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Effect of edible coatings on the quality of frozen fish fillets☆

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ABSTRACT

The objective of this study was to determine the changes in the quality of coated trout fillets after coating with edible materials. Fillets were coated and stored at −18 °C for a period lasting up to 7 months. Coating materials were applied in three different stages (first, second, and last coatings). The coated fillets were fried and analyzed for oil absorption and moisture content throughout the storage period. Sensorial attributes and the physical–biochemical changes were also measured before the frying process in each month. It was observed that it is more advantageous to use gluten as the first coating, xanthan gum as the second coating, and wheat (W) and corn (C) flours in the ratio of 1:1 or 2:1 as the last coating. In terms of the fillet quality, the following results were obtained in the analyses conducted before frying. The lowest pH found was 6.25 in zein-containing samples and 6.30 in guar-containing samples. The effects of the last coatings on pH were unimportant ($P > 0.05$). The lowest thiobarbituric acid levels found were 2.07 mg kg in the fillets coated with casein mixture, 2.44 mg kg in the fillets coated with xanthan gum, and 2.25 mg kg in the fillets coated with W:C flour mixture in the ratio of 2:1. The lowest total volatile basic nitrogen levels found were18.06 mg 100 g in the fillets coated with casein mixture, 18.62 mg 100 g in the fillets coated with xanthan gum, and 18.47 mg 100 g in the fillets coated with W:C flour mixture at 1:1 ratio. In the sensorial analysis, the coated samples were much more preferred than those not coated. As a result of the effects of all the materials, the coating layers on the meat surface provided more resistance against mass transfer during storage.

1. Introduction

Fast-food technology is acquiring importance rapidly because of the increase in the number of both working women and single people on the lookout for easy-to-serve food that is durable with high nutritive value. Due to this phenomenon, nowadays, meat and seafood are processed using different methods and subsequently packed for use by the consumer. Consequently, the consumption of fish containing valuable nutrients has recently increased (Metin, 2001; Metin, Erkan, Varlık, Özden, & Baygan, 2000).

Fish meat may decompose more easily than other meat products. Owing to the difficulties of handling and serving processes, it is traditionally consumed only in fishing areas. Therefore, increasing financial costs are introduced from the stages of processing to serving fish meat. Because the environment negatively affects fish, it must be consumed immediately after fishing or must be stored under suitable conditions to reach consumers without losing its nutritional value (İzgi & Çiftçioğlu, 1997).

Deterioration of fish meat mostly occurs in the fat-containing portions. The proportion of unsaturated fatty acids in fish fat is approximately 80%. These fatty acids are affected by the environmental oxygen that oxidizes and spoils the fish meat. As a result, the taste becomes bitter, and later on, colour changes occur. High water-holding capacity, neutral pH values, enzymes contained in the tissues, and lower connective tissue content have acceleratory effects on the process of spoiling. In the storage or processing steps, microorganisms change the protein structure of the meat resulting in unpleasant odors. All these alter the perceptions and satisfaction of the consumers (Özden & Gökoğlu, 1997; Serdaroğlu & Felekoğlu, 2001).

Longer shelf life and better quality can be made possible by using different processing techniques such as freezing and appropriate combinations of these techniques. Several studies have shown that edible coatings made of protein, polysaccharide, and oil-containing materials help to prolong the shelf life and preserve the attributes of edible quality. Generally, meat and other foods are covered with dry particles (breaded) or dipped in liquid solutions of these particles (battering). Occasionally, these two techniques are

☆ This study was summarized from the PhD work of the first author.

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combined during processing. Owing to their structural characteristics, flours, gluten, protein-based materials such as whey proteins, and supportive polysaccharides structured by gum and starch are commonly used. Hydrophilic edible films contain a barrier of oxygen and carbon dioxide and suitable mechanical properties at low relative humidity. Materials that are used to make edible films are the polysaccharides and protein-based polymers. Interaction with the surrounding environment during storing and processing is decreased to a minimum by coating and it prevents spoilage. In addition, oil absorption during frying is decreased; however, the moisture content of meat is retained. In effect, the sensorial quality of the product increases and weight loss is lowered. Moreover, the sensorial demands of the consumers are achieved, owing to the colour changes and textural qualifications after the frying process (Cutter, 2006; Kulp & Loewe, 1990; Williams & Mittal, 1999).

Edible coatings are important for sensitive foods such as seafood. Therefore, the effectiveness of various coating materials has been evaluated and their effects on trout-fillet quality are compared. The aim of the study is to increase shelf life, to improve the overall eating quality in terms of tenderizing and changing the taste and textural and structural properties of fried fillet, and to provide different alternatives to the consumers. To accomplish this, materials of protein and polysaccharide origin are applied in different types of coatings to the same fillets and the result is observed.

2. Materials and methods

2.1. Materials

Trout of the same age, raised in the farm of the Agricultural College of Yuzuncu Yil University in Turkey, were used, (i) Gluten, zein, blend of potassium caseinate and rennet casein as the first-coating material, (ii) a batter consisting of wheat flour (W), baking powder, and three different gums (guar → 3500–4000 centipoises (cps), xanthan → 1500–1600 cps, and locust bean → 2500–3000 cps) as the secondary-coating material, and (iii) three different mixtures of W, corn flour (C), breadstick (galeta) flour, garlic powder, onion powder, and maltodextrin as the last coating (breading) were used for the study. Zein was purchased from Sunar Corn Products Co. (Adana, Turkey); caseins and gums from Dairy Gold Co. (Ireland); and gluten, onion powders, garlic powders, and maltodextrin from Kurtsan Co. (İstanbul, Turkey). Flours, salt, and baking powder were obtained from the local grocery shops. Hydrogenated palmolein margarine was used as the frying medium (Paksoy Co., Adana, Turkey).

2.2. Methods

The coating formulas used in the study are presented in Table 1.

The trout samples were stored at +4 °C for 1–1.5 h in the laboratory. In the first step, the fillets were coated by the first-coating materials. In the subsequent step, the fillets were dipped in the batters and they were allowed to drain for 5 min. Finally, they were breaded with the third group of coating materials.

Table 1
The coating materials used in the study.

First-coating materials	Second-coating materials	Last-coating materials
Zein, gluten, potassium casein + rennet casein powders	Mix: 97% wheat flour + 2% baking powder + 1% gum (Gums: [1]xanthan, [2]guar, [3]locustbean)	Mix: 1:1, 1:2, 2:1 wheat flour:corn flour
	↓ Second coatings (batters)	↓ Last coatings (breads)
	[1]1:2, [2]1:2, [3]1:1.6 Mix:water	47.5% Mix + 47.5% breadstick flour + 1% onion powder + 1% garlic powder + 1% maltodextrin + 2% Salt

A total of 27 different coating combinations were applied. After the coating process, the fillets were pre-fried at 180 °C for 20 s. They were cooled to room temperature, wrapped using stretch film, and stored at −18 °C. A few analyses for checking the quality were carried out during the 7 months of storage. The twenty-seven treatments were tested along with the control. In addition, during these test periods, the pH, 2-Thiobarbituric acid (TBA) levels, and total volatile basic nitrogen (TVB-N) values of the samples before frying, in addition to the moisture, fat, and sensorial values after frying, were evaluated.

The pH values of the samples were determined using a pH meter (Hanna Instruments, Italy) (Varlık, Uğur, Gökoğlu, & Gün, 1993); the TBA value was determined using a spectrophotometer (Cecil Ce1120, England) at 538-nm wave length and expressed as mg malondialdehyde/kg sample. TVB-N value was determined using vapour distillation, according to Schormüller (1969). The moisture contents were determined at 102 °C for 4–6 h, and the fat contents were determined using the Soxhelet extraction method, according to the method proposed by Association of Official Analytical Chemists (2000). Five semi-trained judges assessed the sensory properties using a hedonic scale for the general appearance, colour, smell, taste-flavour, and texture for acceptability. The different values in the scale indicated the following reactions: 1: extreme dislike, 2: very much dislike, 3: moderate dislike, 4: slight dislike, 5: neutral, 6: like slightly, 7: like moderately, 8: like very much, 9: like extremely (Gökalp, Kaya, Tülek, & Zorba, 1999).

The experimental design was a completely randomized factorial model ($3 \times 3 \times 3$), containing three types of the first-coating materials, three types of the second-coating materials, and three types of the final coating materials, with two replications for each treatment. The data were subjected to analysis of variance (ANOVA), and the results were expressed as mean ± standard deviation (SD). If differences existed among the samples, the differences were compared by the Duncan's multiple-range test at the levels of $P < 0.01$ and $P < 0.05$ using the Statistical Analysis System program (SAS, 1998).

3. Results and discussion

3.1. The moisture and fat contents of coated fillets after frying

Moisture contents of coated fish were determined by two different methods to evaluate the water-holding capacity of meat both without and with coating. In the first group, the coatings were removed after frying, and the meat was minced in the 1st, 3rd, 5th, and 7th months. In the second group, the coatings were not removed, and the fillets were minced in the 2nd, 4th, and 6th months along with their coatings.

On day 0, the moisture was 71.16%, which was higher than the content in other storage periods. In fresh meat, the fat level was 5.29%, which increased rapidly at the end of frying. The effect of the storage period was generally the same (Table 2).

The ANOVAs for the results of moisture contents of fillets minced with their coatings showed that the effects of the second coatings were not significant ($P > 0.05$); however, the other factors were effective ($P < 0.01$). In the ANOVA of fats in this group, the effects of the factors storage duration and the coatings (the first, the second, and the last) were significant ($P < 0.01$). The differences between the moisture and fat values were examined at different storage periods of the second group that was minced along with the coatings after frying, and the results are shown in Table 2. In the beginning, the moisture value was 71.16%. However, it decreased rapidly after frying. This decrease was higher than that of the fillets