The Effects of Packaging Techniques on the Trout Fillet’s Fatty Acid Profiles

Veysel Parlak¹, Gonca Alak¹*, Arzu Uçar¹ and Muhammed Atamanalp¹

¹Department of Aquaculture, Faculty of Fisheries, Ataturk University, TR-25240 Erzurum, Turkey.

Authors’ contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

ABSTRACT

In this study, it was aimed to determine the change in fatty acid profiles of trout fillets stored for 18 days in refrigerator conditions using different packaging techniques (vacuum, stretch, chitosan coating (prepared with acetic acid or lactic acid)). It was observed that different packaging fillets had different fatty acid ratios, specially treated with chitosan group gave better results (p<0.05), at the end of the storage period. When the fatty acid profile of the fillets was examined, it was determined that Saturated Fatty Acids (SFA) was the least affected by the packaging technique. The highest Polyunsaturated Fatty Acid (PUFA) content was found in chitosan-coated groups (p<0.05). It has been determined that packing is more effective than time in terms of fatty acid profile and that chitosan coating gives better results.

Keywords: Fatty acid; EPA; DHA; packing; chitosan; shelf life.

1. INTRODUCTION

Lipids are one of the most important elements for the human organism. They are not only a high energy source but also very important in terms of containing fat-soluble vitamins, combining with proteins to form lipoproteins and playing a role in blood lipid levels.

Increasing awareness of healthy living in recent years has led to the intensification of studies on polyunsaturated fatty acids, which are known to have positive effects on human health. This
situation has made it necessary for researchers to address the work of degradation and protection of fatty acids. The benefits of fish consumption in healthy life are often associated with high omega-3 long chain polyunsaturated fatty acids (n-3 LC PUFA), especially eicosapentaenoic (EPA) and docosahexaenoic acid (DHA) [1].

“The EFSA Panel on Dietetic Products, Nutrition and Allergies has set the following Adequate Intake values: linoleic acid (LA) 4 E% (percentage of total dietary energy per day), alpha linolenic acid (ALA) 0.5 E%; EPA+DHA, adults 250 mg; DHA, pregnancy and lactation, an additional 100-200 mg of DHA, children 6-24 months 100 mg” [2,3].

The lipids, which are very important in terms of nutrient content and product quality, are known as important structures in chemical degradation of aquatic products. Lipid oxidation in seafood is an important issue and causes deterioration of taste, color, texture and nutritional value. At the same time, harmful effects on human health can occur, due to storage time and temperature. In order to reduce these negative effects and delay the deterioration, some applications such as natural antioxidants, physical treatment, and packaging are used [4].

Lipids and foods containing lipids are subject to oxidation by the action of oxygen in the air. Oxygen acts on fat, carbohydrates, and proteins of food causing quality deficits that can be felt more or less.

The aim of the present study is to investigate whether the different packing and/or coating systems have an impact on the fatty acid profile of fillet. In secondary is to determine suitable packing method of fish in terms of observing parameter.

2. MATERIALS AND METHODS

2.1 Fish

The average weight of 250 ± 15 g of rainbow trouts were made into fillets (300 fillets from 150 fish, 30 fillets for per group), then control and treatment groups were established. Two of the groups were coated with two different content edible films (1.5% acetic acid or 2% lactic acid). One of the remaining three groups was not subjected to any treatment, the other group vacuum packed and the last one wrapped with stretch film. The fillets were designed as five treatment groups with three replications. The fillets were stored at 4±1°C for 18 days. The fatty acid profiles were determined at the beginning and the end of the storage.

2.2 Edible Film Production

Preparation of the chitosan solution: Chitosan solution (2%, w/v) was prepared by 10 g of chitosan from crab shells (minimum deacetylate degree of 85%; Sigma) in 500 ml of lactic acid and acetic acid solution (1%, v/v). The mixture was held at 25±1°C and stirred for 10 min. After the chitosan was dissolved completely, the solution was filtered with cheesecloth (mesh size of the cheesecloth was around 1mm square) by vacuum aspiration [5,6]. Prepared solutions with different contents were applied to fillets by immersion method and the whole fillet surface was covered. Each group was kept under vacuum aspirator for 1 hour and the coating solution on the surface was allowed to dry. Each group was stored in refrigerator conditions for 18 days by placing it in appropriate size Styrofoam plates as three replications.

2.3 Extraction of Lipids which Obtained from the Samples

Total lipid extraction process from the samples was performed according to Folchet et al. method [7]. After extracting the lipids by using methanol and chloroform as solvents, the total fat ratio was determined by evaporating the solvents under nitrogen gas. Methyl esters (FAME) were prepared according to Metcalfe and Schmitc [8] and transferred to the vials. The fatty acids were analyzed by the viols passing through the gas chromatography (GC, Agilent, Model:6890).

2.4 Preparing the Fatty Acid Methyl Esters (FAME)

1.5 ml of a 2 M NaOH solution was added to glass test tubes containing samples’ pure fat and the flaps were tightly sealed under nitrogen. The tubes were kept in the incubator at 80°C (Binder FD 53) for 1 hour to saponify the fats inside. At the end of 1 hour, the samples cooled at room temperature than were added 2 ml of 14% BF₃ (Boron trifluoride methanol), again filled with nitrogen gas, and the mixture waited at 80°C for another half hour. At the end of the sample, samples were again taken to room temperature and allowed to cool. Cooled samples were vortexed by adding 1 ml of hexane. 1 ml poor
water was added to tubes and vortexed again. Finally, once again with the addition of tubes hexane, the phase formed on the top was taken with a pastry pipette and transferred to new glass test tubes containing sodium sulphate (Na₂SO₄). The collected hexane layer was transferred to 2 ml of GC vials, filled with nitrogen gas, and their caps were closed [8]. Prepared vials were arranged by gas chromatography (GC) for determining the fatty acids.

2.5 Determining the Fatty Acids

The prepared samples were placed in a 100 ml automated sample tray and analyzed by gas chromatography (GC / MS). In Supelco Component FAME Mix standard system is run, the peaks are calibrated by matching with fatty acids according to their exit times and the values are shown as % area in chromatograms are taken as a result.

2.6 Statistical Analysis

Data were performed with one-way variance analysis (ANOVA), and examined by Duncan’s test for obtaining significant differences (p<0.05).

3. RESULTS AND DISCUSSION

The fatty acid profile of fish oil shows alterations according to fish species, season and water temperature. These parameters are the most important factors affecting the quality of fish oil [2] Fish lipids are characterized by high-poly long-chain polyunsaturated fatty acids such as arachidonic acid (ARA 20: 4n-6), eicosapentaenoic acid (EPA 20: 5n-3) and docosahexaenoic acid (DHA 22: PUFA). The fatty acid composition of fillet lipid samples extracted from different packing is presented in Table 1, which are described as MUFA, PUFA, SFA, EPA, DHA and EPA/DHA. At the end of the experiment, when the reviewed the amount of muriatic acid (14: 0) in the fatty acid composition changes of the stored fillet samples, the highest value was found in the lactic acid chitosan and vacuum packed groups and the lowest value in the control group (p <0.05). The amount of palmitoleic acid (16: 0), another saturated fatty acid, was taken into account, the highest value was determined in the control group. The lowest value of the same fatty acid was found in the vacuum packed file. The highest oleic acid (18:1n-9) was obtained at the group of chitosan fillets acidic acid. The lowest values of this fatty acid were observed at the stretch, vacuumed and chitosan lactic acid fillets, respectively. After one-way analysis of variance was examined, the amount of linoleic acid (18: 2n6) in the filet of the experimental groups, the highest values were determined in the control and chitosan acetic acid group filets. On the other hand, the lowest values of this fatty acid were found in chitosan lactic acid and vacuum packing fillet (p <0.05) n Table 1.

It has been observed that differently packed filets have different SFA, MUFA, PUFA, n3, n6 and n3 / n6, especially the fillets treated with chitosan gave better results. It is seen that SFA is the least affected by the packaging technique in terms of the fatty acid profile of filets in the analyzes performed on certain days during storage. At the end of the storage period, lowest PUFA, n3 and n3/n6 rate was obtained in the control group. During storage time in refrigeration condition, PUFA content decreased in control and stretch film packing groups (p <0.05). This reduction may be a result of oxidative reactions of fatty acid composition with free radicals and other compounds formed during the storage [4].

Some studies have shown that high levels of omega-3 PUFAs, which are highly susceptible to oxidation with unsaturated constituents, can be dangerous [9]. In order to reduce the risks that may be due to omega-3 PUFAs, it is necessary to protect them from environmental and chemical changes during administration and absorption, to increase their stability and thus their antineoplastic activity [9]. Lipid oxidation in seafood is an important issue. Because it contributes to the deterioration of taste, color, texture and nutritional value. At the same time, the presence of natural antioxidants, physical applications, and the type of used chemicals and packaging types can cause harmful effects on human health, especially depending on storage time and temperature [4].

Different PUFA classes affect the lipid metabolism differently. For example; while the acids of n6 group decreasing the serum cholesterol levels at an important stage, the effects of these to triglycerides are too low. On the contrary, the effects of n3 acids on plasma cholesterol level are very low and the triglyceride level is decreased considerably. In recent years, n3 group fatty acids have also become important
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*SFA: saturated fatty acid; MUFA: monounsaturated fatty acid; PUFA: polynsaturated fatty acid; Data are presented as means±SEM (n=10). Means with different superscript letters in a line are significantly different (p < 0.05) in packing technique for each storage time.

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since it has been reported that not only plasma cholesterol level but also plasma triglyceride level constitutes a significant risk factor for coronary heart disease [10]. In this study, PUFA was high more conservative in lactic acid fillets than in the other treatments group fillets especially control. The reason for the decrease in PUFA is a high oxidation rate with the degree of unsaturation [11].

Today, the tendency about our diets is to reduce fat content or change its source. Thus, saturated fatty acids (SFA) are reduced, useful fatty acids such as long chain polyunsaturated fatty acids (PUFA) and conjugated linoleic acid (CLA) are increased [12]. Blanchet et al. [13] found that the amounts of SFA, MUFA, and PUFA of the rainbow trout (Oncorhynchus mykiss) which received from nature as 24.4, 17.0, and in culture rainbow trout as 58.6, 26.9, 32.5 and 40.6. In the present study; obtaining the result of the packaging effect on the SFA and PUFA values were parallel with this researcher.

Fat and fatty acid composition in fish is not stable. These can vary depending on seasonal changes (temperature, salinity), as well as on the life cycle of the fish and the fatty acid composition of the foods it feeds. According to Karlsdottir et al. [14], stored and lower storage temperature has an effect on the conservation of FFA (Free Fatty Acid).

The balance with n6 and n3 in the diets is too important for health. After consumption, these fatty acids compete metabolically for the same enzyme group. DHA and EPA compounds can be synthesized at low levels from α-linoleic acid. Besides, n6 fatty acids increase the net energy efficiency by stimulating the β-oxidation of lipids [15]. Omega-3 fatty acids are also highly effective in decreasing triglyceride and cholesterol levels [16]. n3 fatty acids are not synthesized in the body so they must be taken from the outside with food.

EPA and DHA, especially rich in n3, have been reported to have important roles in nervous and reproductive system functions, reducing the risk of coronary heart disease, reducing the incidence of diabetes, reducing the symptoms of rheumatoid arthritis, and hypertension, preventing cardiac arrhythmia and sudden death [17, 18, 19, 20]. Another factor affecting the level of plasma cholesterol is the ratio of PUFA / saturated fatty acids. Saturated fatty acids increase plasma cholesterol levels while PUFAs decrease plasma cholesterol levels. Different PUFA classes affect lipid metabolism differently. For example while the n6 group acids significantly lower serum cholesterol levels, triglycerides levels are very low. On the contrary, the effects of n3 acids on plasma cholesterol level are very low and the triglyceride level is decreased significantly to [21]. In contrast to present research data, Anelich et al. [22] reported that packing on lipid profiles was not effective for catfish. This may have affected by the packaging with different materials.

4. CONCLUSION
The importance of fish and fish lipids is about their including unsaturated fatty acids. In recent years, fatty acid analysis has been heavily exposed to science and industry due to the nutritional importance of these unsaturated fatty acids and therefore their role in human health, with n-3 fatty acids, especially PUFA, being significantly associated with human health. Therefore, it is important to determine the fatty acids in the different tissues of fish, which are so important for human health. Packaging methods are important as well as processing techniques applied to the preservation and storage of these fatty acids.

In our study, it was obtained that chitosan-treated fillets had a better effect on the fatty acid profile. In order for the obtained data to have a widespread effect, packaging and fatty acid profile relationships should be investigated with different fish species and different packaging techniques.

CONSENT
It is not applicable.

ETHICAL APPROVAL
As per international standard or university standard was written ethical approval has been collected and preserved by the authors.

COMPETING INTERESTS
Authors have declared that no competing interests exist.
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