with scientific name*Citrus sinensis* It belongs to the Rutaceae family and is one of the most important crops grown in tropical and subtropical regions [16]. Citrus essential oil and extract obtained from different parts of these plants (skin, seed, leaf and fleshy part of the fruit) is a rich source of bioactive compounds such as monoterpenes, acids, flavonoids and phenolic compounds, which have antioxidant activity. And the antimicrobial properties of these compounds play a significant role [17]. Essential oils and extracts of different citrus species have different biological activities, such as antimicrobial, antiviral, and antifungal effects, and these compounds are also used as flavoring and antioxidant compounds, and they are a safer alternative to artificial preservatives [18].].

Using edible coatings based on gelatin and natural bioactive compounds is a suitable strategy to improve the quality and shelf life of food products. On the other hand, due to the lack of a study in the field of investigating the effect of gelatin coating alone along with orange peel aqueous extract in order to increase the storage time of protein products, this study aims to use gelatin coating along with orange peel extract to improve quality. The shelf life and improvement of sensory characteristics of rainbow salmon fillets stored in the refrigerator were carried out.

2- materials and methods

1-2- Preparation of orange peel extract

Thomson Orange (*Citrus sinensis*) was collected, washed and peeled from the gardens of Mazandaran province, Amol city. The skins were dried in the shade and then completely powdered by grinding. To prepare the extract by the maceration method[1] (soaking) was used. 1000 ml of sterile distilled water was added to 10 g of the prepared powder and mixed thoroughly for 24 hours at room temperature. Then the obtained solution was passed through Whatman paper and the aqueous extract was obtained with a freeze dryerChrist, Osterode, Germany) dried and It was stored in dark containers in the refrigerator until use [19].

2-2- Preparation of rainbow trout meat

Rainbow salmon meat samples were bought from the market and transported to the laboratory under completely hygienic conditions and with ice. The skin was first washed completely with water and then the

[1]- Maceration

fish fillets were separated. Two fillets were separated from each fish.

2-3- Preparation of studied coatings and coating of rainbow trout meat pieces

To prepare 4% gelatin coating, 4 grams of fish skin gelatin powder (Sigma Aldrich) was completely dissolved in 100 ml of sterile distilled water at room temperature. Glycerol (Merck, Germany) was added to the solution at a ratio of 0.3 wt/wt of gelatin and was thoroughly mixed for 30 minutes [20]. Antimicrobial coatings were prepared by mixing different amounts of orange peel extract (concentration 2% and 4%) in 4% gelatin coating solution. A homogenizer (12000 rpm and 5 minutes) was used to mix the extract in the gelatin solution. For coating, the pieces of fish meat were divided into 4 equal groups (pieces of 10 grams) (Table 1). The studied groups include the first group as a control, the second group of samples coated with 4% gelatin, the third group of samples coated with 4% gelatin containing 2% of orange peel extract and the last group of samples coated with Gelatin 4% containing 4% of orange peel extract.

The samples were immersed in the coating solutions for 5 minutes and allowed to check water for 30 seconds [21]. Then the coated parts were placed in sterile plastic bags and were subjected to microbial, chemical and sensory evaluation for 16 days at 4 degrees Celsius at 4-day intervals (0, 4, 8, 12 and 16).

Table 1 List of treatments in the present study.

NO	Treatment	Description
1	With	Samples without any coating solution
2	G	Samples coated with Gelatin solution
3	G+EX1	Samples coated with Gelatin solution containing 2% of *Citrus sinensis* extract
4	G+EX2	Samples coated with Chitosan solution containing 4% of *Citrus sinensis* extract

4-2- Microbial analysis of samples

10 grams of fish meat sample was mixed and homogenized with 90 ml of 0.1% peptone water under sterile conditions and successive dilutions were prepared from it. 0.1 ml of each dilution was cultured on the surface of the specific agar culture medium. To count aerobic mesophilic bacteria ([2]TVCs) from the cultivation environment[3]PCA at 30 degrees Celsius for 48 hours and to count psychrotrophic bacteria (TPCs[4]), from the cultivation environmentPCA And greenhouse was used at 7 degrees Celsius for 24 hours. Finally, the results are as follows$\log_{10}$ CFU/g It was reported [21].

5-2- Chemical analysis

Volatile nitrogen bases (TVB-N) were measured in fish meat samples according to the method of Ajaq et al. (2010). The amount of TVB-N was reported based on mg of free nitrogen per 100 g of fish meat [22]. To measure pH, 90 ml of distilled water was added to 10 grams of fish meat sample and then the pH of the samples was measured by a digital pH meter (Metrohm Ltd., CH-9101 Herisau, Switzerland). The method of Song et al. (2011) was used to measure the amount of thiobarbituric acid (TBARS) and the amount of TBARS was expressed as milligrams of malondialdehyde (MDA) per kilogram of fish meat [23].

6-2- Sensory evaluation

For sensory evaluation, the 5-point hedonic method was used. 10 justified evaluators were used to check the sensory characteristics of the samples (odor, color, texture and overall acceptance). The samples were provided to the evaluators in a raw and random form along with a special code. The evaluators rated the samples from 1 to 5 (number 1 equals very bad, number 5 equals very good and number 3 equals average). The samples were evaluated at room temperature and with the same light [24].

2-7- Statistical analysis

In this research, to analyze the results of the softwareSPSS version 26(SPSS Inc., Chicago, IL, USA) used. All experiments were performed in 3 repetitions. In order to compare the microbial and chemical averages during the study period, repeated measures ANOVA test and to compare two by two between different treatments by one-way analysis of variance (One-way ANOVA) and Duncan's multi-range post hoc test was used, as well as the Kruskal-Wallis test to analyze sensory data.Kruskal-Wallis) was used. In all assessments0/05> p It was considered statistically significant.

3- Results and discussion

1-3- Microbial test results

ChangesTVCs in fish fillet during storage at refrigerated temperature is shown in Table 2(a). Initial amountTVCs In the control group at the beginning of the courseCFU/g It was 2/34 and At the end of the course toCFU/g Received 7/98.

[2]- Total viable count

[3]- Plate count agar

[4]- total psychrotrophs counts

Counting in all treatmentsTVCs It was significantly lower than the control group and gelatin alone (*P<0.05*). Maximum acceptableTVCs in the flesh log CFU/gis 7 [25]. LevelTVCs In the control and gelatin treatments, it reached more than the acceptable limit on the 12th day, but in the treatments covered with gelatin containing 2 and 4% orange peel extract, the amountTVCs It was acceptable until the 12th day. The results showed that the combined use of gelatin coating and orange peel extract increased the shelf life of fish meat. Also, the results showed that the gelatin coating alone has no antimicrobial effect, which is consistent with the study of other researchers [20,26].

The counts of psychrotrophic bacteria during the storage period are presented in Table 2(b). This group of microorganisms is the main cause of food spoilage stored in the refrigerator [27]. Initial values of psychrotroph counts in all treatments rangedCFU/g It was 2/2-25/17. Psychrotroph counts increased in all treatments during the maintenance period. The greatest effect is related to two treatmentsG+EX1 AndG+EX2 Was. At the end of the storage period, the highest amount of psychrotrophs related to control treatments and gelatin alone (CFU/g 8/62 and 8/73) and the lowest amount related to the treatmentsG+EX1 AndG+EX2 (CFU/g 7/10 and 6/75).

The results of the present study showed that the antimicrobial property increases with the increase in the concentration of the extractTVCs AndTPCs They had their lowest amount during the maintenance period. In different studies, the antimicrobial effect of orange peel extract has been attributed to the presence of compounds such as limonene, beta-pinene, gamma-terpinene, linalool and sabinene [28]. The mechanism of antimicrobial action of most of the extracts is due to the reaction of the effective compounds of the extract with the membrane and cell wall of bacteria, which increases the permeability of the membrane and the leakage of cell contents, swelling of the membrane and inhibiting the enzymatic activities of bacteria and making the bacteria unable to absorb nutrients and inhibiting the growth of bacteria. [29]. In the studies conducted in connection with the coating of rainbow salmon meat with herbal compounds, Barkhouri et al. 2019 showed that during the storage period, the amount of microbial load increased and the intensity of the increase in the control treatment was higher than the coated samples with plant essential oils [30]. Also, in the investigation of the antimicrobial effect of citrus extracts such as orange and lemon, the results showed that the combined use of coating and plant extracts improves the shelf life of food and reduces the amount of aerobic mesophilic bacteria and psychrotrophs during the study period, which is in agreement with the results of the study. The present corresponds to [19]. In studies done

Table 2 Effect of Gelatin-enriched *Citrus sinensis* extract on (a) the total viable counts (TVCs, log CFU/g), (b) the total psychrotrophs counts (TPCs, log CFU/g) of rainbow trout fillets during storage at 4 ± 1 °C

Treatment	Storage time (days)				
	0	4	8	12	16
			(a) TVCs		
Con	2.34 ± 0.31 ^{aE}	4.23 ± 0.22 ^{abD}	4.45 ± 0.30 ^{aC}	7.34 ± 0.42 ^{aB}	7.98 ± 0.15 ^{aA}
G	2.10 ± 0.23 ^{aE}	4.34 ± 0.32 ^{aD}	5.50 ± 0.45 ^{aC}	7.19 ± 0.28 ^{aB}	8.08 ± 0.26 ^{aA}
G+EX1	2.20 ± 0.33 ^{aE}	3.75 ± 0.28 ^{bcD}	4.61 ± 0.27 ^{bC}	5.50 ± 0.45 ^{bB}	6.77 ± 0.32 ^{bA}

G+EX2	2.26 ± 0.52 ^{aE}	3.43 ± 0.31 ^{cD}	4.21 ± 0.21 ^{bC}	5.05 ± 0.26 ^{bB}	6.14 ± 0.30 ^{cA}
(b) TPCs					
Con	2.25 ± 0.16 ^{aE}	5.13 ± 0.18 ^{aD}	6.80 ± 0.36 ^{aC}	7.86 ± 0.44 ^{aB}	8.62 ± 0.35 ^{aA}
G	2.21 ± 0.24 ^{aD}	5.09 ± 0.24 ^{aC}	6.70 ± 0.47 ^{aB}	8.21 ± 0.30 ^{aA}	8.73 ± 0.30 ^{aA}
G+EX1	2.21 ± 0.26 ^{aE}	3.83 ± 0.29 ^{bD}	4.93 ± 0.19 ^{bC}	6.21 ± 0.26 ^{bB}	7.10 ± 0.21 ^{bA}
G+EX2	2.17 ± 0.19 ^{aE}	3.24 ± 0.19 ^{cD}	4.26 ± 0.27 ^{cC}	5.52 ± 0.26 ^{cB}	6.75 ± 0.31 ^{bA}

Values represent mean ± standard deviation (n = 3).
Means in the same row with different capital letters are significantly different ($P < 0.05$).
Means in the same column with different small letters are significantly different ($P < 0.05$).

2-3- Chemical analysis results

1-2-3- Measurement pH

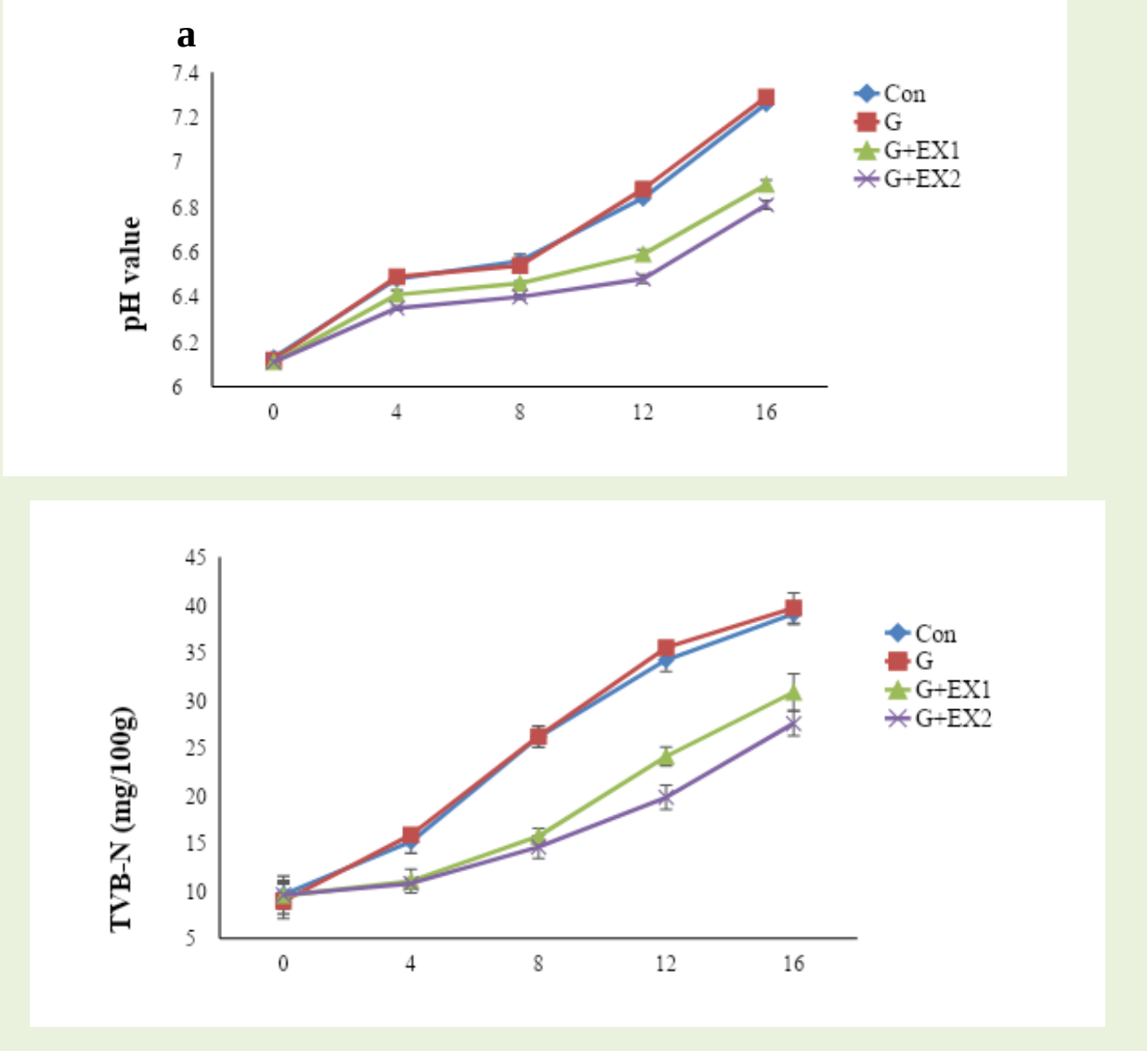
Figure 1(a) The amount of changes pH It shows during the 16-day period. Initial amount pH It was 13.6 in fish fillet. Level pH During the study period, there was an increasing trend, which is consistent with the study of other researchers in this direction [31]. Changes pH In the control treatment, there was a significant difference from the other treatments. While no significant difference was observed between control and gelatin treatment alone. In other treatments, the amount of changes pH During the 16-day period, it was significantly less than the control and gelatin treatment alone. Samples treated with orange peel extract have pH were lower than the control and gelatin treatment alone during the 16-day study period and with increasing concentration of orange peel extract pH It decreased significantly, which can be due to the inhibition of the growth of proteolytic bacteria by the phenolic compounds present in the orange peel extract and the increase in the resistance of fish meat against internal protease enzymes[32]. pH Meat generally showed an increasing trend in all treatments, which may be due to the production of alkaline compounds such as ammonia, trimethylamine by spoilage bacteria and internal enzymes [33].

2-2-3- Measurement of volatile nitrogen bases TVB-N)

TVB-N It is an important index to evaluate meat quality and consists of trimethylamine, dimethylamine, ammonia and other volatile nitrogenous compounds related to spoilage, which are produced by spoilage bacteria, autolytic enzymes, deamination of amino acids and nucleotides. [21]. Changes TVB-N in different treatments during the study period is shown in Figure 1(b). Amounts TVB-N In all treatments, there was an increasing trend during the maintenance period, which is consistent with the study of Andvari et al. (2011) [20]. In the treatment of control and gelatin alone, this increase was more intense, which is related to spoilage bacteria in meat. The difference in gelatin treatment alonesignificant with the control groupIt was not seen, but other treatments had a significant difference with the control group and gelatin and the amount TVB-N In the treatments containing orange peel extract during the storage period, it was significantly lower than the control group, which indicated the antimicrobial properties of these compounds in maintaining the quality of fish fillets, which was studied refuge et al. (2022) is consistent [19].

3-2-3- Measurement of thiobarbituric acid (TBARS)

Measurement resultsTBARS In the fish fillet shown in Figure 1(c). Meat sensitivity to fat oxidation and increaseTBARS It depends on various factors such as animal species, anatomical position of body muscles, duration of storage, packaging methods and addition of antioxidants. Thiobarbituric acid is an indicator that is widely used to evaluate fats and expresses the amount of malonaldehyde, which is the end product of fat oxidation [34]. The preliminary results of the measureTBARS in the control groupmg MDA / kg It was 0.18. At the end of the periodTBARS in the control groupmg MDA / kg 4/30 receipt if in treatmentG+EX2 LevelTBARS mg MDA / kg It was 1/29. The results showed that by increasing the duration of keeping fish fillets at 4°C, the amountTBARS There was an increasing trend in all treatments, but in the samples containing orange peel extract, this The process took place at a very low speed, which indicates the antioxidant activity of the extract. The increasing trend of this index during the period is due to the increase of free iron and other peroxides in meat, as well as the production of aldehydes from secondary products resulting from the breakdown of hydroperoxides [35]. In the combined use of food coatings and herbal extracts and essences in sardines, beef, lamb and pork under conditions of cold storage.Gomez-Staca et al. (2007),No and Colleagues (2007) respectively reported that the use of edible coatings containing plant extracts compared to samples without coatings and extracts.TBARS showed less during the storage period, which is consistent with the results of the present study [36,37].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TVB-N (mg/100g)
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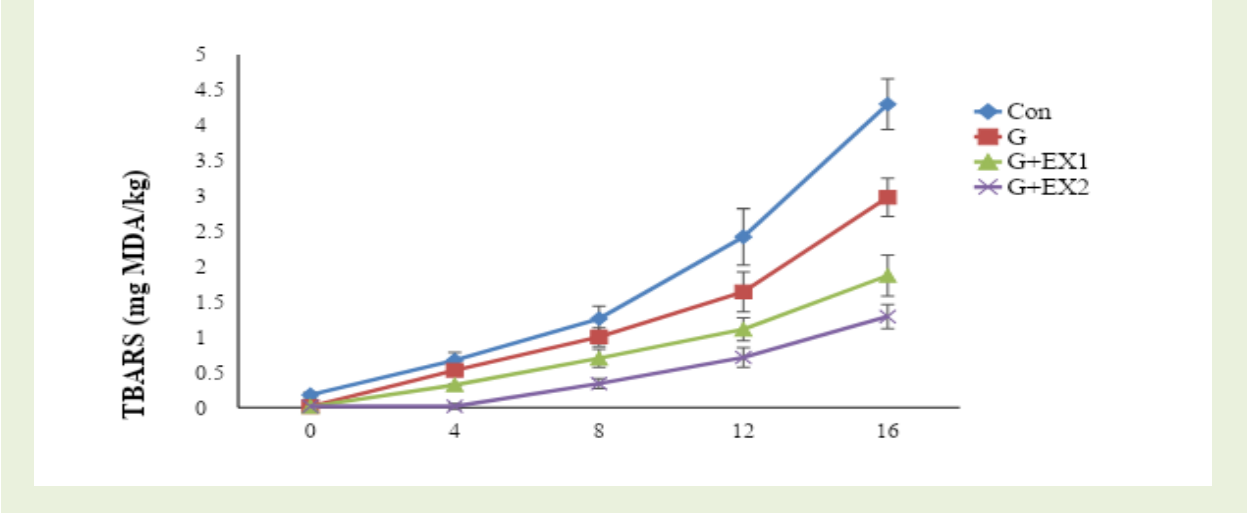

Figure 1 Effect of Gelatin enriched *Citrus sinensis* extract on (a) pH, (b) total volatile bases nitrogen (TVB-N), (c) thiobarbituric acid (TBARS) of rainbow trout fillets during storage at 4 ± 1 °C. Each value represents the mean of three samples ± standard deviation.

4-2-3- Sensory evaluation results

The sensory evaluation results of fish fillet are shown in Table 3. As can be seen in the table, gelatin coating alone had no significant effect on the sensory characteristics of fish fillets compared to the control group.). In the evaluation of sensory evaluation, no significant difference was observed between the treatments on day zero, and on day zero, all treatments had the highest level of acceptance. During the storage period, none of the evaluators rejected the samples coated with gelatin and orange peel extract and all received a score higher than 3. But in the control and gelatin samples alone, from the 12th day onwards, they had scores lower than the acceptance limit. The results showed that during the period, acceptance of samples in all treatments had a decreasing trend. The trend of sensory evaluation changes during the study period was consistent with the oxidation and microbial changes of the tested treatments, which could be caused by the oxidation and spoilage of fish fillets during the storage period and the reduction of the sensory quality of fish fillets [38]. With the oxidation and hydrolysis of fats, the stability of proteins decreases and causes tissue destruction and oxidation of proteins [39]. The high score of the samples coated with gelatin and orange peel extract can be due to the antimicrobial and antioxidant properties of these compounds, which improve sensory characteristics such as color, texture, smell, and overall acceptance of food samples [40].

Table3 Effect of gelatin coating and *Citrus sinensis* on sensory characteristics of trout fillets during storage at 4 ± 1 °C

Sensory characteristic	Treatment	Storage time (days)				
		0	4	8	12	16
Texture	With	4.60 ± 0.50 ^{aA}	4.24 ± 0.59 ^{aA}	2.84 ± 1.10 ^{bB}	1.96 ± 0.88 ^{bC}	1.52 ± 0.82 ^{bC}
	G	4.54 ± 0.50 ^{aA}	4.29 ± 0.69 ^{aA}	2.95 ± 0.85 ^{bB}	2.20 ± 0.77 ^{bBC}	2.00 ± 0.72 ^{bC}

	G+EX1	4.66 ± 0.48 ^{aA}	4.58 ± 0.50 ^{aA}	4.12 ± 0.76 ^{aAB}	3.62 ± 0.65 ^{aBC}	3.19 ± 0.80 ^{bC}
	G+EX2	4.70 ± 0.51 ^{aA}	4.50 ± 0.46 ^{aA}	4.20 ± 0.80 ^{aAB}	3.72 ± 0.63 ^{aBC}	3.18 ± 0.48 ^{BC}
Color	With	4.54 ± 0.50 ^{aA}	3.83 ± 0.70 ^{aB}	2.83 ± 0.70 ^{BC}	2.33 ± 1.00 ^{BC}	1.25 ± 0.44 ^{aD}
	G	4.45 ± 0.50 ^{aA}	4.33 ± 1.09 ^{aA}	3.66 ± 1.00 ^{aB}	2.28 ± 1.17 ^{BC}	1.66 ± 0.56 ^{aD}
	G+EX1	4.62 ± 0.49 ^{aA}	4.41 ± 0.80 ^{not}	3.95 ± 0.80 ^{bB}	3.46 ± 0.95 ^{bC}	3.01 ± 0.65 ^{bC}
	G+EX2	4.58 ± 0.33 ^{aA}	4.58 ± 0.50 ^{that}	4.08 ± 0.65 ^{cB}	3.65 ± 0.80 ^{cC}	3.18 ± 0.80 ^{bC}
Odor	With	4.50 ± 0.51 ^{aA}	4.37 ± 0.48 ^{aA}	2.37 ± 0.49 ^{bB}	1.37 ± 0.57 ^{bC}	1.12 ± 0.33 ^{bc}
	G	4.50 ± 0.51 ^{aA}	4.33 ± 0.33 ^{aA}	2.66 ± 0.81 ^{aB}	1.50 ± 0.51 ^{bC}	1.25 ± 0.44 ^{bC}
	G+EX1	4.58 ± 0.50 ^{aA}	4.50 ± 0.51 ^{aA}	3.62 ± 0.50 ^{aB}	3.12 ± 0.57 ^{aB}	3.03 ± 0.58 ^{aB}
	G+EX2	4.58 ± 0.50 ^{aA}	4.50 ± 0.51 ^{aA}	3.66 ± 0.58 ^{aB}	3.44 ± 0.49 ^{aB}	3.11 ± 0.55 ^{aB}
Overall	With	4.72 ± 0.45 ^{aA}	4.12 ± 0.72 ^{abA}	2.84 ± 0.68 ^{bB}	2.04 ± 0.78 ^{bBC}	1.80 ± 0.81 ^{bC}
	G	4.58 ± 0.50 ^{aA}	3.41 ± 0.88 ^{bB}	2.50 ± 0.79 ^{bC}	1.91 ± 0.82 ^{bC}	1.83 ± 0.81 ^{bC}
	G+EX1	4.58 ± 0.50 ^{aA}	4.33 ± 0.86 ^{not}	4.00 ± 0.83 ^{aA}	3.68 ± 0.93 ^{aAB}	3.25 ± 0.32 ^{aB}
	G+EX2	4.56 ± 0.50 ^{aA}	4.43 ± 0.94 ^{aA}	4.00 ± 0.83 ^{aAB}	3.75 ± 0.56 ^{aB}	3.42 ± 0.76 ^{aB}

Values represent mean ± standard deviation (n = 10).
Means in the same row with different capital letters are significantly different ($P < 0.05$).
Means in the same column with different small letters are significantly different ($P < 0.05$).

4- Conclusion

Edible coatings are widely used in the food industry. In this study, edible gelatin coating containing 2 and 4% orange peel extract was used in rainbow salmon fillet. The results showed that the gelatin coating containing orange peel extract leads to a decrease in oxidation parameters due to its inhibitory properties.TBARS(and the growth of aerobic mesophilic bacteria)TVCs(and psychrotrophic bacteria)TPCs) becomes Also covered examples of changespH AndTVB-N compared to the control sample and gelatin alone. Among the different samples, the samples coated with gelatin and 4% orange peel extract(G+EX2) They had more antimicrobial and antioxidant effects. Considering the high level of oxidation in meat products, especially fish meat and the relationship between oxidation and cardiovascular diseases, the use of coatings and edible films containing bioactive compounds such as essential oils and plant extracts can be a good solution to increase Durability, quality and consumption of meat products.

5- References

]1[El-Shamery. G. E. D. M., 2010. Studies on contamination and quality of fresh fish meats during storage. *Egyptian Academic Journal of Biological Sciences, G. Microbiology*, *2*(2), 65-74.

[2] Tabatabaei Moradi. L., Sharifan, A., and Larijani. K., 2015. Antimicrobial activity of lemon and peppermint essential oil in edible coating containing chitosan and pectin on rainbow trout (Oncorhynchus mykiss) fillets. *Journal of Medical Microbiology and Infectious Diseases*, *3*(1), 38-43.

[3] Javadifard. M., Khodanazary. A., and Hosseini. S. M., 2023. The effects of chitosan-nanoclay

nanocomposite coatings incorporated with gallic acid on the shelf life of rainbow trout during storage in the refrigerator. *Journal of Food Measurement and Characterization*, *17*(2), 1794-1805.

[4] Alfaro. A. D. T., Balbinot, E., Weber, C. I., Tonial, I. B., and Machado-Lunkes. A., 2015. Fish gelatin: characteristics, functional properties, applications and future potentials. *Food Engineering Reviews*, *7*, 33-44.

[5] Shahbazi. Y., Shavisi. N., Karami. N., Lorestani. R., and Dabirian. F., 2021. Electrospun carboxymethyl cellulose-gelatin nanofibrous films encapsulated with Mentha longifolia L. essential oil for active packaging of peeled giant freshwater prawn. *Lwt*, *152*, 112322.

[6] Staroszczyk. H., Kusznierewicz. B., Malinowska-Pańczyk. E., Sinkiewicz. I., Gottfried. K., and Kołodziejska. I., 2020. Fish gelatin films containing aqueous extracts from phenolic-rich fruit pomace.*LWT*, *117*, 108613.

[7] Hanani. Z. N., Yee. F. C., and Nor-Khaizura. M. A. R., 2019. Effect of pomegranate (Punica granatum L.) peel powder on the antioxidant and antimicrobial properties of fish gelatin films as active packaging. *Food Hydrocolloids*, *89*, 253-259.

[8] Eghbalian. M., Shavisi. N., Shahbazi. Y., and Dabirian. F., 2021. Active packaging based on sodium caseinate-gelatin nanofiber mats encapsulated with Mentha spicata L. essential oil and MgO nanoparticles: Preparation, properties, and food application. *Food Packaging and Shelf Life*, *29*, 100737.

[9] Salem. A., Jridi. M., Abdelhedi. O., Fakhfakh. N., Nasri. M., Debeaufort. F., and Zouari. N., 2021. Development and characterization of fish gelatin-based biodegradable film enriched with Lepidium sativum extract as active packaging for cheese preservation. *Hellion*, *7*(10), e08099.

[10] Mirzapour-Kouhdasht. A., and Moosavi-Nasab. M., 2020. Shelf-life extension of whole shrimp using an active coating containing fish skin gelatin hydrolysates produced by a natural protease. *Food science & nutrition*, *8*(1), 214-223.

[11] Oliveira. M. A., Gonzaga. M. L., Bastos. M. S., Magalhães. H. C., Benevides. S. D., Furtado. R. F., and Garruti. D. S., 2020. Packaging with cashew gum/gelatin/essential oil for bread: Release potential of the citral. *Food Packaging and Shelf Life*, *23*, 100431.

[12] Jridi. M., Mora. L., Souissi. N., Aristoy. M. C., Nasri. M., and Toldrá. F., 2018. Effects of active gelatin coated with henna (L. inermis) extract on beef meat quality during chilled storage. *Food Control*, *84*, 238-245.

[13] Manzur. M., Luciardi. M. C., Blázquez. M. A., Alberto. M. R., Cartagena. E., and Arena. M. E., 2023. Citrus sinensis essential oils an innovative antioxidant and antipathogenic dual strategy in food preservation against spoliage bacteria. *Antioxidants*, *12*(2), 246.

[14] Carson. C. F., and Hammer. K. A., 2011. Chemistry and bioactivity of essential oils. *Lipids and essential oils as antimicrobial agents*, 203-238.

[15] Raut. J. S., and Karuppayil. S. M., 2014. A status review on the medicinal properties of essential oils. *Industrial crops and products*, *62*, 250-264.

[16] Bora. H., Kamle. M., Mahato. D. K., Tiwari. P., and Kumar. P., 2020. Citrus essential oils (CEOs) and their applications in food: An overview. *Plants*, *9*(3), 357.

[17] Agarwal. P., Sebghatollahi. Z., Kamal. M., Dhyani. A., Shrivastava. A., Singh. K. K., and Baek. K. H., 2022. Citrus Essential Oils in Aromatherapy: Therapeutic Effects and Mechanisms. *Antioxidants*, *11*(12), 2374.

[18] Kang. H. J., Chawla. S. P., Jo. C., Kwon. J. H., and Byun. M. W., 2006. Studies on the development of functional powder from citrus peel. *Bioresource technology*, *97*(4), 614-620.

[19] Panahi. Z., Khoshbakht. R., Javadi. B., Firoozi. E., and Shahbazi. N., 2022. The Effect of Sodium Alginate Coating Containing Citrus (Citrus aurantium) and Lemon (Citrus lemon) Extracts on Quality Properties of Chicken Meat. *Journal of Food Quality*, *2022*.

[20] Andevari. G. T., and Rezaei. M., 2011. Effect of gelatin coating incorporated with cinnamon oil on the quality of fresh rainbow trout in cold storage. *International journal of food science & technology*, *46*(11), 2305-2311.

[21] Panahi. Z., and Mohsenzadeh. M., 2022. Sodium alginate edible coating containing Ferulago angulata (Schlecht.) Boiss essential oil, nisin, and NaCl: Its impact on microbial, chemical, and sensorial properties of refrigerated chicken breast. *International Journal of Food Microbiology*, *380*, 109883.

[22] Ojagh. S. M., Rezaei. M., Razavi. S. H., and Hosseini. S. M. H., 2010. Effect of chitosan coatings enriched with cinnamon oil on the quality of refrigerated rainbow trout. *Food chemistry*, *120*(1), 193-198.

[23] Song. Y., Liu. L., Shen. H., You. J., and Luo. Y., 2011. Effect of sodium alginate-based edible coating containing different anti-oxidants on quality and shelf life of refrigerated bream (Megalobrama amblycephala). *Food control*, *22*(3-4), 608-615.

]24[Meenatchisundaram. S., Chandrasekar. C. M., Udayasoorian. L. P., Kavindapadi Rajasekaran. R., Kesavan. R. K., Srinivasan. B., and Muthusamy. S., 2016. Effect of spice-incorporated starch edible film wrapping on shelf life of white shrimps stored at

different temperatures. *Journal of the Science of Food and Agriculture*, *96*(12), 4268-4275.

[25] Chouliara. E., Badeka. A., Savvaidis. I., and Kontominas. M. G., 2008. Combined effect of irradiation and modified atmosphere packaging on shelf-life extension of chicken breast meat: microbiological, chemical and sensory changes. *European Food Research and Technology*, *226*, 877-888.

]26[Fazlara. A., Pourmahdi. B. M., and Molaei. F., 2017. The effect of gelatin-Avishan Shirazi (Zataria multiflora Bioss) coating on microbial, chemical and sensorial characteristics of ostrich fillets in refrigerated condition.

[27] Bazargani-Gilani. B., Aliakbarlu. J., and Tajik. H., 2015. Effect of pomegranate juice dipping and chitosan coating enriched with Zataria multiflora Boiss essential oil on the shelf-life of chicken meat during refrigerated storage. *Innovative food science & emerging technologies*, *29*, 280-287.

]28[Oraii. F., Hosseini. S.E., Zorriehzahra. S.M.J., Safari. R., 2020. Determination of minimum inhibitory concentration of the ethanolic extract of orange peel and the effects on the growth inhibition of spindle spindlefilet bacteria during refrigerated storage. *Iranian scientific fisheries journal*, 29(3), 25-36.

[29] Holley. R. A., and Patel, D., 2005. Improvement in shelf-life and safety of perishable foods by plant essential oils and smoke antimicrobials. *Food microbiology*, *22*(4), 273-292.

[30] Barkhori-Mehni. S., Khanzadi. S., Hashemi. M., and Azizzadeh. M., 2019. The effect of sodium alginate coating incorporated with lactoperoxidase system and Zataria multiflora boiss essential oil on shelf life extension of rainbow trout fillets during refrigeration. *Iranian Journal of Chemistry and Chemical Engineering*, *38*(1), 163-172.

[31] Vital. A. C. P., Guerrero. A., Ornaghi. M. G., Kempinski. E. M. B. C., Sary. C., Monteschio. J. D. O., and do Prado. I. N., 2018. Quality and sensory acceptability of fish fillet (Oreochromis niloticus) with alginate-based coating containing essential oils. *Journal of food science and technology*, *55*, 4945-4955.

]32[Stop. A., Alizadeh Doghiklai. E., Zakipour Rahimabadi. I., 2013.Investigating the antioxidant effect of orange peel extract on the quality of common carp fillet (Cyprinus carpio) stored in a refrigerator (4 C°). *Iranian journa of natural resources*, 66(2), 185-197

[33] Hashemi. M., Pourmousavi. F. S., Mohajer. F., and Noori. S. M. A., 2022. Impacts of Nano-Gelatin Coating Containing Thymol and Nisin on Chemical Quality Indices of Rainbow Trout Fillets Stored at 4° C. *Jundishapur Journal of Natural Pharmaceutical Products*, *17*(3).

[34] Fernandez. J., Pérez-Álvarez. J. A., and Fernández-López. J. A., 1997. Thiobarbituric acid test for monitoring lipid oxidation in meat.*Food chemistry*, *59*(3), 345-353.

[35] de Azevedo Gomes. H., Da Silva. E. N., do Nascimento. M. R. L., and Fukuma. H. T., 2003. Evaluation of the 2-thiobarbituric acid method for the measurement of lipid oxidation in mechanically deboned gamma irradiated chicken meat. *Food chemistry*, *80*(3), 433-437.

]36[Gómez-Estaca. J., Montero. P., Giménez. B., and Gómez-Guillén. M. C., 2007. Effect of functional edible films and high pressure processing on microbial and oxidative spoilage in cold-smoked sardine (Sardina pilchardus). *Food chemistry*, *105*(2), 511-520.

[37] No. H. K., Meyers. S. P., Prinyawiwatkul. W., and Xu. Z., 2007. Applications of chitosan for improvement of quality and shelf life of foods: a review. *Journal of food science*, *72*(5), R87-R100.

]38[Véronique. C. O. M. A., 2008. Bioactive packaging technologies for extended shelf life of meat-based products. *Meat science*, *78*(1-2), 90-103.

[39] Rodríguez. A., Carriles. N., Cruz. J. M., and Aubourg. S. P., 2008. Changes in the flesh of cooked farmed salmon (Oncorhynchus kisutch) with previous storage in slurry ice (− 1.5 C). *LWT-Food Science and Technology*, *41*(9), 1726-1732.

]40[Han. J. H., 2014. Edible films and coatings: a review. *Innovations in food packaging*, 213-255.

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مقاله علمی_پژوهشی

تأثیر پوشش ژلاتین حاوی عصاره آبی پوست پرتقال (*Citrus sinensis*) بر افزایش ماندگاری گوشت ماهی قزل آلای رنگین کمان طی نگهداری در دمای یخچال

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چکیده

امروزه، استفاده از بسته بندی های فعال حاوی ترکیبات ضدمیکروبی طبیعی مانند اسانس ها و عصاره های گیاهی جهت افزایش مدت زمان نگهداری مواد غذایی، افزایش یافته است. هدف از مطالعه حاضر بررسی تأثیر پوشش ژلاتین حاوی عصاره پوست پرتقال بر افزایش ماندگاری گوشت ماهی قزل آلای رنگین کمان می باشد. پوشش ژلاتین ۴ ٪ به همراه سطوح مختلف عصاره پوست پرتقال (۲٪ و۴ ٪) تهیه شدند. پس از تهیه قطعات گوشت ماهی قزل آلای رنگین کمان، تمامی قطعات پوشش دهی شدند و از بابت خصوصیات شیمیایی (pH، TVB-N، TBARS)، میکروبی (باکتری‌های مزوفیل هوازی و سرماگراها) و خواص حسی (بو، رنگ، بافت و پذیرش کلی) به مدت ۱۶ روز در دمای ۴ درجه سانتی گراد با فاصله زمانی ۴ روزه (۰، ۴، ۸، ۱۲ و ۱۶) ارزیابی شدند. نتایج حاصل از بررسی اثر ضد میکروبی نشان داد که در نمونه‌های پوشش داده شده با سطوح ۲ ٪ و ۴ ٪ عصاره پوست پرتقال، میانگین شمارش باکتری‌های مزوفیل هوازی و سرماگراها بطور معنی داری کمتر از نمونه شاهد و ژلاتین به تنهایی بود ($p < 0.05$). نتایج بررسی خصوصیات شیمیایی نمونه‌ها نشان داد، pH، TVB-N و TBARS در طول دوره روند افزایشی داشتند ولی این افزایش در نمونه‌های پوشش داده شده با سطوح مختلف عصاره پوست پرتقال با سرعت کمتری صورت گرفت. در ارزیابی خصوصیات ارگانولپتیکی، در ابتدای دوره، تمامی نمونه‌ها بالاترین حد پذیرش را داشتند و با گذر زمان و ظهور نشانه‌های فساد، از امتیازات کاسته شد، خصوصاً در نمونه شاهد که فاقد هرگونه پوششی بود، علایم فساد زودتر بروز کرد و امتیاز کمتری را به خود اختصاص داد. بطور کلی، نتایج نشان داد پوشش ژلاتین به همراه سطوح مختلف عصاره پوست پرتقال، تأثیر مثبتی در افزایش مدت زمان نگهداری گوشت ماهی دارد و می‌توان از این ترکیبات بصورت توام جهت افزایش ماندگاری مواد غذایی پروتیینی استفاده کرد.