

Sensory and Chemical Qualities of Marinated African Catfish (*Clarias gariepinus*, B., 1822) Preserved in Oil and Tomato Sauce

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ABSTRACT

In this study, the sensory criteria and chemical analysis of catfish marinades in tomato sauce and oil was investigated. After the marinating process, catfish fillets were packed in airproof plastic containers; one being plain (Group A: sun flower oil) and the other being sauced (Group B: sunflower oil and tomato sauce). Then, they were stored in +4 °C for 200 days. During storage, sensory and chemical analyses were carried out. At the end of 200 days of storage, TVB-N, TBA, PV and pH values were found to be 15.82/16.29 mg/100g, 4.94/4.81 mg MA/kg, 3.57/3.40 meq/kg and 4.35/4.36 in sample marinades packaged as plain and sauced respectively. At the end of storage process, it was determined that African catfish marinades packaged as plain (Group A) and sauced (Group B) can be stored in +4 °C for 200 days and maintained the chemical quality criteria. According to the results of sensory assessments, the shelf life of marinated catfish was found to be 110 days for Group A and 80 days for Group B.

KEYWORDS: *Clarias gariepinus*, African catfish, marinated fish, tomato sauce, quality

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1. Introduction

Marination is one of the most ancient processing methods in food preservation and dates back to the 7th century B.C. However, the spread of marination method throughout European markets coincides with the 19th century when menhaden fishing reached to peak quantities. Marination is the technology of processing and ripening fresh, frozen, salted fish or fish parts via acidic acid and salt mixtures without heat effect to enable the durability, and the resulting product is termed as marinated product. The underlying principle in marination technique is based on ripening of fish which was exposed to one or more preprocessing techniques inside acid and salt brine in a cold store for a few days. These products, when required, can be seasoned via spices or mayonnaise, oil and various additives as alternative options (Varlik et al., 2004).

The emergence of taste and aroma in marinated products takes place with the burning of present protein and fats in the fish stimulated by the joint effects of acetic acid, salt and enzymes of the fish and the bacteria (Mclay, 2001). The first step of marination, ripening process, consists of physical and chemical reactions taking place in a complex way. Ripening process cannot take place with the effect of acetic acid only or salt only (Varlik et al., 2004). Salt and acetic acid, although react in the fish flesh concurrently and coordinately, they are opposite-poled agents that normally repel each other. While salt provides hardness to the material, acetic acid gives softness to the material (Kilinc and Cakli, 2004). In the ripening process, salt and acetic acid penetration into the fish tissue is continued until salt and acetic acid levels in fish tissue water are equalized with the salt and acetic acid levels in the solution (Karl et al., 1995). It is reported that this transmission is completed quickly within two days at most (Dokuzlu, 2000) however; the duration is also subject to the environment temperature and thickness of the flesh.

African catfish (*Clarias gariepinus*, Burchell, 1822) is a freshwater fish species spread throughout South Africa and Middle East regions. This species is widely found in Asi, Ceyhan and Göksu rivers in Adana, Antakya and Mersin provinces in Turkey. Inland capture fisheries are the main source of

African catfish production in Turkey and the annual harvest of this species was around 260-350 tonnes in recent years (TURKSTAT, 2017). Though a popular species in some Middle Eastern countries and some regions of Southern Turkey, the demand for catfish is not very significant at national level. Processing and value addition seems to be one of the tools for promoting demand and boosting the market for African catfish. To this end the objective of this study was to evaluate the suitability of African catfish for marination and to investigate the preservative effects of tomato sauce on marinated catfish. Chemical and sensory analyses were conducted to investigate the changes in quality and to determine the shelf life of marinated catfish in oil and tomato sauce during storage at +4 °C.

2. Materials and methods

2.1 Raw Material

In the present study, 28 kg of African catfish (*Clarias gariepinus*) were caught from the natural environment in Çavuşbucak village in Taşucu-Silifke. The fish were iced in Styrofoam boxes (Strobuzkap, Onay Machinery, İstanbul) to be transported to the laboratory, and their fillets were peeled. Next they were washed with drinkable tap water, and extra water was drained. Then, they were sliced transversely in 2x3 cm sizes, and as blood draining process, they were kept in identified salty water for 30 minutes. After removing from salty water, sliced fish flesh was rewashed to clean the salt residuals and was left to drain.

2.2 Processing

For the process of marination, 3.5% acetic acid (Merck Group, İstanbul) and 11% salt (Safir industrial salt, Safir, Ankara) containing brine water was prepared with ready drinkable water instead of tap water. Sliced African catfish meats were put into plastic bins at ratio of 1:1.5 (fish: marinated brine water) and kept in +4 °C for the ripening process. The control stages proved that the marinate reached its formation at the end of 15 days. Following this stage, extra water of the fish was removed from brine water. Drained fish material was packed in two different forms namely, as sauced and oily. In packaging process, 300 ml- plastic cups were used.

For each packaging process made in oil, each pack contained 210 grams of fish and 105 ml liquid sunflower oil. For each packaging process made with sauce, each pack contained 210 grams of fish, 100 ml liquid sunflower oil, 4 grams of tomato paste, 1g garlic and one stem of dill. All the packed samples were conserved in +4 °C as it was in ripening process.

2.3 Chemical analyses

Thiobarbituric acid number was identified via (TBA) Tarladgis (1960) method, total volatile basic nitrogen (TVB-N) via Antonacopoulos and Vyncke (1989) method, peroxide value (PV) were determined based on AOAS (1994) method. pH value in fish meat was measured via HANNA model Microprocessor pH meter (Ludorff and Meyer, 1973).

2.4 Sensory Analyses

Each assessment was carried out by five trained panelists. Sensory analysis of catfish marinates (appearance, odour, taste and texture) were assessed according to the method of Schormüller (1968) with modification. A hedonic scale from 9 to 1 was used to evaluate catfish marinates. A score of 9 represents 'very good quality', a score of 7–8, "good quality", a score of 5–6 "acceptable", while a score of 1–4 was regarded as "bad or unacceptable". Texture was scored from 1 to 4. The score of 1 denoted as spoiled, the score of 2 indicated "acceptable", the score of 3 indicated "good" quality and the score of 4 indicated "very good" quality.

2.5. Statistical analysis

SPSS v.11.5.1 package software was used to conduct statistical analyses. In statistical analyses, $P < 0.05$ and $P < 0.01$ results were accepted as meaningful. Repeated Measurement variance analysis (ANOVA) was utilized to examine if any difference with respect to packaging method existed between groups.

3. Results and Discussions

The results of chemical quality analysis detected in our study are given in Table 1. TVB-N value of fresh African catfish was measured as 17.14 ± 0.72 mg/100g. At the onset of storing it was measured in both groups as 12.11 ± 0.73 mg/100g while at the end of storing it was found to be 15.82 ± 0.70 mg/100g in group A (conserved in oil), and 16.29 ± 1.47 mg/100g in group B (conserved in sauce). Findings of this study indicate that with respect to packaging method there is no significant difference between groups ($P > 0.05$). Kaya et al. (2010) found out that TVB-N value of the marinated prepared by using frozen African catfish increased throughout the storing process and at the end of 150th day of storing the value reached 17.23mg/100g. Erkan et al. (2000) in their research on the effect of packaging with modified atmosphere on the shelf life of breaded trout marinates detected that in control group TVB-N value was 17.29 mg/100g. It was reported that consumable threshold value of fresh water fish with respect to TVB-N value is 32–36mg/100g (Varlik, 2000). Hence, TVB- N values obtained in our study are lower than accepted threshold values, and our findings are compatible with literature data.

It was reported that in a very good material thiobarbituric acid (TBA) value used to determine the rancidity in oils should be lower than 3, and in a good material it should not be higher than 5. When TBA exceeds 4 mg MA/kg in fish flesh, rancidity starts and the threshold value for consumability is 7–8 mg MA/kg (Schormuller, 1969). TBA value measured as 1.24 ± 0.42 mg MA/kg in raw material was, on the 0th day of ripening and 1.88 ± 0.30 mg MA/kg in both groups, hence there was no statistically significant difference between both groups ($P > 0.05$).

Table 1. The chemical changes of marinated catfish during storage period

Storage time (day)	Chemical composition in terms of the packing style							
	TVB-N mg/100g		TBA mg MA/kg		PV meq/kg		pH	
	A	B	A	B	A	B	A	B
Raw material	17.14±0.72		1.24±0.42		1.78±0.07		6.11±0.02	
0	12.11± 0.73	12.11± 0.73	1.88± 0.30	1.88± 0.30	1.84± 0.14	1.84± 0.14	3.80± 0.04	3.85± 0.04
15	12.99± 1.93	12.06± 0.73	2.30± 0.53	2.12± 0.25	2.10± 0.07	1.98± 0.36	3.95± 0.04	4.06± 0.05
30	13.02± 0.72	12.56± 0.03	2.65± 0.25	2.57± 0.18	2.05± 0.33	2.10± 0.40	4.09± 0.05	4.10± 0.06
50	13.04± 0.72	13.04± 0.72	3.06± 0.22	2.88± 0.29	2.22± 0.10	2.28± 0.07	4.14± 0.06	4.13± 0.04
80	13.96± 1.23	13.49± 0.73	3.12± 0.09	3.11± 0.14	2.47± 0.92	2.01± 0.12	4.17± 0.03	4.18± 0.04
110	14.44± 1.44	13.95± 1.24	3.97± 0.39	3.87± 0.41	2.61± 0.14	2.31± 0.14	4.24± 0.03	4.24± 0.03
140	14.90± 0.71	14.90± 0.68	4.33± 0.14	4.18± 0.18	2.88± 0.06	2.53± 0.07	4.28± 0.04	4.29± 0.07
170	15.36± 0.04	15.36± 1.24	4.57± 0.12	4.48± 0.09	3.26± 0.06	3.19± 0.06	4.31± 0.02	4.32± 0.09
200	15.82± 0.70	16.29± 1.47	4.94± 0.16	4.81± 0.22	3.57± 0.07	3.40± 0.15	4.35± 0.04	4.36± 0.03

n = 3; (mean value ± standard deviation) Group A: sun flower oil Group B: sunflower oil and tomato sauce

In both groups TBA values increased in due time and in all stages of storing the difference in both marinate groups was significant ($P < 0.05$). It was reported by Kaya et al. (2010) that the TBA values of African catfish marinates conserved for 150 days did not exhibit a regular increase or decrease. At the end of their study they measured the TBA value as 4.13 mg MA/kg, which is close to values measured in our study.

One of the first products shaped in the oxidation of unsaturated fat acids are peroxides. From this point of view, identification of the peroxides formed at the early stage of rancidity is frequently used as a quality indicator. It is reported that in a very high quality material, peroxide value should be lower than 2 mmol O_2 /kg oil (= 4 meq/kg). It should not be above 5 mmol O_2 /kg oil (=10 meq/kg) value for good material, and threshold value of consumability is 10 mmol O_2 /kg (=20 meq/kg) (Varlik, 1993). According to our results; PV measured as 1.78±0.07 meq/kg in raw material reached 3.57±0.07 meq/kg in Group A at the end of 200 days of conservation and reached 3.40±0.15 meq/kg in Group B. In this regard both groups can be classified as a good quality product.

In our study, pH value was measured as 6.11±0.02 in raw material which is within the pH values that must be present in fresh fish meat. After the ripening stage of marinate (0th day) pH value in Group A was recorded as 3.80±0.04 and as 3.85±0.04 in Group B. Throughout storing process, pH values in both groups showed a rise, and on the 200th day which was the last day of storing this figure reached 4.35±0.04 in Group A and 4.46±0.03 in Group B. Since in both groups pH was lower than 4.5, both groups are within the acceptable threshold values for marinated products.

Due to the effect of enzyme and bacteria, redox balance of fish flesh changes. This change occurs in the concentration of free hydrogen and hydroxyl ions which correspondingly increase the pH value. Accepted pH value is 6.0-6.5 in fresh fish and consumable threshold values are between 6.8-7.0. However, pH on its own is not a criterion and should be completed and supported via sensory and chemical tests (Varlik, 1993). pH values in fish are subject to change in different seasons and species, and there are also certain variations according to the size of the fish. Smaller fish have higher pH values than larger ones and pH value in live fish tissue exhibits a value close to neutral. After rigor mortis,

pH values of fish directly point to a figure between 6.2 and 6.5 (Suvanich and Marshall, 1998). Ozden and Baygar (2003) underlined that in marinated products pH value should be between 4- 4.5; however Varlık (1993) pointed out that the best pH interval is between 3.8-4.3. Dokuzlu (1997) reported that at the onset of storing process, pH value of anchovy marinates stored in +4 °C was 3.87, but at the end of storing it was measured as 3.98. Yapar (1998) suggested that in the marinates that contained 10% salt + 2% vinegar, 4.50 pH value in the 1st week increased during the storing process and in the 10th week it reached 5.08. In the marinates that contained 15% salt + 2% vinegar, pH was 4.55 in the 1st week, reaching 5.02 in the 10th week which was the last week of storing. Poligne and Collignan (2000) found out that in the anchovy samples that ripened inside acetic acid pH value increased from 3.90 to 4.21 then remained fixed. Ozden and Baygar (2003) conducted a research to see if different packaging methods affected the quality criteria of marinated fish. They concluded that pH value of the fish they conserved in glass jars filled with vegetable oil and inside polyethylene bags was below 4.5. Sallam (2007) marinated pacific garfish with 2% acid and 12% salt. pH value was 4.37 at the start of storing and increased during the storing process and at the end of storing process, on the 90th day, this value reached 4.56. Values of pH measured in our research are compatible with the data reached by the rest of the researchers.

The results of the sensory evaluation (appearance, texture, odour and taste) of marinates samples are shown in Table 2. According to results of assessment of physical shape of African catfish marinates during storing process, plain African catfish marinates were in “good” quality from the start of storing till 30th day and consumable between 50 -200th days. Sauced African catfish marinate was classified as “good” quality till the 110th day, and consumable between 140-200th days. After the 140th

day the difference between groups diminished and plain and sauced African catfish marinates exhibited the same values. Statistical assessment of African catfish marinates in terms of taste and odor, reveal that there was no difference between different packaging methods. It was observed that depending on the length of storing, a decrease was measured compared to the initial score. Statistical analysis showed a significant difference (P<0.01). Both marinate groups were classified as “good” from the first day till the 30th day of storing and consumable from the 50th day till the last day of storing. The statistical assessment with respect to texture indicated no significant differences between plain and sauced African catfish marinates. However, with respect to time, the change that was seen in marinate groups was statistically significant (P<0.01).

The results of our research point out that plain African catfish (Group A) marinate was within acceptable levels till the 110th day and sauced African catfish (Group B) marinate was within acceptable levels till the 80th day. However; in the subsequent days of storing both groups were not acceptable with respect to texture limit.

Kolodziejska et al. (2002) reported that the shelf life of processed seafood decreases during storage due to microbial activity. Taskaya et al., (2016) reported that the shelf life of marinated gibel carp (Group A: sunflower oil and tomato paste) was 90 days according the results of sensory analyses. Duman et al. (2015) reported that at the end of the storage period, the sensory criteria of all groups decreased. Ozoğul and Balikci (2013) reported that the shelf life of mackerel marinates was 9 months in the sensory aspects. Kilinc and Cakli (2005) reported that the shelf life of sardine marinades in tomato sauce was 6 months. Duyar and Eke (2009) reported that the shelf life of marinated bonito was 130 days, and that of marinated anchovy was 155 days according the results of sensory analyses.

Table 2. The sensory changes of marinated catfish stored in oil and tomato sauce

Storage time (day)	Sensory changes in terms of the packing style					
	Appearance		Odour and taste		Texture	
	A	B	A	B	A	B
0	5.00±0.71	5.40±0.55	4.60±0.89	5.00±1.00	2.40±0.55	2.40±0.55
15	5.00±0.71	5.40±0.55	4.40±0.55	4.60±8.94	2.20±0.45	2.20±0.45
30	4.40±0.55	4.80±0.45	4.20±4.47	4.40±5.48	2.00±0.71	1.80±0.45
50	4.00±0.00	4.40±0.55	4.00±0.00	4.00±0.00	1.80±0.84	1.80±0.45
80	4.00±0.00	4.20±0.55	4.00±0.00	4.00±0.00	1.60±0.55	1.60±0.55
110	4.00±0.00	4.40±0.55	4.00±0.00	4.00±0.00	1.60±0.55	1.20±0.45
140	4.00±0.00	4.00±0.00	4.00±0.00	4.00±0.00	1.40±0.55	1.40±0.55
170	4.00±0.00	4.00±0.00	4.00±0.00	4.00±0.00	1.40±0.55	1.20±0.45
200	4.00±0.00	4.00±0.00	4.00±0.00	4.00±0.00	1.20±0.55	1.00±0.00

n =5; (mean value ± standard deviation) Group A: sun flower oil Group B: sunflower oil and tomato sauce

4. Conclusions

In this study, sensory and chemical quality of African catfish (*Clarias gariepinus*) marinades in sun flower oil and sunflower oil with tomato sauce were investigated. At the end of the 200 days storage period both oil and sauces samples were found consumable according to the results of TVB-N, TBA, PV values and pH analysis. Consequently in terms of sensory analysis samples of group A and group B were found to preserve their properties as acceptable at 110th, 80th day respectively. The overall results of the study reveal that African catfish is a good source of raw material for marinating and it can be consumed as marinated fish. In this sense study sheds light on perspectives of using African catfish fillets as ready to eat food item and hence helping to promote demand and market for this species.

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