Evaluation of Tench (*Tinca tinca* L., 1758) Meat as Fish Cake and Determination of Shelf Life

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A B S T R A C T

In this research, the suitability of tench (*Tinca tinca* L., 1758) for the production of fish cake and changes in nutrient components were determined. The supplied fish materials were minced followed by forming into fish cakes with the addition of various additives. Chemical and organoleptic analyzes of the minced fish and fish cakes were made. Also, thiobarbutyric acid (*TBA*), total volatile basic nitrogen (*TVB-N*), pH parameters were determined and total mesophilic aerobic bacteria (*TMA*), total psychophilic bacteria (*TPA*), coliform group bacteria, and yeast-mold counts were performed in fish cakes on the 1., 4., 7. and 10. days of the storage at 4 ± 1 °C. According to the organoleptic analysis findings, the fish cakes obtained from tench were considered suitable for consumption. TBA, TVB-N, pH values, and microbiological analysis results of storage have shown that deterioration occurs as storage time increases. Especially the changes after the 7th day of storage are statistically significant ($p<0.05$). As a result of the research, it is concluded that fish cakes made using tench can contribute to the economy. It was determined that the obtained fish cakes which were stored at $4\pm1°$ C maintained the good quality parameters until the 7th day while they deteriorated after the 10th day of the storage.

Keywords: Tench, fish cake, shelf life

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Kadife Balığı (*Tinca Tinca L.*, 1758) Etinin Balık Köftesi Olarak Değerlendirilmesi ve Raf Ömrünün Belirlenmesi

Öz: Bu araştırmada kadife balığının *(Tinca tinca L.*, 1758) köfte yapımına uygunluğu ve besin bileşenlerindeki değişimler belirlenmiştir. Tedarik edilen balık filetoları kıyma haline getirilerek çeşitli katkı maddelerinin eklenmesiyle balık köftesi yapılmıştır. Balık kıyması ve balık köftesinin kimyasal ve organoleptik analizleri yapılmıştır. Ayrıca balık köftesinde 4 ± 1 °C'de depolamanın 1., 4., 7. ve 10. günlerinde tiyobarbütirik asit (*TBA*), toplam uçucu bazik azot - (*TVB-N*), pH parametrelerine bakılmıştır. Toplam mezofilik aerobik bakteri (*TMA*), toplam psikofilik bakteri (*TPA*), koliform grubu bakteri ve maya-küf sayımı yapılmıştır. Organoleptik analiz bulgularına göre, kadife balığından elde edilen köfte tüketime uygun görülmüştür. *TBA*, *TVB-N*, pH değerleri ve depolamanın mikrobiyolojik analiz sonuçları depolama süresi arttıkça bozulma olduğunu göstermiştir. Özellikle depolamanın 7. gününden sonraki değişimler istatistiksel açıdan önemlidir (p <0,05). Araştırma sonucunda, kadife balığı kullanılarak yapılan balık köftesinin ekonomiye katkı sağlayabileceği sonucuna varılmıştır. Elde edilen balık köftelerinin, 4 ± 1 ° C'de depolama sürecinde iyi kalite özelliklerinin 7. güne kadar korunduğu ve depolamanın 10. gününden sonra kötüleştiği tespit edilmiştir.

Anahtar kelimeler: Kadife balığı, balık köftesi, raf ömrü

Introduction

Nowadays, advances in technology have enabled the awareness of the consumer and have brought the brainpower to the fore in most occupational groups.

As a result, the orientation towards the food rich in protein and unsaturated fatty acids, easily digestible has increased. Fisheries is the food group that meets the expectations of the consumer while fish meat

takes the first place among all aquaculture. Fish meat is a sufficient foodstuff due to its high content of essential nutrients such as protein, unsaturated fatty acids, and essential amino acids required for the body (Duman and Dartay 2007).

Red meat consumption as a source of protein is more common in our country. Consumption of red meat is quite high especially in fast working life as meatballs because of the reason that usage of meatballs in some meat products as hamburgers, etc. is necessary. However, alternative sources for burgers and meatballs are being investigated because of the concerns that high cholesterol in red meat may cause cardiovascular diseases. Fish meat may be an alternative to red meat because of its low cholesterol level and high omega-3 fatty acid content that prevents cardiovascular disease (Balıkçı et al. 2018).

Species belong to the Cyprinidae family is very common in Turkey's freshwater. 226 fish species and subspecies belonging to 27 families were found to live in inland waters of the country. 170 of them live in freshwater. 108 of these fish belong to the family of *Cyprinidae* (Hamalosmanoğlu and Kuru 2004).

Tench (*Tinca tinca*, Linnaeus 1758) is a freshwater cyprinid and a benthos-eating omnivorous widely lives in parts of Europe and Asia (Secci et al. 2018). It has great potential for the aquaculture sector. The natural distribution of this fish was undefined for centuries since it was understood that it was comestible and suitable for culture and transport in middle ages (Avlijaš et al. 2018).

Fish cake is a fish product obtained by adding spices after cleaning, boiling, and mincing the fish meat (Öksüztepe et al. 2010; Özpolat and Çoban 2012). Different recipes are given for the production of fish cakes and these recipes are applied by taking into consideration the characteristics of the raw material. In the study in which fish cakes were produced from carp (*Cyprinus carpio*), fish were filleted after skinning and boiled in boiling water for 1-2 minutes to separate meat from a fishbone. After the process of separation of meat from fishbone, groundfish were obtained by passing fish meat from a grinder with a hole diameter of 3 mm. To give the product a certain elasticity, 0.3 % sodium polyphosphate and to enhance the flavour, 0.9 % salt, 0.4 % black pepper, 0.5 % cumin, 0.5 % red pepper, and 1.3 % parsley were added to the experimental groups. Then, different groups were added to the fish cakes and 5 groups were formed together with the control group (Group A: 6 % onion; Group B: 6 % onion + 4 % sunflower oil; Group C: 1.4 % garlic; Group D: 1.4 % garlic + 4 % sunflower oil, Group E: Control group). The products were shaped by placing 6 cm diameter and 1 cm depth of stainless steel circle molds (Yanar and Fenercioğlu 1999).

In a study about the investigation of some quality parameters of fish cakes made from raw and boiled fish meat, fish were decapitated, eviscerated, and minced orderly. Mixed seasonings (black pepper, allspice, cumin) and additives (starch, garlic) were added into the minced fish meat, then kneaded and finally given fish cake shapes. The fish cakes were prepared with an average of 25 g weight, packed with stretch film by the placement of 3 pieces each on styrofoam plates and soted at +4 ± 1 °C (Akkuş et al. 2004).

In a research conducted in the aquaculture processing plants which process the zander (*S. lucioperca*) and the tench fish fillets, the evaluation of fillet residues that do not conform to the calibration as fish cakes to contribute to the economy was investigated. Zander and tench fillet residues were obtained from local enterprises as material. Fish cakes were made after mincing these supplied materials and the addition of various additives (Ünlüsayın et al. 2002).

In this study, the processability of tench, which is common in Turkey's inland waters was aimed to evaluate differently. In this way, the meat of tench which is not preferred by consumers should be approved by converting into fishcakes. In addition to this, depending on a consumer's pleasure it was aimed to extend the shelf life of the tench meat and develop a new product that has gained economic value.

Materials and Methods
Materials
In the study, a total of 100 tenches (*Tinca tinca*) with a mean length of 24 ± 1cm and a weight of 190 ± 20 g were used which caught from Lake Beyşehir (Konya, Turkey). Additives and spices used in the production of fish cakes were supplied from the local market of Eğirdir (Isparta, Turkey).

Fishing and transport of the fish
T. tinca samples forming the material of this study were fished from Lake Beyşehir by the operation of hauling with extension nets. After that, fish that were in the same size group were selected and brought to the Eğirdir Fisheries Research Institute Food Laboratory for assay.

Preparation of fish cakes
The fish to be used in the study were eviscerated and washed with plenty of water. The washing process was made carefully not to remain any residues as blood, mucus, and so on. Cleaned fish were filleted and the groundfish were obtained by passing fish meat from a grinder with a hole diameter of 3 mm. 3 different formulations were prepared by adding additives and spices to the groundfish. The

preparation of fish cakes were similar to known methods (Damarlı et al. 1992; Avcı 1996). All fish cakes were prepared by shaping in which each of them was put in a 10 g weight, 5 cm diameter and 0.5 cm deep stainless steel circle molds. In preparation of control group fish cakes in addition to the groundfish, 1 % salt, 0.5 % black pepper, 0.5 % red pepper, 0.5 % cumin, 1 % parsley, 10 % tail fat 10 % semolina were added. In addition to the control group; 1 % thyme was added into the first fish cake group and 1 % ginger was added into the second fish cake group. After the fish cakes were prepared by 3 different formulations, they were evaluated separately by 10 panelists. The fish cakes were packaged with aluminum foil and stored at 4 ± 1 ° C for 1, 4, 7, 10 days (under refrigerator conditions). Then, samples were taken for each stated day and shelf life was determined for these products by examining sensory, chemical and microbiological changes. The preparation of the fish cakes was carried out according to the following product processing flow diagram (Figure 1).
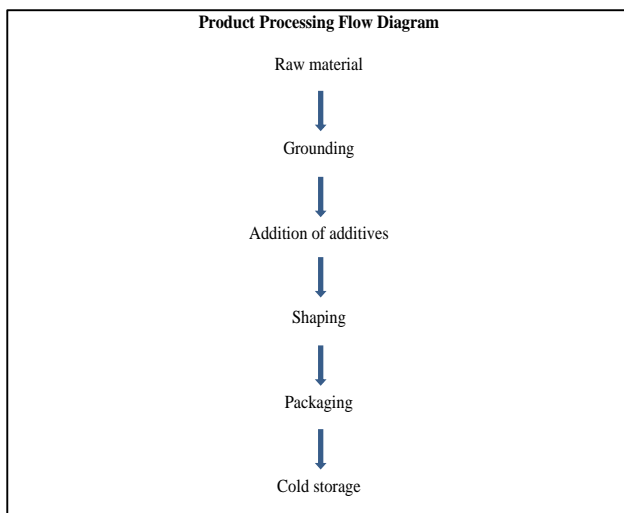
Figure 1. Product processing flow diagram.

All analyzes in the study were carried out in fresh fish and fish cake samples taken periodically on the 1st, 4th, 7th, and 10th days of the storage.

Biometrical measurements

The meat yield of the fish brought to the laboratory was calculated by measuring the lengths by mm graduated of a gauge and weights by a scale with a sensitivity of 0.01 g (Dikel and Çelik 1998).

Determination of pH

pH measurement was conducted according to TSE 2002. Samples (10 g) were taken periodically from fresh fish and fish cakes during storage and homogenized with the help of mixer. Then measurements were carried out at 16 ± 1 °C with WTW branded 320 sets of digital pH-meter (Er 2010).

Chemical composition analysis

Determination of moisture was carried out according to TS 1743 (110±1 °C) (Anonymous 1974a) while deternination of inorganic matter (crude ash) was carried out according to TS 1746 (550±1 °C) (Anonymous 1974b) in fresh fish, processed and stored fish cake samples. Additionally, crude protein analysis was carried out according to Kjeldahl Method (Nx6.25), (Anonymous 1983) and crude oil analysis was carried out according to Soxhlet Method (Keskin 1975).

Determination of Thiobarbituric Acid Reactive Substances (TBARS)

In this analysis, a method based on the occurrence of red color as a result of heating of thiobarbituric acid with malonaldehyde which is formed by oxidation of unsaturated fatty acids was used. The amount of malonaldehyde specified as TBA number was determined as spectrophotometric (at 538 nm wavelength) and the results were given in mgMA/kg (Varlık et al. 1993).

Determination of Total Volatile Basic Nitrogen (TVB-N)

Total volatile basic nitrogen determination of fresh and processed fish meat was made according to the Lucke-Geidel method modified by Antonacopoulas and Vyncke (1989) and the results were given in mg/100 g (İnal 1992).

Microbiological Analysis
Preparation of samples for microbiological analysis

25 g of fish meat was weighed with the help of sterile forceps, scalpel and scissors in aseptic conditions and 225 ml of buffered peptoned water (Merck 7228) was added onto it. It was then homogenized in 2-3 minutes pre-sterilized blender and diluted 10-fold. Cultivations were carried out by using pour plate method. For cultivation two parallels were used from each dilution. 30-300 colonies-including plaques in Petri dishes were enumerated (Refai 1979; Varlık et al. 1993).

Total mesophilic aerobic (TMA) bacteria count

Plate Count Agar (Merck 5463) was used for the count of total mesophilic aerob bacteria. After cultivation petri dishes were incubated at 30±1 °C for 72 hours and forming colonies were enumerated at the end of the incubation (Refai 1979; Varlık et al. 1993).

Total psychrophilic aerobic (TPA) bacteria count

Plate Count Agar (Merck 5463) was used for the count of total psychrophilic aerob bacteria. Forming colonies were enumerated after 72 hours of incubation at 22±1 °C (Anonymous 1993).

Coliform bacteria count

Violet Red Bile Agar (Merck 1406) was used as the medium. Plates were evaluated by incubating at 37±1 °C for 24 hours and counted bold red coloured colonies (Kocatepe et al. 2011).

Yeast and mould count

Potato Dextrose Agar (Merck 10130), which was adjusted to pH 3.5 by using 10 % tartaric acid, was used as the medium. Plates were enumerated after incubation at 22±1 °C for 3-5 days (Anonymous 1983; Varlık et al. 1993).

Sensory analysis

In the sensory analyzes, the appearance, odor, texture, taste and general appreciation of the fish cakes were evaluated by the panellists with a score of 10 points in compliance with the hedonic scale. According to this, 10 points were evaluated as very good, 5 points were insignificant, and 4 points and under were inconsumable (Haq et al. 2013).

Statistical analysis

The data obtained from the study were subjected to the variance analysis (F-test) with JMP program, and the means for the calculated parameters were compared with the LS Means Student T Multiple Comparison Test. The significance level was chosen as $p < 0.05$.

Results

The meat yield rates of biometric measured samples were determined by seperating the viscera, head, skeleton, skin. Accordingly, the yield was determined as 43.769 ± 0.670 % (Table 1).

Table 1. Meat yield of tench *(T. tinca* L. 157) samples.

Weight (g)	193.275±16.970
Total length (cm)	24.475±0.848
Fork length (cm)	23.274±0.707
Viscera (%)	11.987±1.137
Head (%)	16.693±0.621
Meat (%)	43.769±0.670
Skeleton (%)	13.998±0.602
Skin (%)	13.308±0.488

The results of sensory analysis of the fish cakes are given in Table 2.

Table 2. Sensory analysis of fish cake.

Panellists	Control*	Group 1*	Group 2*
Day 0	8.26 [b]	8.18 [b]	9.05 [a]
Day 1	8.32 [b]	8.15 [b]	9.24 [a]
Day 4	8.17 [b]	8.19 [b]	9.31 [a]
Day 7	7.26 [b]	7.51 [a]	7.2 [b]
Day 10	4.89 [a]	4.20 [b]	4.25 [b]

*Different superscript letters in the same line indicate significant difference between means ($p < 0.05$).

As a result of the sensory analysis of the products obtained, a large part of the panelists liked fish cakes in terms of taste, smell, texture and appearance. Obtained fish cakes got between 8.18 and 9.05 on a ten point scale as a result of first sensory analysis. Second group fish cakes were the most admired group with 9.05 points. The sensory values of the fish cakes stored in the cold decreased depending on the storage period.

In ground fish, water was found to be 83.15, crude protein was 13.07, fat 1.14, inorganic matter was 1.89, carbohydrate was 1.21 in percentages. In the control group water was found to be in amount of 70.69, crude protein 10.85, fat 7.11, inorganic matter 3.95, carbohydrate 8.17 while in the first group water was 70.29, crude protein 10.72, fat 7.17, inorganic matter 4.14, carbohydrate 8.25 and in the second group water was 70.11, crude protein 10.56, fat 7.11, inorganic matter 4.05, carbohydrate 8.21.

Chemical compositions of ground fish and fish cakes are given in Table 3.

Table 3. Chemical compositions of ground fish and fish cakes.

Chemical Composition	Ground Fish* x±SH	Control* x±SH	Group 1* x±SH	Group 2* x±SH
Water %	83.15±1.10ª	70.69±1.14ᵇ	70.29±1.21ᵇ	70.11±1.35ᵇ
Protein %	13.07±1.09ª	10.85±1.23ᵇ	10.72±1.66ᵇ	10.56±1.01ᵇ
Fat %	1.14±0.41ᵇ	7.11±0.12ª	7.17±0.29ª	7.03±0.36ª
InorganicMatter %	1.89±0.2 ᵇ	3.95±0.30ª	4.14±0.63ª	4.05±0.51ª
Carbohydrate %	1.21±0.42ᵇ	8.17±1.53ª	8.25±0.56ª	8.20±0.54ª

*Different superscript letters in the same line indicate significant difference between means ($p < 0.05$).

Chemical and microbiological analysis results of fish cake are given in Table 4 and Table 5. According to the results of the analysis made in ground fish; TBA was found to be 1.05 ± 0.30, TVB-N was 10.4 ± 1.09 and pH was 6.25 ± 0.39.

In microbiological analysis performed in ground tench fish, the count of TMAB was detected as 4.462 ± 0.023 log cfu/g, TPA was 3.726 ± 0.016 log cfu/g, coliform bacteria was 1.301 ± 0.026 log cfu/g and yeast-mold was 1.079 ± 0.009 log cfu/g.

Table 4. Chemical analysis results of ground fish.

Chemical Analysis	TBA x±SH	TVB-N x±SH	pH x±SH
Ground Fish	1.05±0.30	10.4±1.09	6.25±0.39

Table 5. Microbiological analysis results of ground fish.

Microbiological Analysis	TMA x±SH	TPA x±SH	COLIFORM x±SH	YEAST - MOULD x±SH
Ground Fish	4.462±0.023	3.726±0.016	1.301±0.026	1.079±0.009

The TBA values of fish cakes were increased according to storage time. Time dependent TBA changes in fish cakes are given in Table 6. TBA values of the product ranged from 1.43 ± 0.18 to 8.51 ± 0.33 (mg malonaldehyde/kg) at $+4\pm1$ °C during storage. In a very good material TBA values should be less than 3, and in a good material should not be more than 5. The consumption limit value is between 7-8 (Duman and Özpolat 2012; Varlık et al. 1993).

The TVB-N values of fish cakes were increased according to storage time. Time dependent TVB-N changes in fish cakes are given in Table 7. The TVB-N values of the product increased during storage and ranged from 11.33 ± 0.97 to 37.37 ± 0.38 mg/100 g at $+4\pm1$ °C. The difference of TVB-N change between the products on the 4th, 7th and 10th days of the storage was significant ($p<0.05$).

Table 6. Time dependent TBA changes in fish cakes (mg malonaldehyde/kg).

Days	Control* x±SH	Group 1* x±SH	Group 2* x±SH
Day 0	1.43±0.101[b]	1.58±0.138[a]	1.56±0.194[a]
Day 1	2.88±0.153[b]	3.03±0.143[a]	3.04±0.136[a]
Day 4	4.97±0.101[b]	5.51±0.140[a]	5.47±0.063[a]
Day 7	6.81.13±0.112[b]	7.5±0.180[a]	7.2±0.106[ab]
Day 10	8.26±0.077[b]	8.39±0.154[ab]	8.51±0.187[a]

*Different superscript letters in the same line indicate significant difference between means (p < 0.05).

Table 7. Time dependent TVB-N changes in fish cakes (mg/100 g).

Days	Control* x±SH	Group 1* x±SH	Group 2* x±SH
Day 0	11.33±0.560[a]	11.37±0.317[a]	11.33±0.664[a]
Day 1	13.53±0.520[b]	13.6±0.529[b]	12.87±0.845[a]
Day 4	19.43±0.120[b]	19.97±0.348[b]	21.6±0.321[a]
Day 7	25.13±0.712[b]	27.5±0.208[a]	27.03±0.470[a]
Day 10	35.43±0.578[b]	36.3±0.321[ab]	37.37±0.218[a]

*Different superscript letters in the same line indicate significant difference between means (p < 0.05).

The pH values of the product ranged from 6.4 ± 0.03 to 6.76 ± 0.18 at $+ 4 \pm 1$ ° C during storage. The difference in pH between the products on the 4th, 7th and 10th days of the study was significant ($p<0.05$). Time dependent pH changes in fish cakes are given in Table 8.

Total mesophilic aerobic bacteria values of the products ranged from 4.579 ± 0.023 log cfu/g (3.8×10^4 cfu/g) to 7.36 ± 0.049 log cfu/g (2.3×10^7 cfu/g) at $+4\pm1°$ C. Total mesophilic aerobic (TMA) bacteria counts of the fish cakes were increased depending onstorage time. The difference

between total mesophilic aerobic bacteria change between the products on the 1st, 4th, 7th and 10th days of the study was significant ($p<0.05$). Time dependent total mesophilic aerobic (TMA) bacteria count changes in fish cakes are given in Table 9.

According to the criteria published by the Ministry of Agriculture and Forestry in terms of total aerobic bacteria content (TMA), the consumption limit of fresh fish meat is 10^7 cfu/g (Çolakoğlu et al. 2006). Tench fishcakes reached thelimit on the 10th day. In terms of

total mesophilic aerobic bacteria content, they maintained their consumable properties until the 10th day.

The total psychrophilic bacteria (TPA) load values of the products were ranged between 3.99 ± 0.11 log cfu/g (1.0×10^4 cfu/g) and 6.907 ± 0.014 cfu/g (8.1×10^6 cfu/g) at $+4 \pm 1°$ C. Total psychrophilic aerobic (TPA) bacteria counts of the fish cakes were increased depending on storage time. The difference of total psychrophilic bacterial change between the products on the 1st, 4th, 7th and 10th days of the study was significant ($p < 0.05$). Time-dependent total psychrophilic aerobic (TPA) bacteria count changes in fish cakes are given in Table 10.

Table 8. Time dependent pH changes in fish cakes.

Days	Control* x±SH	Group 1* x±SH	Group 2* x±SH
Day 0	6.71 ± 0.177^a	6.71 ± 0.072^a	6.76 ± 0.101^b
Day 1	6.57 ± 0.074^a	6.63 ± 0.60^b	6.66 ± 0.061^b
Day 4	6.53 ± 0.032^a	6.46 ± 0.029^{ab}	6.4 ± 0.014^b
Day 7	6.63 ± 0.01^a	6.56 ± 0.014^b	6.55 ± 0.015^b
Day 10	6.73 ± 0.018^a	6.64 ± 0.017^b	6.62 ± 0.017^b

*Different superscript letters in the same line indicate significant difference between means ($p < 0.05$).

Table 9. Time dependent total mesophilic aerobic (TMA) bacteria changes in fish cakes (log cfu/g).

Days	Control* x±SH	Group 1* x±SH	Group 2* x±SH
Day 0	4.579 ± 0.013^a	4.616 ± 0.009^b	4.591 ± 0.11^{ab}
Day 1	4.62 ± 0.009^a	4.663 ± 0.005^b	4.71 ± 0.007^c
Day 4	5.263 ± 0.007^b	5.271 ± 0.007^b	5.342 ± 0.011^a
Day 7	6.078 ± 0.020^a	6.212 ± 0.023^b	6.372 ± 0.031^c
Day 10	7.1 ± 0.030^b	7.192 ± 0.032^b	7.36 ± 0.028^a

*Different superscript letters in the same line indicate a significant difference between means ($p < 0.05$).

Table 10. Time dependent total psychrophilic aerobic (TPA) bacteria changes in fish cakes (log cfu/g).

Days	Control* x±SH	Group 1* x±SH	Group 2* x±SH
Day 0	3.99 ± 0.063^b	3.994 ± 0.051^b	4.053 ± 0.026^b
Day 1	4.115 ± 0.066^b	4.173 ± 0.033^{ab}	4.306 ± 0.030^a
Day 4	4.999 ± 0.025^b	5.087 ± 0.044^b	5.27 ± 0.020^b
Day 7	5.821 ± 0.013^b	5.812 ± 0.019^b	5.931 ± 0.007^a
Day 10	6.783 ± 0.010^a	6.845 ± 0.009^b	6.907 ± 0.007^c

*Different superscript letters in the same line indicate significant difference between means ($p < 0.05$).

Coliform group bacterial load values of the products ranged from 1.36 ± 0.102 log cfu/g (2.3×10^1 cfu/g) to 2.175 ± 0.029 log cfu/g (1.5×10^2 cfu/g) at $+ 4 \pm 1°$ C. Coliform bacteria counts of the fish cakes were increased depending on storage time. The difference of coliform group bacterial change between the products on the 1st, 4th, 7th and 10th days of the study was significant ($p < 0.05$). Time dependent coliform bacteria count changes in fish cakes are given in Table 11.

Yeast and mold load values of the products ranged from 1.56 ± 0.072 log cfu/g (3.6×10^1 cfu/g) to 2.548 ± 0.019 log cfu/g (3.5×10^2 cfu/g) at $+ 4 \pm 1°$ C. Yeast and mould counts of the fish cakes were increased depending on storage time. The difference between yeast and mold changes was found to be significant ($p < 0.05$) between the products on the 1st, 4th, 7th and 10th days of the study. Time dependent yeast and mould count changes in fish cakes are given in Table 12.

Table 11. Time dependent coliform bacteria changes in fish cakes (log cfu/g).

Days	Control* x±SH	Group 1* x±SH	Group 2* x±SH
Day 0	1.36 ± 0.058^b	1.46 ± 0.087^{ab}	1.519 ± 0.041^a
Day 1	1.56 ± 0.041^b	1.634 ± 0.032^{ab}	1.725 ± 0.026^a
Day 4	1.725 ± 0.026^b	1.752 ± 0.026^{ab}	1.823 ± 0.022^a
Day 7	1.937 ± 0.17^b	1.969 ± 0.015^{ab}	2.014 ± 0.017^a
Day 10	2.175 ± 0.011^b	2.111 ± 0.032^b	2.145 ± 0.013^a

*Different superscript letters in the same line indicate significant difference between means ($p < 0.05$).

Table 12. Time dependent yeast and mould count changes in fish cakes (log cfu/g).

Days	Control* x±SH	Group 1* x±SH	Group 2* x±SH
Day 0	1.56±0.0416[b]	1.634±0.032[ab]	1.752±0.026[a]
Day 1	1.969±0.015[b]	2.014±0.013[ab]	2.053±0.026[a]
Day 4	2.185±0.009[b]	2.212±0.018[b]	2.328±0.025[a]
Day 7	2.263±0.007[b]	2.286±0.07[b]	2.409±0.011[a]
Day 10	2.437±0.005[c]	2.472±0.004[b]	2.548±0.010[a]

*Different superscript letters in the same line indicate significant difference between means ($p < 0.05$).

Discussion

In this study the processability of tench was tried to be determined. For this purpose some physicochemical and microbiological analysis were conducted to detect quality criteria. Generally, results obtained in this study were in accordance with the similar studies as indicated below.

The panelists reported that; they felt the smell of fish cakes more than fish and they received a pleasant taste due to the effect of spices. These results are in accordance with those reported by Ünlüsayın et al. (2002) in which similar results were obtained from fish cakes.

With the effect of spices and additives used in fish cake production, decrease in water and protein ratios and increase in fat, inorganic and carbohydrate ratios in fish cakes contrast to ground fish were observed. Results were in agreement with Avcı (1996), who studied physical and chemical changes in trout fish cake and salad during cold storage. In addition, in a study about fish cakes obtained from carp meat conducted by Yanar and Fenercioğlu (1999), reported smilar results.

The TBA results and the results of the fish cakes for day 0 were similar and the values of the control group were found to be lower. This is also an expected condition for raw material. Ünlüsayın et al. (2002) reported that the results of fish cakes obtained from zander and tench were 6.13±0.39 – 6.21±0.48 for pH; 1.15±0.97 – 1.05±0.54 for TBA and 0.08±1.23 – 10.93±1 for TVB-N, orderly. The results obtained from the study show accordance with previous studies.

The products began to deteriorate on the 7th day of the study and exceeded the limit of consumption on the 10th day. It has been observed that TBA analysis findings in the study were in agreement with other studies (Yanar and Fenercioğlu 1999; Ünlüsayın et al. 2002). In a different study, TBA values ranged between 1.70-4.49 (mg MDA/kg) in the control group and 1.92-3.83 (mg MDA/kg) in the Sunset Yellow FCF supplemented group during storage. The reasons for lower TBA values include factors such as raw material and process differences, such as smoked garfish. (Kaba et al. 2012).

Quality classification of fish and fish products according to TVB-N values are stated as; TVB-N value up to 25 mg/100 g is "very good", up to 30 mg / 100 g is "good", up to 35 mg / 100 g is "marketable" and over 35 mg / 100 g is deteriorated. Beside this TVB - N consumable limit value is given as 32-36 mg / 100 g in freshwater fish (Çetinkaya 2017; Varlık et al. 2000). Tench fish cakes could be characterized as "very good" until the 7th day, "marketable" between 7 – 10 days and deteriorated after 10 days according to this classification.

In a study about the investigation of some quality parameters of fish cakes made from raw and boiled fish meat, the TVB-N values of the fishcakes made from raw anchovies increased in dependence on the storage period and exceeded the limit value with the values of 39.33 mg / 100 g on the 18th day of the first trial and 36.03 mg / 100 g on the 15th day of the second trial (Akkuş et al. 2004). In a similar study, TVB-N value of fresh bonito was 10.6 ± 0.02 mg / 100g. This value was found to be 12.6±0.00 mg/100g on the first day of storage in fishcakes obtained from smoked bonito, and 30.51±0.09 at the end of 10 days storage period (Kaba et al. 2013). It was observed that the TVB-N results in the study were consistent with other shelf life of fishcakes determination studies.

pH values of fish cakes were firstly decreased depending on storage time and then increased. In a study conducted to determine the shelf life of marinated fiscakes, the pH value of the fishcake marinades stored in the cold was 4.19 at first, but then increased and then decreased depending on the storage time (Varlık et al. 2000).

In the study on the production of fishcakes from fillets of pike perch and tench, pH values of pike perch and tench fishcakes at +4±1° C were initially determined as 6.16±0.02 and 6.93±0.42, respectively. decreased and then increased on the 14th day of the study were determined as 9.12 ± 0.88 and 6.78 ± 0.09, respectively, during the study period, it decreased firstly and then increased to 9.12±0.88 and 6.78±0.09 on the 14th day of the study, respectively (Ünlüsayın et al. 2002).

In our study, changes in pH values of fishcakes during 10 days storage were found to be acceptable.

In general, fresh fish pH value is reported to be 6.0-6.5, consumability limit value is 6.8-7.0 (Gökoğlu and Varlık 1992; Akkuş et al. 2004). The pH values are also in line with the results of the study in which Öksüztepe et al. (2010) examined the effect of sodium lactate addition on fish cakes.

In the study on microbiological quality of fresh and processed atherina fish (*Atherina boyeri*, Risso 1810), the average total aerobic bacteria count and coliform bacteria count in fresh fish were reported as $2.2x101$ cfu/g and $2.9x101$ cfu/g, respectively. In the study on the production of fishcakes from fillet residues of pike perch and tench, total mesophilic aerobic bacterial values of pike perch and tench fishcakes were initially determined as $4.0x10^4$ cfu/g and $4.2x10^4$ cfu/g, respectively, then increased on the 14th day of the study and determined as $1.2x10^7$ cfu/g and $1.4xl0^7$ cfu/g, respectively (Ünlüsayın et al. 2002).

In the study of the examination of some quality parameters of fishcakes made from raw and boiled fish meat, total mesophilic aerobic bacteria value of fishcakes made from raw anchovy increased depending on the storage time and the value in the first trial at the beginning of storage was found to be $4.8±0.007$ log cfu/g and in the second trial it was $4.6±0.021$ log cfu/g. On the 12th day of the storage, the value in the first trial was found to be $7.4±0.014$ log cfu/g and in the second trial it reached to $7.3±0.002$ log cfu/g and exceeded the limit value (Akkuş et al. 2004). In the study on the shelf life of anchovy fishcakes stored in cold, total mesophilic aerobic bacteria value increased by storage time and was determined as 4 log cfu/g ($1.0x10^4$ cfu/g) at the beginning of storage and reached 7.76 log cfu/g ($5.8x10^7$ cfu/g) value on the 10th day of storage (Turhan et al. 2001).

The total psychrophilic bacteria (TPA) all samples remained below the limit of 10^7. In the study of the examination of some quality parameters of fishcakes made from raw and boiled fish meat, total psychophilic bacterial load value of fishcakes made from raw anchovy increased depending on the storage time and in the first trial at the beginning of storage, it was found to be $4.0±0.001$ log cfu/g and in the second trial it was $4.5±0.004$ log cfu/g. On the 12th day of the storage, the value in the first trial was found to be $7.7±0.002$ log cfu/g and in the second trial it reached to $7.8±0.014$ log cfu/g and exceeded the limit value (Akkuş et al. 2004).

Bacterial content of coliform group, which is an indicator of the hygienic quality of the product, was determined below the limit value of $2.1x10^2$ cfu/g given in all three sample types (Anonymous, 2002; Çolakoğlu et al., 2006). In the study on the shelf life of anchovy fishcakes stored in cold, bacterial value of coliform group increased depending on storage time and it was determined as 1.3 log cfu/g ($2.0x10^1$ cfu/g) at the beginning of storage and reached 4.84 log cfu/g ($6.9x10^4$ cfu/g) on 10th day of storage (Turhan et al. 2001).

Yeasts and molds are not found in normal flora in fish. These microorganisms are generally of soil origin and are known to be contaminated with water at the time of hunting or the tools and materials used after hunting (Göktan 1990; Patır and Duman 2006). It is thought that the yeast and mold detected in the products may be contaminated from the environment during processing or from the refrigerator where the storage is made.

The freshwater of Turkey has a large population in terms of tench (*T. tinca*). These fish are usually consumed as fresh in the regions where they are fishing, while some of them are filleted in the processing plants and put on the market. Due to the fact that both having less knowledge about the tench and having low demand for frozen fish, the fish is sold at a very low price and consumed in a small amount. In this study to increase fish consumption and offer different products to the consumers, the products obtained have been highly appreciated and a different taste has been revealed.

The results of the microbiological analysis obtained in this study are in accordance with the literature. According to the results of microbiological analysis, the fishcakes obtained in the study exceeded the limit values after the 10th day. It is estimated that the microbiological analysis results of the group 2 fishcakes were high and these values were statistically significant ($p < 0.05$) due to the high microbial load of the ginger used at the beginning.

As a result, the fish cakes obtained from the tench fish were maintained the edible property until the 10th day and then spoiled according to the results of chemical and microbiological analysis. Fish cakes could be stored in aluminum packaging for 10 days under refrigerator conditions at $4±1$ °C, but the first 7 days of storage is classified as good quality class for the products. In addition, in the light of the findings obtained, a new product variety and consumer taste is presented with a different flavor, and the shelf life of the fish cake obtained from the tench has also been determined.

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