Influence of Glaze Solution Mixed with Rosemary Oil on the Oxidative Stability of Frozen Trout

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Abstract

In this study, it was investigated that the influence of glaze solution mixed with rosemary oil on the oxidative stability of frozen trout. 1% and 5% rosemary oil solution were used for glazing. Water-glazed (WG) and nonglazed (NG) rainbow trout fillets were used as control groups. Fish filets frozen at -25°C were glazed and were stored in a freezer at -18°C for 6 months. Samples were analyzed monthly for total volatile basic nitrogen, thiobarbituric acid, peroxide value and free fatty acids. According to our results, rosemary oil was found effective in controlling lipid oxidation in frozen rainbow trout fillet ($p< 0.05$).

Keywords: Oncorhynchus mykiss, glaze, rosemary oil, lipid oxidation, chemical quality

Dondurulmuş alabalıkların oksidatif stabilitesi üzerine biberiye yağı ile karıştırılmış glazing solusyonun etkisi

Özet

Bu çalışmada, dondurulmuş alabalıkların oksidatif stabilitesi üzerine biberiye yağı ile karıştırılmış glazing solüsyonunun etkisi araştırıldı. Glazing için % 1 ve % 5 biberiye yağı solüsyonu kullanıldı. Kontrol grupları olarak su ile glazinglenen ve glazing yapılmayan gökkuşağı alabalığı filetoları kullanıldı. -25°C'de dondurulmuş olan balık filetoları glazinglendi ve -18°C'de dondurucuda 6 ay süreyle saklandı. Örneklerin toplam uçucu bazik azot, tiyobarbitürik asit, peroksit değeri ve serbest yağ asitleri aylık olarak analiz edildi. Sonuçlarımıza göre, biberiye yağı; dondurulmuş gökkuşağı alabalık filetosunda lipid oksidasyonunun kontrolünde etkili bulundu ($p<0,05$).

Anahtar kelimeler: Oncorhynchus mykiss, glazing, biberiye yağı, lipit oksidasyon, kimyasal kalite

INTRODUCTION

Freezing is one of the most employed methods used for preserving fresh fish and other seafood products. However, freezing not able to completely inhibit microbial and chemical reactions, such as lipid oxidation, protein denaturation and surface dehydration (due to sublimation and recrystallization of ice crystals) leading to deterioration of fish quality during prolonged storage (Fan et al., 2009; Gonçalves and Gindri Junior, 2009; Rodriguez-Turienzo et al., 2011).

Different methods applied to minimize the undesirable effects of fish lipid and protein oxidation contain appropriate packaging, glazing with various chemicals, and the incorporation of antioxidants (Erickson, 1997). Glazing excludes air from the surface of the product and decreases the rate of oxidation (Santos and Regenstein,1990; Taheri, 2015). Due to recently found carcinogenic and teratogenic effects of synthetic antioxidants used to prolong storage time of foods, natural antioxidants have become the choice of consumers. Rosemary (*Rosemarinus officinalis*) is one of these natural antioxidants.

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This plant from the Labitae family is included in the GRAS list. There are numerous studies in the literature investigating antioxidant and antimicrobial effects of rosemary extract (Serdaroglu and Felekoglu, 2005; Rıznar *et al*. 2006; Yanishlieva *et al*. 2006).

The present work aimed at evaluating the effect of glaze solution mixed with rosemary oil (1% and 5%) as alternative replace water with glazing on oxidative stability of frozen fish.

MATERIAL and METHODS

Fish: A total of 28 rainbow trout, each weighing 250±10 g, were obtained from Keban Alabalık Co. aquaculture farm, which is located on Keban Dam Lake at Elazığ in the eastern Anatolia region of Turkey. Fishes were transferred within 1 h to the laboratory of the Faculty of Fisheries of Fırat University in sealed foam boxes containing ice. They were eviscerated and washed with clean water.

Rosemary oil*:* Water-soluble rosemary oil was purchased from Kalsec® Inc. (Kalamazoo, MI).

Chemicals: All chemicals and solvents used in this study were analytical grade commercial products purchased from Merck Chemical Company.

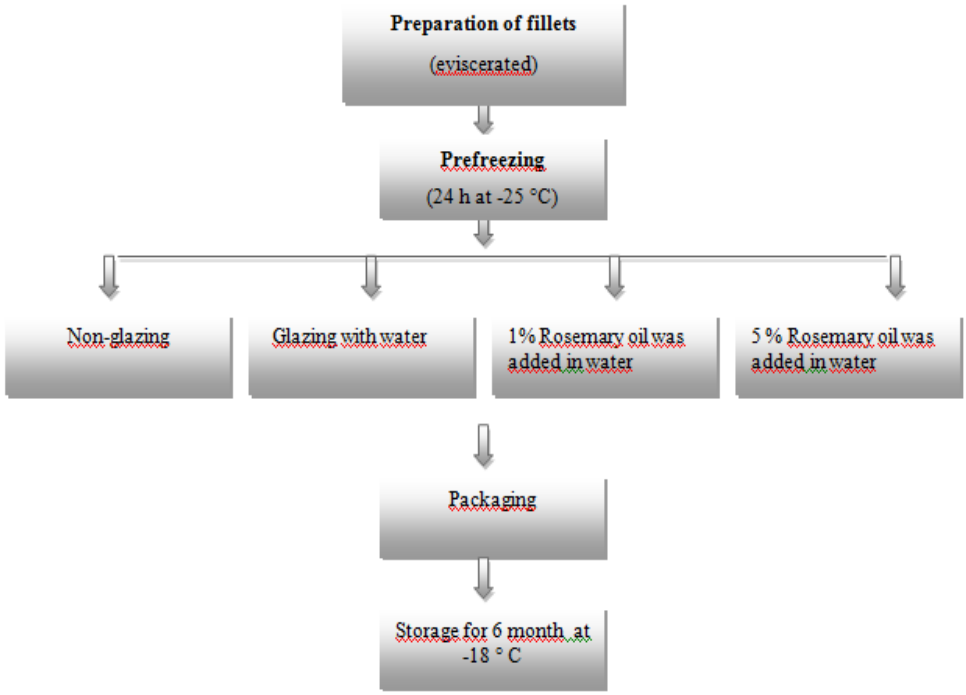

Fig 1. Experimental design

Preparation of fillets and glazing process

Fishes were transferred within 1 h to the laboratory of the Faculty of Fisheries of Fırat University in sealed foam boxes containing ice. They were eviscerated and washed with water. Then fish fillets were divided into four groups and frozen for 24 h at -25°C. One of the groups were placed on styrofoam plates without any processing (Non glazing), the second group received glazed with only water (Water glazing). Other groups were applied rosemary oil. Water-soluble rosemary oil were added in water. Frozen fish were dipped into 1% and 5% essential oil solution (4°C) for 1 min.

Glazed fishes were packaged, put in a foam plates, wrapped in linear low-density polyethylene film (LLDPE) and stored at -18°C for 6 months. Quality control analyses were performed during the storage on monthly intervals. Frozen fishes were selected randomly from each group for each month and thawed in refrigerator conditions (+4°C) overnight.

Proximate analyses

Proximate composition in terms of moisture, crude lipid and crude protein were carried out according to the Association of Official Analytical Chemist methods (AOAC 2002).

Lipid oxidation analyses

Lipid oxidation was assessed by the TBA method (thiobarbituric acid) based on Varlik *et al*. (1993) and is expressed as μg malondialdehyde/g tissue. In addition, Peroxide value (PV), expressed in milliequivalents of peroxide oxygen per kilogram of fat, was determined according to AOAC. The amount of free fatty acids (FFA) was calculated as oleic acid % (Varlik *et al*., 1993). The total volatile basic nitrogen (TVB-N) content of fillets were determined according to the method of Varlik *et al*. (1993) and expressed as mg TVB-N per 100 g muscle.

Statistical Analyses

All analyses were performed on monthly. Experiments were replicated twice on different occasions with different fish samples. The mean each sample for each group was analyzed three times. Data were subjected to analyses of variance. Tukey's honest significant difference procedure was used to test for differences between means ($P < 0.05$) using SAS 6.1 (SAS Institute Inc., Cary, NC).

RESULTS and DISCUSSION

The mean (±SD) of crude protein, crude fat, moisture and chemical quality criteria in the rainbow trout fillet are presented in Table 1. Crude protein, crude fat and moisture contents of rainbow trout meat averaged 19.29 %,6.90% and 72.79%, respectively. The present values are appropriately comparable with published reports in different studies (Ozyılmaz, 2007; Emir Çoban, 2013). As shown in Table 1, rainbow trout fish studied in the present study had higher lipid content (6.90%) and lower protein content (19.29%) when compared to the reported findings by Jouki *et al*. (2014). As Gonzalez-Fandos *et al*. (2005) reported, such variations in the chemical composition of fish is related to the nutrition, age and size of the fish, quality of water, pH of water and temperature, sexual variation, spawning cycles, as well as other environmental terms.

Table 1. Proximate composition and chemical quality of rainbow trout (*Oncorhynchus mykiss*)

Proximate composition	**%**	**Chemical quality criteria**	**Value**
Moisture	69.29 ± 1.18	pH	6.58 ± 0.13
Crude lipid	6.90 ± 0.06	TVB-N (mg/100g)	10.52 ± 0.91
Crude protein	19.29 ± 0.33	TBA (mgMDA/kg)	0.48 ± 0.09
		PV (meq O_2/kg)	0.80 ± 0.16
		FFA (oleic acid %)	0.83 ± 0.11

Values are mean ± standard deviation

TBA-value is a valuable test in determination of lipid oxidation. The acceptability limit being 7-8 mg MDA/kg (Varlik *et al*., 1993), the TBA value was below the acceptable upper-limit throughout the storage period in all groups according to our results (Fig 2).

The TBA value in raw material was found to be 0.48±0.09 mg MDA/kg and the TBA value increased in each group throughout the storage period. Samples glazed with water had a higher TBA value compared to samples glazed with water and rosemary oil and the difference was found to be significant ($p<0.05$). The prevention of malondialdehyde formation was more effective in rosemary groups starting from the 1st month compared to other groups ($p<0.05$). Rosemary oil, a natural antioxidant, was found to be effective in reducing TBA formation throughout the storage period. The lower TBA value in rosemary oil groups may be explained with antioxidative effects of phenolic substances found in rosemary oil. These results are consistent with findings of Lin and Lin (2005); Emir Çoban and Tuna Keleştemur (2017).

Formation of free fatty acids might be an important measure of rancidity of foods. FFAs are formed due to hydrolysis of triglycerides and may get promoted by reaction of oil with moisture (Freja et al., 1999). Free fatty acids, determined to be 0.83 ± 0.11 in trout fillet, was found to be 10.62 in the control group, 9.33 in the group glazed with water, 5.02 in the 1% rosemary group and 4.07 in the 5% rosemary group at the end of 6-month storage period (Fig 2B). This increase may be explained with the increase in free fatty acid level in fat due to enzymatic activity during long-term storage. Rosemary concentration was found to be effective on FFA amount ($p<0.05$). It was reported that rosemary extract significantly prevented the increase in FFA amount (Serdaroğlu and Felekoğlu, 2005).

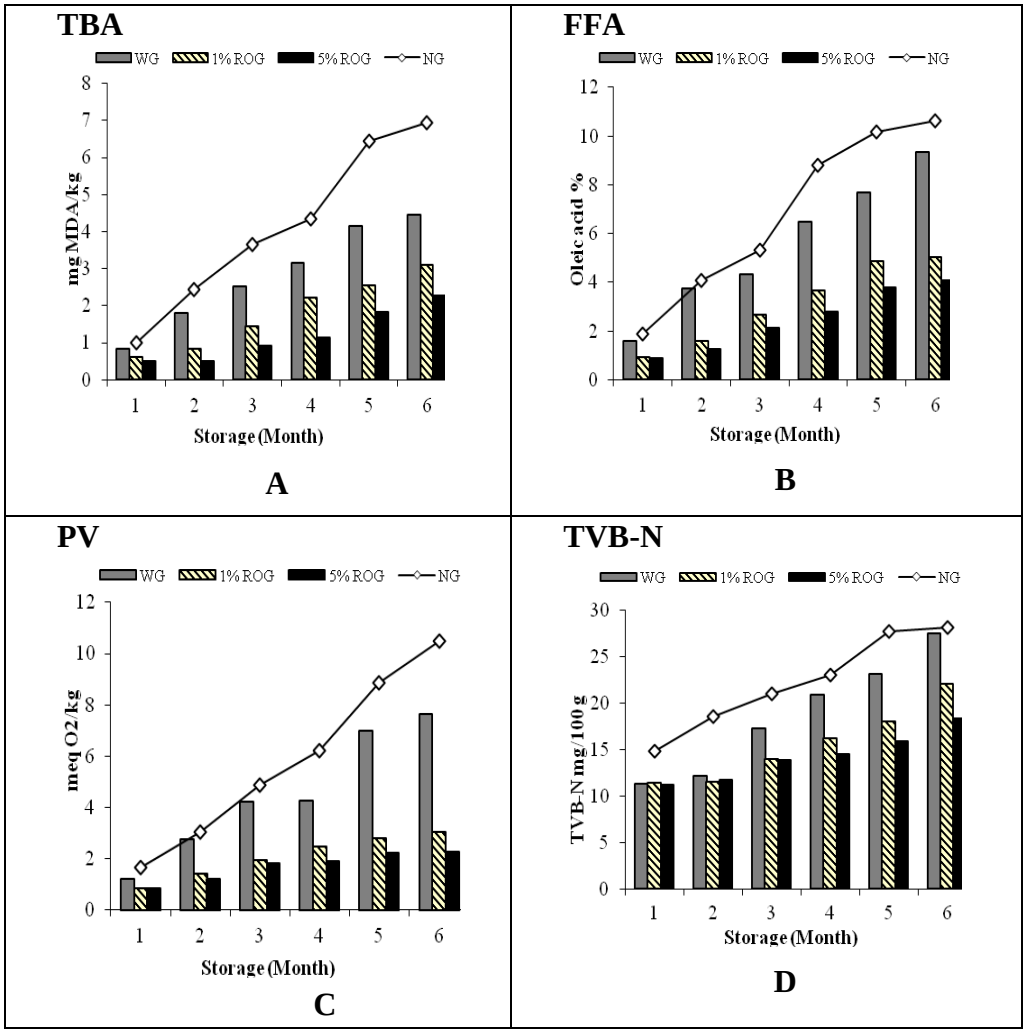

Fig 2. Influence of glazing enriched with rosemary oil on oxidative stability of frozen rainbow trout fillet (*Oncorhynchus mykıss*) **NG:** Nonglazıng, **WG:** Glazıng With Water, **1% ROG :** 1% Rosemary oil was added in water, **5% ROG :** 5% Rosemary oil was added in water

Peroxide value (PV) is widely used to measure the primary lipid oxidation indicating the amount of peroxides formed in fats and oils during oxidation. Peroxides are unstable compounds, and they were breaken down to aldehydes, ketones and alcohols, which are volatile, and cause off-flavor in products (Emir Çoban, 2013) The influence of glaze solution mixed with rosemary oil on the oxidative stability of frozen trout is depisted in Fig 2C. Glazing was observed to have a significant effect on peroxide formation (Fig. 2C). Significantly higher PV ($p<0.05$) was obtained from the NG group throughout the storage period. The lower PV was observed for both group 1% ROG and 5% ROG. Quitral et al. (2009) stored Chilean jack mackerel in ice prepared from aqueous extracts of oregano and rosemary and examined chemical changes. As a result of the research, the authors reported that PV of fish stored in ice prepared with rosemary oil was quite lower compared to other groups. This increase may be explained with the antioxidant properties of rosemary oil are

due to their high content of phenolic compounds (Pizzale *et al*. 2002; Fasseas *et al*. 2008). Similar findings were reported by other researchers (Rızna*r et al*. 2006; Yanishlieva *et al*. 2006).

Total Volatile Bases Nitrogen (TVB-N) is one of the most widely used methods today to estimate the degree of decomposition of fish. It includes the measurement of trimethylamine (produced by spoilage bacteria), dimethylamine (produced by autolytic enzymes during frozen storage), ammonia (produced by the deamination of amino-acids and nucleotide catabolites) and other volatile nitrogenous compounds associated with seafood spoilage (Ruiz-Capillas and Moral, 2001; El-Hanaf *et al*., 2011). TVB-N amount was found to be 10.52±0.91 mg/100 g in trout fillet and it increased throughout the storage period in all groups. At the end of the storage period, the highest TVB-N value was found to be 28.08±01.53 mg/100g. The difference between the rosemary oil groups and other groups was found to be significant ($p<0.05$) (Fig 2D). Lin and Lin (2005) glazed chilled tuna fillet with green tea extract added to water and examined its quality during the storage at -20°C. The researchers reported that the TVB-N value of green tea groups increased less compared to other groups during the storage.

CONCLUSION

In conclusion, glazing was found to be effective in preventing or delaying lipid oxidation which causes loss of quality during chilled storage of trout fillets, however rosemary oil, a natural antioxidant, was more effective compared to glazing in terms of delaying oxidative reactions. It was concluded as a result of the study that rosemary oil could be used as a natural preservative for chilled products.

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