E.Ü. Su Ürünleri Dergisi 2003
E.U. Journal of Fisheries & Aquatic Sciences 2003
Cilt/Volume 20, Sayı/Issue(1-2): 147 - 154

ISSN 1300 - 1590
http://jfas.ege.edu.tr/

Quality Changes of Fish Burger from Rainbow Trout During Refrigerated Storage

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Özet: ***Soğutularak depolama boyunca Gökkuşağı Alabalığı'ndan hazırlanan balık burgerlerde meydana gelen kalite değişimleri.*** Taze ve dondurulmuş-çözündürülmüş alabalık filetolarından hazırlanan balık burgerlerin (Grup A ve Grup B) 4°C'deki 21 günlük depolama süresi boyunca fiziksel, kimyasal, mikrobiyolojik ve duyusal değişimleri saptanmıştır. Her iki grubun pH ve TBA değerleri arasında önemli fark ($p<0.05$) saptanırken depolamanın l. günündeki doku özellikleri haricinde gruplar arasında duyusal nitelikler açısından önemli fark ($p>0.05$) bulgulanmamıştır. Balık burgerler depolama sonunda fiziksel, kimyasal ve duyusal analiz sonuçlarına göre iyi kalitede bulunmalarına karşın, mikrobiyolojik analiz sonuçlarına göre Grup A'nın iyi kalitede olmadığı. Grup B'nin ise 9 günden önce tüketilmesinin uygun olacağı bulunmuştur.

Anahtar Kelimeler: Balık burger, gökkuşağı alabalığı, kalite değişimleri

Abstract: Physical, chemical, microbiological and sensory changes of fish burgers prepared from fresh rainbow trout fillets (Group A) and frozen-thawed rainbow trout fillets (Group B) were determined during the storage at 4°C for 21 days. There were significant differences ($p<0.05$) between pH and TBA values of two groups but there were no significant differences ($p>0.05$) between sensory attributes except texture properties at 1^{st} day of the storage. Although fish burgers were found in good quality limits at the end of the storage due to the results of physical, chemical and sensory analysis, according to microbiological analysis results, Group A is not in good quality limits and Group B should consume before 9 days of the storage.

Keywords: Fish burger, rainbow trout, quality changes

Introduction

In recent years, the preference of the consumers was directed towards the fast food consumption since there has been a rapid urbanization and an increase in working women population. There have been many studies about the production and quality stability of the fishery fast food products including fish cake, fish crackers, fish balls and fish burgers (Herborg, 1976; Sipos *et al.*, 1979; Siaw *et al.*, 1985; Choi *et al.*, 1988; Ihm *et al*., 1992a; Ihm *et al*., 1992b; Jensen, 1993; Lazos, 1996).

Fish burgers are acceptable fast food products by the consumers in the world. Unfortunately, although burgers prepared from beef and poultry were served to the Turkish market, fish burgers were not produced commercially. Studies in the production of fishery fast food products in Turkey are developing newly. There is no study in the production of the fish burgers but Gökoğlu (1994) prepared fish balls from mackerel and studied the quality changes at 4°C. Generally tuna fish, mackerel, sardine and some fresh water fish species were used in the production of the fish burgers in many studies. It was noticed by the researchers that the main problem encountered was fishy taste and smell and sometimes high fat content in the production of the fish burgers from marine fish (Hoogenkamp, 1992; Almanderes-Martinez, 1993). Lazos

(1996) also stated that fish balls were produced at first quality when fresh water fish were used as the raw material.

Most important fresh water fish species, trout, takes the part of nearly 60% of the total production from aquaculture in Turkey (Anonymous, 1999). In some fish processing plants in Turkey, trouts over cultured were frozen after filleting and stored as blocks, and these blocks were thawed when they were required. In order to determine the difference in quality changes of fish burgers, they were prepared from both fresh and frozen-thawed rainbow trout fillets with natural additives. Chemical compositions of the rainbow trout fillets and fish burgers were determined. In addition physical, chemical, microbiological and sensory changes of fish burgers were evaluated during the storage period at 4°C for 21 days.

Materials and Methods

Rainbow trout (*Oncorhynchius mykiss* W., 1792) fillets (without skin) weighed approximately 80-120 g were obtained from Bağcı Fishery Products and Energy Production Ind. Trade Corp. (Köyceğiz-Muğla). Salt[a], table sugar[a], baking soda[a], onion powder[a], garlic powder[a], black pepper[a], breadstick crumbs[a] and soy oil[a] were used as ingredients ([a]: Commercial brand).

Fresh fillets from rainbow trouts newly caught and fillets shocked at -35°C, kept frozen at -24°C for 3 months were used as the raw materials in the present study. Fresh rainbow trout fillets in commercial foam box including ice bags and frozen rainbow trout fillets at frozen state were reached to the laboratory within 5 h. Frozen fillets were thawed in the refrigerator the night before for the preparation of the fish burgers.

Fish fillets were passed through a meat grinder to obtain a homogenous mixture. Ingredients were added to the minced fish flesh and they were mixed well. 50 g of this mixture placed on the plastic wrap was pressed by using manual hamburger press machine. In this manner, it was provided to pack the burgers one by one with plastic wrap. Fish burgers prepared from fresh fillets were indicated as Group A while the burgers prepared from frozen-thawed fillets were indicated as Group B. They were stored at 4°C for 21 days.

Chemical composition of rainbow trout fillets and fish burgers were determined as crude protein (AOAC, 1984), crude fat (Bligh and Dyer, 1959), crude ash (AOAC, 1984), moisture (Ludorff and Meyer, 1973), carbohydrate (Dubois *et al.*, 1956) and salt (Schormüller, 1968). Analyses were made in three parallels.

pH values of samples were measured by using digital pH meter (Ebro). Sample was homogenized in distilled water in a ratio 1:1 (w/v) and its pH was measured at room temperature. Thiobarbyturic acid (TBA, mg malonaldehyde/kg) values were determined as described by Tarladgis *et al.* (1960). Analyses were made in three parallels.

For all microbiological counts, 10 g of sample were taken and transferred in 90 ml 0.1% peptone water (Difco, 0118-17-0). From the 10^{-1} dilution, other decimal dilutions were prepared. Total viable count was determined by using pour plate method. Plate Count Agar (Difco, 0479-17) was used as medium (Harrigan and McCance, 1976). Plates were incubated at 30°C for 24-48 h. For coliform bacteria count Most Probable Number method was used. Lauryl Tryptose Broth (Difco, 0241-17-0) was used as medium and confirmation test was made in Brilliant Green Bile 2% (Difco, 0007-17-4). Tubes were incubated at 37°C for 24-48 h (Harrigan and McCance, 1976). Coagulase-positive *Sfaphylococcus aureus* count was determined by using spread plate method. Baird Parker Agar (Difco, 0768-17-3) was used as medium. Plates were incubated at 37°C for 24-48 h (Harrigan and McCance, 1976). Analyses

were made in two parallels. Results of the total viable counts were given as the mean value of two parallels. Results of the coliform bacteria counts of two parallels were given as separately.

For the determination of sensory quality of the fish burgers scoring test was used (Paulus *et al.*, 1979). All burgers were served to 11 panelists as cooked on electric grill for 4-5 min to evaluate the sensory attributes (colour, smell, flavor, spice, texture, general acceptability) of the samples by using 9-points descriptive scale. According to the scoring table, scores between 7-9 indicated 'high quality', scores between 4-6 indicated 'moderate quality' and scores between 1-3 indicated the limit of 'unacceptability'.

Statistical evaluations of the chemical composition and sensory analysis of fish burgers were made by using 't test' (two sample assuming equal variances) in Microsoft Excel 7.0. Physical and chemical analysis data were evaluated by employing a randomized block design.

Results and Discussion

Table 1 shows the chemical composition of the fresh and frozen-thawed rainbow trout fillets and fish burgers at 0 day of the storage. Protein, carbohydrate and ash rates of frozen-thawed rainbow trout fillets were lower than the rates of fresh ones and found as 19.83%, 0.32% and 1.53%, respectively. Decrease in the protein rates of frozen-thawed rainbow trout fillets resulted from the protein denaturation because of the frozen effect. Carbohydrate found as small amount in fresh fish was almost decomposed in frozen fish fillets since long period passed after catching the fish. It was obvious that protein, fat and moisture rates of fish burgers were lower than the rates of rainbow trout fillets while carbohydrate, salt and ash rates were higher in burgers as compared to the rainbow trout fillets. This case was due to the use of some ingredients in the production of the fish burgers. Ihm *et al.* (1992a) determined that protein and moisture rates of sardine burgers were lower than the rates of sardine as the raw material but increase in fat and ash rates was found in sardine burgers. These results except increase in fat rates in sardine burgers are in good agreement with the results of present study. The reason of increase in fat rates in the study of lhm *et al.* (1992a) was thought to be used high amount of fat in the production of sardine burgers.

Table 1. Chemical composition[a] of fresh and frozen-thawed rainbow trout fillets and fish burgers (Group A and Group B).

Chemical composition (%)	Fresh rainbow trout fillets	Frozen-thawed rainbow trout fillets	Fish burger (Group A)	Fish burger (Group B)
Crude protein	21.67±0.25	19.83±0.36	16.63±0.25	17.50±0.25
Crude fat	3.66±0.13	4.11±0.05	1.95±0.08	2.87±0.10
Carbohydrate	1.19±0.39	0.32±0.03	14.43±0.70	14.56±0.30
Salt	0.45±0.07	0.78±0.02	0.88±0.03	0.78±0.02
Moisture	71.92±0.20	74.21±0.21	63.61±0.20	61.87±0.38
Crude ash	1.56±0.25	1.53±0.18	3.38±0.22	3.33±0.30

[a] *: Mean value±standard error; n= 3*

Statistical results showed that there were no significant differences ($p>0.05$) between protein, carbohydrate, salt and ash rates of Group A and Group B at 0 day of the storage. Significant differences were observed ($p<0.05$) between fat and

moisture rates of Group A and Group B.

Table 2 shows the changes in pH and TBA values of Group A and Group B during the storage period at 4°C for 21 days. pH values of Group B were lower than the values of Group A and this difference between the groups was significant according to variance analysis ($p<0.05$). At day 0, pH values of Group A and Group B were measured as 7.03 and 6.83, respectively and these values dropped orderly to the values of 5.82 and 5.61 at day 21.

Table 2. Change in pH and TBA values[a] of fish burger (Group A and Group B) during the period at 4°C.

Days of storage	Group A	pH	Group B	Group A	TBA	Group B
0	7.03±0.02		6.83±0.01	0.33±0.06		0.11 ±0.03
2	6.97±0.01		6.77±0.00	0.22±0.02		0.42±0.03
4	6.95±0.01		6.76±0.01	0.31±0.08		0.24±0.02
6	6.87±0.02		6.70±0.03	0.26±0.03		0.28±0.01
8	6.46±0.02		6.36±0.00	0.35±0.04		0.27±0.04
10	6.40±0.01		6.18±0.01	1.53±0.17		1.25±0.13
12	6.37±0.00		6.05±0.01	0.69±0.05		0.44±0.04
14	6.20±0.01		5.98±0.02	1.45±0.10		0.58±0.08
18	6.06±0.02		5.90±0.03	1.26±0.08		0.64±0.02
21	5.82±0.01		5.61±0.01	1.38±0.03		1.00±0.03

[a] *: Mean value±standard error; n= 3*

TBA value of fresh fish fillet was measured as 0.11 mg malonaldehyde/kg while it was found as 0.21 mg malonaldehyde/kg for frozen-thawed fish fillet (data not shown). When the fish burgers were prepared from these fish fillets, TBA values of Group A and Group B were determined as 0.33 mg malonaldehyde/kg and 0.11 mg malonaldehyde/kg, respectively at day 0. Up to 10^{th} day of the storage no significant difference ($p>0.05$) was found between TBA values of both Group A and Group B but peak values that were 1.53 mg malonaldehyde/kg for Group A and 1.26 mg malonaldehyde/kg for Group B, were reached at day 10. At the end of the storage TBA values of Group A and Group B reached to the values of 1.38 mg malonaldehyde/kg and 1.00 mg malonaldehyde/kg, respectively. As it was shown in table, TBA values of Group B during the storage were lower than TBA values of Group A and there was a significant difference between the two groups ($p<0.05$). Oxidative rancidity, as occurs particularly in fatty fish is a very complex deterioration and one of the common methods for the determination of lipid oxidation is TBA method (Icekson *et al.*, 1998). It is suggested that maximum level of TBA value indicating the good quality of the material is 5 mg malonaldehyde/kg while it may consume up to the level of 8 mg malonaldehyde/kg TBA value (Schormüller, 1969). Waters (1982) showed that any rancid flavor or odor was not detected in peak TBA values that were measured as 6.7 mg malonaldehyde/kg for filleted spot (*Leiostomus xanthurus*) and 7 mg malonaldehyde/kg for minced spot stored at -18°C for 12 months. Tha data obtained in the present study suggest that TBA values both raw materials and fish burgers are in the good quality limits after 21 days of the storage at 4°C.

Total viable and coliform bacteria

counts of Group A and Group B during the refrigerated storage were demonstrated in Table 3. Total viable counts of fresh fish and frozen-thawed fish fillets were determined as >7.48 log CFU/g and 5.58 log CFU/g, respectively (data not shown). It was obvious that microbial load of fish burgers was lower than the values offish fillets at 0 day of the storage because of the antimicrobial effects of the ingredients (i.e., spices) used in the burger formulation. Total viable count of Group A was determined as 6.00 log CFU/g at day 3, increased during the storage and reached 8.20 log CFU/g at the end of the storage. At 0 day of the storage total viable count of Group B was 4.04 log CFU/g and increased less than 1 log unit (4.86 log CFU/g) at day 3. Microbial load sharply increased at 9th day of the storage and reached approximately 9.00 log CFU/g at the last day of the storage. Coliform bacteria counts of fresh fish fillet was found as (>1400/g; >1400/g) and it was determined as (200/g; 1100/g) for frozen-thawed fish fillet (data not shown). Since coliform bacteria count of fresh rainbow trout fillet, like total viable count, was higher than the counts of frozen-thawed rainbow trout fillet. Group A kept the high level during refrigerated storage and coliform bacteria count of Group B decreased to the certain level (95; 150) at day 0 and kept this level up to 9th day of the storage.

Table 3. Total viable bacteria (TVB; log cfu/g) and coliform bacteria (CB; MPN/g) counts of fish burgers (Group A and Group B) during the storage period at 4°C.

		Day of storage				
Analysis	Group	0	3	9	10	21
TVB count	A	-[a]	6.00	-[a]	7.68	8.20
	B	4.04	4.86	8.43	-[a]	8.91
CB count	A	-[a]	>1400	-[a]	>1400	1100
			>1400		>1400	115
	B	95,	25,	45,	-[a]	9,
		150	250	250		14

[a] *: Not analysed.*

Total viable count is an important criterion for quality evaluation. The maximum of 107 CFU/g for the acceptability of fresh and frozen fish, as recommended by International Commission of Microbiological Standards for Foods (ICMSF, 1978) was exceeded for fresh fish fillet but not reached for frozen-thawed fish fillet. There is no standard for fish burgers in Turkey but according to hamburger standard maximum total viable count was given as 106 CFU/g (Anonymous, 1992) and maximum level for the same product was 107 CFU/g (Wehr, 1982). ICMSF (1978) suggested that maximum level of total viable count for some fish products (i.e., fish sticks, fish portions, fish cakes) was 107 CFU/g. Considering these values, Group A came to the critical value at day 3. Up to 10th day of the storage total viable count of Group A increased 1.5 log unit but total viable count of Group B increased 3.5 log unit from 3 to 9 day of the storage. It is possible to say that total viable counts of Group A and Group B exceeded the microbiological limits of acceptability before 9 and 10 days of the storage (Table 3) but quality assessment by means of only total viable

count is not enough. Coliform bacteria and *S. aureus* are good indicators for hygiene and handling. Maximum level of fecal coliform bacteria in fish products (fish sticks, fish portions, fish cakes) was given as 400/g by ICMSF (1978) and coliform bacteria must not exceed 1000/g in hamburger (Wehr, 1982). Thus, coliform bacteria counts of Group B were almost at low level during the storage but coliform bacteria counts of Group A stayed at high level (Table 3). Coagulase-positive *S.aureus* was not detected in neither fish fillets nor fish burgers during the refrigerated storage.

Changes in scoring of the sensory attributes of Group A and Group B during the storage at 1st, 10th and 21st days were shown in Table 4. According to the statistical analysis results, there were no significant differences ($p>0.05$) between taste, spice, smell, colour, texture and general acceptability properties of two groups during the storage except the texture properties at 1st day of the storage ($p<0.05$). Generally fish burgers prepared from frozen-thawed fish fillets received low scores but none of the groups was indicated as 'unacceptable' by the panelists.

Table 4. Changes[a] in scoring of the sensory attributes of fish burgers (Group A and Group B) the storage period at 4°C.

Quality		Day of storage		
criteria	Group	1	10	21
Taste	A	6.82±0.50	5.69±0.35	4.92±0.42
	B	6.09±0.49	6.38±0.43	4.00±0.46
Spice	A	6.55±0.69	4.92±0.46	4.58±0.42
	B	5.64±0.72	5.38±0.37	4.25±0.46
Smell	A	6.45±0.62	6.15±0.50	5.25±0.59
	B	5.91±0.48	6.77±0.39	3.83±0.56
Colour	A	6.45±0.59	6.46±0.42	6.00±0.49
	B	6.18±0.62	7.31±0.35	5.00±0.49
Texture	A	7.09±0.41	5.69±0.46	5.50±0.34
	B	5.91±0.37	5.85±0.41	4.75±0.57
General	A	6.55±0.51	6.07±0.37	5.08±0.51
acceptability	B	5.91±0.49	6.85±0.36	3.67±0.56

[a]*: Mean value±standard error- n= l l*

It was stated that chemical and microbiological parameters correlated well with sensory findings of iced-stored Barents sea cod (Oehlenschlager, 1998) and chemical parameters indicating spoilage found at low levels were confirmed by receiving high scores of coated and uncoated fillet portions (Manthey *et al.*, 1986). Manthey *et al.* (1988) stated that neither the chemical and physical investigations nor the microbiological analysis confirmed the end of storage of iced European catfish. The visual inspection of the fish was more informative than the sensory evaluation of the cooked samples. These mean that determination of the quality deterioration by physical, chemical, microbiological and sensory analysis depends on the sample analysed. Group A in the present study is not in microbiologically good quality limits from the point of view of high coliform bacteria count even if it was found in good quality limits due to the results of physical, chemical and sensory analysis during the refrigerated storage. Group B should consume before 9 days of the storage because of high total viable

count. In order to prolong the shelf-life of the fish burgers it is advisable to use some food preservatives or vacuum packaging to control the growth of microorganisms.

Conclusion

Quality changes of fish burgers prepared from fresh rainbow trout fillets and frozen-thawed rainbow trout fillets were studied during the storage at 4°C for 21 days. During the storage period there were significant differences ($p<0.05$) between the physical and chemical analysis of two groups of fish burgers. pH and TBA values of fish burgers prepared from fresh fish fillets were higher than the values of other fish burger group. No significant difference ($p>0.05$) was observed between sensory attributes exception of the texture properties at 1st day of the storage but generally fish burgers prepared from frozen-thawed fish fillets received low scores. It was established that all quality criteria mentioned above except the microbiological analysis were not reached to the maximum limits for the acceptability of fish burgers. Microbiological parameters were more informative alone other than pH, TBA and sensory analysis for quality deterioration of fish burgers during the refrigerated storage. It is advisable to use other chemical methods (TVB-N, TMA) for assessing spoilage of the product. It was noticed that microbiological quality of raw material is important to produce good quality product.

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