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Effect of chitosan enriched with orange essential oil on the quality of refrigerated fish burger

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Abstract

Seafood has a limited shelf life and is very perishable. Endogenous chemical and enzymatic reactions are just a few of the numerous responses that occur during storage and cause quality changes. Shelf life and safety are associated with pathogenic microorganisms, and food decomposition impacts both shelf life and safety. Synthetic additives are widely used in fish preservation to increase shelf life while maintaining quality and safety. Research has shown that naturally occurring preservatives from plants, animals, and microbes may effectively replace manufactured antimicrobials. Antimicrobials derived from plants may lessen lipid oxidation and lengthen the shelf life of fish. Edible films and coatings improve food quality and the shelf life of almost any food system. The fish burger is one of the most popular processed fish flesh products, offering a simple taste and adding a variety of flavors to fish-eating habits. This study aims to mix chitosan films with orange essential oil (OEO) and examine how they affect the chemical makeup and refrigerated fish burgers' microbiological and sensory analysis. We used OEO emulsions with chitosan to prevent oxidation and maintain fish burgers' chemical and microbial quality. Incorporating OEO into the films enhanced its antioxidant characteristics. For sensory analysis, the chitosan with EOs coating treatment achieved the highest scores in both color and scent, surpassing even the control group. Acquired taste and acceptance declined gradually. Adding OEO to the chitosan coating increased its antioxidant properties, giving the fish burgers a better color and flavor.

Key Words: *chitosan, essential oil, seafood, burger, antioxidant*

Introduction

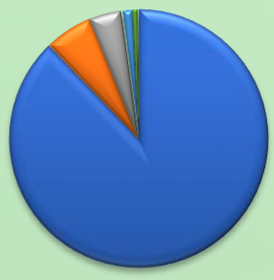
Fresh fish degrade rapidly after being collected due to contamination, endogenous enzymes, and microbial development. As a result of their decomposition, several fish components release new compounds. Moreover, protein oxidation, breakdown, and changes in the fish's taste, texture, and odor are caused by compositional changes during decomposition. Therefore, the necessity to create efficient preservation techniques to increase fish shelf life is rising (Mei et al., 2019). Soft or mushy fish are less marketable since they usually have a shorter shelf life. Storage temperature, oxygen levels, protease activity (both microbial and endogenous), and moisture content during postmortem handling can negatively affect fish's color, odor, texture, and flavor. Traditionally, fish have been kept cold and preserved using ice slurries, flake ice, chilled seawater, or chemical treatments. The fisheries industry continues to seek innovative preservation techniques to extend shelf life and maintain optimal sensory and nutritional quality for consumers (Rey et al., 2012).
The growing demand for minimally processed foods, changing dietary habits, and concerns over food safety continue to shape food packaging systems. Foods with less processed components risk containing harmful bacteria that compromise their safety and quality. Fadiji et al. (2023) state that consumer preferences for minimally processed foods with few synthetic chemicals and the need to extend shelf life and prevent food-borne illnesses motivate the development of innovative solutions, such as antimicrobial packaging. A cuisine item made from minced fish flesh is a fish burger. Usually, it is marketed and stored cold. The product's flavor, texture, smell, and appearance change due to microbial growth, protein degradation, and fat oxidation. This shortens the product's shelf life while being stored (Shahinfar et al., 2017). Along with the technological developments in the world, significant technological developments have been made in the fish processing sector. Studies show that storage below -12°C inhibits microbial growth, and enzymatic activity slows down (Rodriguez-Turienzo et al., 2011). However, cooling or freezing alone is insufficient to prevent lipid oxidation, protein denaturation, and microbial activity completely. For this reason, it has become common to use multiple processing and packaging technologies together today. Packaging technology is widely used to extend shelf life and maintain hygiene and quality, especially in foods sensitive to microbial and oxidative spoilage (Ahmad et al., 2012).
The increased consumer demand for natural, environmentally friendly, and preservative-free goods presents issues for the food business. Studies on "naturally derived" antimicrobials for food packaging have increased due to this change and tighter laws governing artificial or chemical preservatives. Studies on using essential oils in this sector have recently increased. In earlier research, many essential oils have demonstrated potential as antioxidants, antimicrobials, anti-cancer agents, and eco-friendly food preservatives. Moreover, essential oils have been

successfully incorporated into biodegradable films as antimicrobial agents, helping to control microbial growth on food surfaces, prolong shelf life, and maintain product quality (Zhang et al., 2021). While several reviews have highlighted progress in antimicrobial packaging research, including the biological properties of chitosan and essential oils and their use in food packaging, there is limited information on the latest advancements in applying these antimicrobial methods for food preservation (Sharma et al., 2021). This study aimed to evaluate the effects of chitosan films enriched with orange essential oil on the quality of fish burgers during refrigerated storage. To achieve this, the fish burgers coated with chitosan films containing orange essential oil emulsions were periodically assessed for their sensory qualities throughout the storage period.

Materıals And Methods

***Materials**:* Orange essential oil (OEO) was purchased from the local market in Turkey, and the fish was bought fresh from a farm in the Niğde region.
***Fish burger preparation**:* All fresh fish were first beheaded, gutted, and thoroughly washed. The fish flesh was then minced using a meat mincer with a pore size of 1.0 mm. The minced fish meat was prepared for fish burger formulation following the method outlined in Figure 1, mixed thoroughly, and divided into three equal portions, serving as control and treated groups, as detailed (A: control, B: OEO; C: chitosan with OEO). Each portion was individually packed (with each pack containing 50 g), shaped into burgers using a hamburger press machine, and stored at 4±1°C for 21 days.

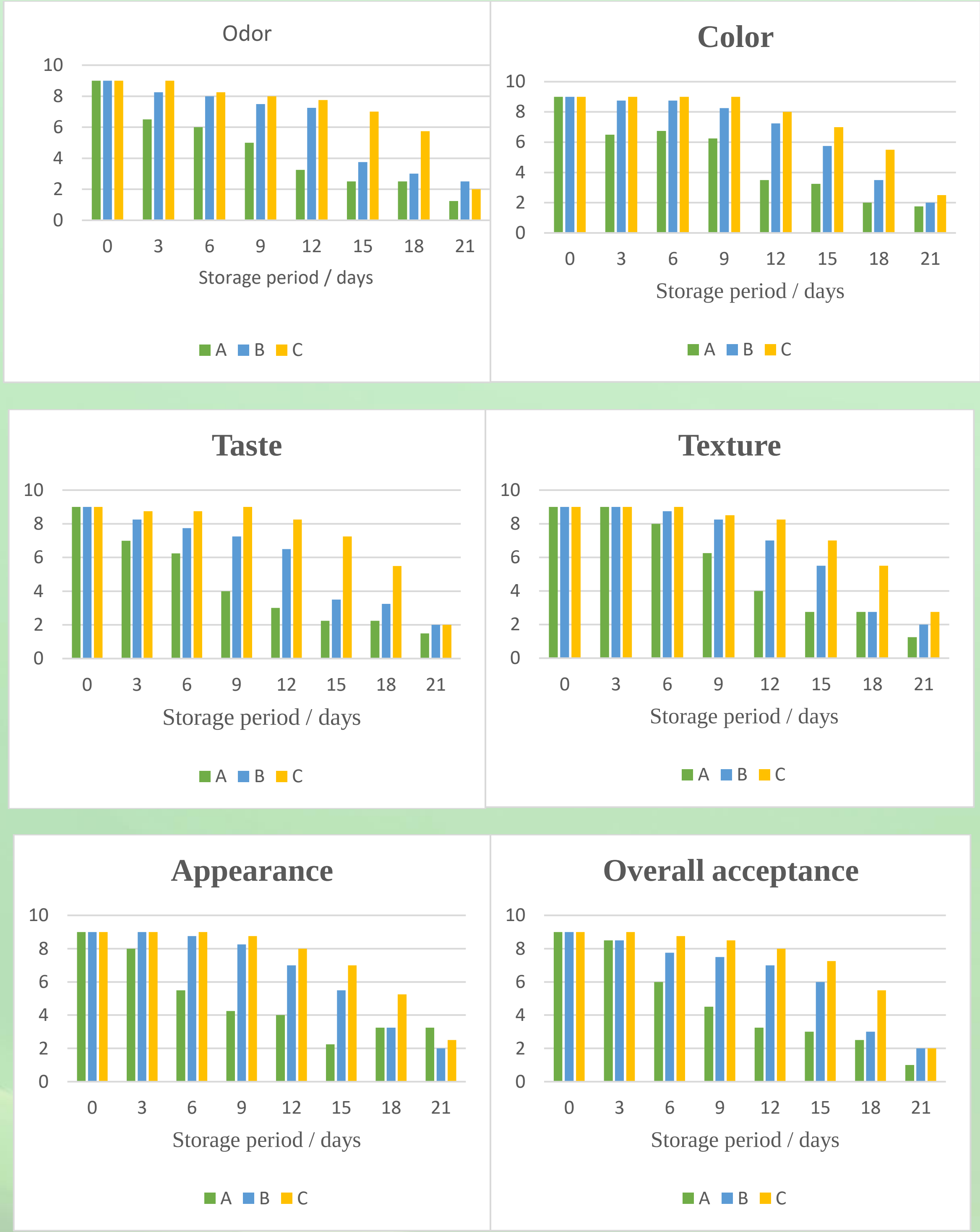
Figure 1: Ingredients of fish burgers



***Sensory Evaluation**:* Fish burgers were cooked following the method described by Dreeling et al. (2000). Briefly, both sides of each burger were fried on a hot plate for 10 minutes until fully cooked. During storage, samples were fried regularly on days 0, 3, 6, 9, 12, 15, 18, and 21. Sensory evaluation was conducted on these same days using a 9-point hedonic scale. The panelists, who were first trained to understand the product characteristics, assessed the samples based on color, odor, taste, texture, and overall acceptability. The scoring system ranged from 1-3 (unacceptable), 4-6 (good), 7-8 (very good), and 9 (excellent).
***Statistical Analysis**:* Each group's sensory indices were expressed as median (minimum, maximum) values and standard deviation by using SPSS software (version 21).

The results

A sensory analysis measures the qualities and perceptions of food by analyzing and interpreting the senses of sight, smell, taste, hearing, and touch. Sensory assessments are always crucial when assessing the freshness and quality of fish (Doğan & İzci, 2017). The sensory results of the fish burger are presented in Figures 1 to 6. 5 experienced panelists evaluated the sensory analysis of fish burgers, and a hedonic scale from 9 to 1 was used. After cooking, fish burgers were evaluated by giving points for some parameters, including taste, texture, smell, appearance, and overall acceptance. The sensory evaluation of fish burgers immersed in chitosan solution supplemented with a 1% concentration of OEO. Fish meat was considered safe for humans until sensory value reached 4 (Ojagh et al., 2010). The sensory panelists' ratings are based on the Taste, smell, texture, appearance, and overall acceptance of control and chitosan-coated fish burgers during 21 days of storage. The control samples were unacceptable in all sensory measures after the 9th day of storage. The ratings ranged from 3.5 to 2.0, indicating that the samples were rotten, prompting panelists to reject control samples on the ninth day of storage. Similarly, after 18 days of storage, other chitosan coating samples were found unacceptable, even though the values were in the middle of 4 to 5. Compared to control samples, the chitosan coating samples supplemented with essential oils extend the shelf life of fish burgers by nine days. Chitosan coatings supplemented with OEO at concentrations of 1 % were deemed "appropriate" for humans eating up to an 18-day storage duration; the scores were in the middle (4.0 to 6.0).



Figures 1, 2,3,4,5, and 6: Changes in sensory scores of fish burgers during storage at 4 °C.

As expected, the sensory scores of fish burgers with OEO-enriched chitosan membranes showed higher values than those of the control and non-chitosan oil groups. The results of our sensory analysis showed that appearance, color, taste, odor, and texture all decreased with storage duration for all groups. According to the sensory evaluation, control samples A were rejected on the ninth day, while Group B and C samples were rejected on the eighteenth day. The quality of the fish burger in Groups B and C maintained its quality for nine more days compared to the control samples. Compared to the control group, it was found that combining OEO with chitosan positively affected fish burgers, as the B and C groups were more favored, and their sensory scores were higher. At the same time, the direct oil addition b results were better than those of the control group but less than those of the c Group. The control sample had the lowest results, whereas those that combined the usage of chitosan and OEO had the highest scores. The findings showed that adding chitosan and OEO to fish burgers enhanced their sensory appeal. These findings are consistent with research conducted by Carbo et al. (2009), which examined the use of thyme oil and modified atmospheric packing to reduce microbial deterioration in packaged fresh cod hamburgers, and Mahmoudzadeh et al. (2010), which assessed sensory scores of fish items treated with rosemary extract. Similarly, the application of biopolymer EOs boosted fish fillets' overall acceptability (Ojagh et al., 2010; Jouki et al., 2014). Fan et al. (2009) stored silver carps coated with a 2% chitosan solution at -3C for 30 days. They discovered that the shelf life had been extended while the quality remained intact. Changes in sensory characteristics, such as taste, odor, texture, color, appearance, and overall acceptability, can result from compositional variation and influence the acceptability of fish as food by influencing microbial development. By applying chitosan and orange oils together, the acceptance feature of fish burgers during cold storage was extended to 18 days.

Conclusion

It was aimed to minimize undesirable microbial, oxidative, and chemical changes throughout the storage. As mentioned earlier, the study concluded that OEO has good antioxidant factors, which help prevent the growth of microorganisms and lipid oxidation. Therefore, these essential oils can be used to extend the shelf life of fish. According to sensory assessment, the shelf life of fish burgers was nine days for the control group, 18 days for the B group, and C. It can be concluded that the quality of fish burgers can be better preserved after using OEO in chitosan films. Based on all the above results, our project successfully concluded that the antioxidant and antimicrobial effects of chitosan coatings prepared with OEO emulsions were effective for storing and preserving fish burgers.

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