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CHANGES IN CHEMICAL AND ORGANOLEPTIC PROPERTIES OF FRIED NILE TILAPIA FILLETS (*OREOCHROMIS NILOTICUS*) DURING CHILLING AND FROZEN STORAGE

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Abstract

Modifications in proximate composition, fatty acids, chemical quality, as well as changes in organoleptic traits, were studied in raw Nile tilapia fillets (*Oreochromis niloticus*), pan-fried fillets in sun flower oil for 4 minutes and reheated fried Nile tilapia fillets (in a conventional oven for 15 min. at 80°C) after storage for one week at 5±1°C and for one month at –10±2°C.

Our results reveal that the frying process has considerable effect on the composition (moisture, protein, fat and ash), fatty acids profile, chemical quality characteristics (total volatile basis nitrogen TVBN, trymethylamin nitrogen TMAN, thiobarbeturic acid TBA and peroxide value PV) and sensory properties (colour, taste, flavour, juiciness and overall acceptability) of Nile tilapia fillets, and extending the shelf life of Nile tilapia fillets during chilling storage at 5±1°C or frozen storage at –10±2°C.

INTRODUCTION

Precooked and frozen food that is reheated immediately before its consumption is a major element in diets preparation. Although, the subject is attracting a lot of attention from nutritionists, there is little information about the effect that these consecutive processes performed in the food. Regular consumption of fish, particularly marine fish due to its low fat contents is recommended for the elderly and those with

coronary heart disease and hypercholesterolaemia (Puwastien *et al.*, 1999). Also, Dalgaard and Jorgensen (2000) reported that, to extend the short shelf-life of fish seafood and to provide products with desirable sensory properties, brining, smoking, biopreservation, packaging and other simple preservation methods are recommended. Lightly preserved seafood including cooked and brined fish products typically keeps the quality for 4 weeks or more at the recommended storage temperature of 5°C. Musaiger (2008) concluded that, the traditional methods of cooking fish and shrimps have an effect on their nutrient composition and heavy metal content hence, it is advisable to avoid excessive frying.

Chemically, conventional cooking methods (deep-fat-frying and baking) have an effect upon proximate composition, mineral concentration and fatty acids profile (Mustafa and Medeiros, 1985). Muniz *et al.* (1992) indicated that, the fat composition of sardines and thereby having *n*-6/ *n*-3 ratio could be deeply changed when sardines are fried. Effects of microwave heating, deep-fat frying and conventional oven baking on proximate composition and cholesterol concentration in channel catfish (*Ictalurus punctatus*) fillets were examined by Wen-Hsin and Lillard (1998), they declared that, fillets that were deep-fat fried showed the lowest moisture content with high fat content. Erkan *et al.* (2010) found that, fried fish had intermediate fat values, whereas grilled and steamed fishes had a comparatively low value. Ansorena *et al.* (2010) revealed that, fat content and total energetic value increased significantly after the frying process only in the lean fish, without relevant changes in the fatty fish. Extra virgin olive oil led to a higher fat absorption rate than sunflower oil in both fish. Frying hardly affected the lipid profile of farmed salmon regardless the oil used, however it drastically changed in fried cod compared to raw cod. Omega-6/omega-3 ratio increased from 0.08 in raw cod to 1.01 and 6.63 in fried cod with olive oil and sunflower oil, respectively. In farmed salmon, the omega-6/omega-3 ratio was 0.38 (raw), and 0.39 to 0.58 in fried salmon. Mnari *et al.* (2010) indicated that,

the lipid content increased with frying. The maximum moisture value was found in steamed fish (P<0.05). Fried sea bream in corn and sunflower oils contained a lower content of n-3 polyunsaturated fatty acids (P<0.05) (3.87 and 5.32% of total fatty acids (TFA) in farmed fish and 2.96 and 2.14% total fatty acids in wild fish). The n-3/n-6 ratio decreased significantly after cooking, particularly after frying in corn and sunflower oils, respectively. The trans fatty acid levels remained stable after steaming and grilling, but they were significantly affected by frying.

Organoleptically, both fish fingers and fish fillets showed a decrease in colour lightness and yellowness during drying. Redness decreased for fish fingers but increased for fish fillets during frying. Fish type showed no significant effect on colour of the breaded product (Schubring, 1996). Also, Raju *et al.* (1999) demonstrated that, overall acceptability of fish cullets prepared from pink perch (*Nemipterus japonicus*) fried at 160-170°C for 4-5min. in oil were acceptable and showed good texture and flavour throughout the period of frozen storage.

The objective of this study was to determine the effects of deep-fat-frying followed by chilling or freezing storage on proximate composition, fatty acids profile, chemical quality characteristics and sensory properties of Nile tilapia fillets.

MATERIALS AND METHODS

Samples preparation

Nile tilapia (*Oreochromis niloticus*) was used in this study. An initial batch was directly obtained from farm of Central Laboratory for Aquaculture Research (CLAR), Abbassa, Abu-Hammad Sharkia Governorate. All of the fish (8.0 kg.) were transported to the laboratory and immediately washed with tap water. The head, scales and all fins of the fish were removed using a sharp knife. Thereafter, the fish were washed again and soaked in tap water for one hour and dressed in a fillets

style weighing approximately 75g. and divided into four lots. The four different groups were treated as follows: one was kept fresh and raw and was so analyzed; three groups were pan-fried in sunflower oil for 4 min after thinly coated with enriched white corn flour, and then one of the three groups was immediately analyzed. The second group (of the three fried groups) was frozen to –10±2°C for one month, while the last group (of the fried groups) was stored at 5±1°C for one week. On the other hand, the two groups of fried stored frozen and at chilled were reheated. It's reheated after packing of fillets with an aluminum wrapper in a conventional oven for 15 minutes at 80°C.

Analytical techniques

Homogeneous mixtures of each sample (3-5g) were dried at 105ºC to constant weight for moisture, total protein, lipids, ash and peroxide value (PV) determination in each sample was measured as described in AOAC (2005). Fatty acids were analyzed as described by Castrillon *et al*. (1997). Total volatile bases nitrogen (TVBN), and trimethylamine nitrogen (TMAN) were determined according to the method recommended by the AMC (1979). Thiobarbituric acid (TBA) was measured according to the method described by Tarladgis *et al.* (1960).

Organoleptical evaluation

Samples were organoleptically evaluated for colour, taste, flavour, juiciness and overall acceptability. A group of 10 staff members of Processing and Quality Control Department, Central Laboratory for Aquaculture Research as judges checked the organoleptic properties of the samples and grades ranged from zero to 10 (Teeny and Miyauchi, 1972) as mentioned in Table (1).

Table 1. Description of organoleptic properties scores.

Score	Description	Score	Description
10	Ideal	4	Fair
9	Excellent	3	Poorly fair
8	Very good	2	Poor
7	Good	1	Very poor
6	Fairly good	0	Repulsive
5	Acceptable		

Statistical analysis

Three replications of each trial were performed. Moisture, protein, fat, ash, total volatile bases nitrogen (TVBN), trimethylamine nitrogen (TMAN), thiobarbituric acid (TBA), peroxide value (PV), and sensory data were analyzed using ANOVA and means were separated by Duncan' test (1955) at a probability level of $P<0.05$ (SAS, 2000).

RESULTS AND DISCUSSION

Chemical composition of fresh and fried Nile tilapia fillets

From Table (2), it could be observed that due to frying of Nile tilapia fillets, the moisture content was significantly reduced ($P<0.05$), while protein, fat as well as ash were significantly increased ($P<0.05$). Frying increased fat content, possibly as a result of both moisture content losses and absorption of some frying sun flower oil inside the tissues. The increase of other components may be due to loss of moisture.

It could be observed that chilling and frozen storage of fried Nile tilapia fillets resulted in significant changes ($p>0.05$) of gross chemical composition compared with the fried Nile tilapia fillets at zero time. In general, by storage at chilling at 5±1°C and freezing at –10±2°C, the moisture, protein, fat and ash were slowly reduced. It might be assumed that with drip separated during thawing of freezing samples, some losses

of moisture, protein, fat and ash were occurred, as reported by Wen-Hsin and Lillard (1998); Puwastien *et al.* (1999); Santerre *et al.* (2000), Musaiger (2008); Erkan *et al.* (2010) and Ansorena *et al.* (2010).

Table 2. Proximate composition of fresh Nile tilapia fillets, pan-fried fillets "A" and reheated fried Nile tilapia fillets after storage for one week at 5±1°C "B" and for one month at -10±2°C "C". (* % on dry weight basis).

Constituent		Moisture%	*Protein%	*Fat%	*Ash%
Fresh fillets		77.71±1.5[a]	82.28±0.7[a]	7.99±0.3[c]	6.34±0.05[c]
Storage period of fried fillets	A	62.41±0.9[b]	79.22±0.5[b]	15.56±0.5[a]	4.68±0.07[d]
	B	61.81±1.0[b]	77.32±0.3[c]	15.05±0.2[ab]	7.09±0.03[b]
	C	61.51±0.7[bc]	76.48±0.9[cd]	14.44±0.2[b]	8.84±0.02[a]

[a-d] Means within a column with the same superscript significantly different (P<0.05).

Fatty acids composition

Data presented in Table (3) revealed that the oil fatty acids contents in raw Nile tilapia filets has high levels in C18:1, C16:0, C18:2, C16:1 and C18:0; they were 26.3, 26.0, 18.1, 9.1 and 8.6%, respectively. After frying Nile tilapia fillets, the results showed an increase in C18:2 and C18:1 to reach 38.7 and 29.0%, respectively. While there were decreases in C16:0, C18:0 and C16:1 which reached to 18.9, 5.1 and 2.6%, respectively. These results may be due to increased contents of sun flower oil which is used in frying processing (Table 2); especially from C18:1 and C18:2 that increased to reach to 30.3 and 55.44%, respectively. Frying decreased the content from C16:1, C16:0 and C18:0 to 0.0, 7.6 and 5.1%, respectively.

On the other hand, in the fresh Nile tilapia fillets, percentages of monounsaturated fatty acids (MUFA) were higher than the percentages of saturated fatty acids (SFA) or the percentages of polyunsaturated fatty acids (PUFA), whereas, unsaturated / saturated U/S ratio was 2.17%. Frying in sun flower oil produced a noteworthy change in fatty acids

contents. In fact, the total SFA content decreased to 21.50%, the MUFA content decreased to 32.20%, while the PUFA content increased to reach to 46.3%, U/S ratio was 3.65%.

Table 3. Fatty acids composition % of fresh Nile tilapia fillets, pan-fried fillets "A" and reheated fried Nile tilapia fillets after storage for one week at 5±1°C "B" and for one month at -10±2°C "C".

Samples	Fresh fillets	Storage period of fried fillets			Sun flower oil	
Carbon No.		A	B	C	Unused	Used
C14:0	2.910	0.720	1.250	1.210	----	----
C16:0	22.60	16.42	16.65	16.55	9.50	9.920
C18:0	4.800	2.840	2.990	2.890	3.90	3.820
C20:0	-----	----	----	----	0.700	0.720
C22:0	0.430	0.530	0.550	0.540	----	----
C23:0	0.350	0.390	0.400	0.400	0.370	0.350
C24:0	0.490	0.600	0.610	0.600	0.180	----
Σ SFA	31.58	21.50	22.45	22.19	14.65	14.81
C16:1	2.110	0.600	0.580	0.530	14.18	14.23
C18:1	34.61	31.10	28.98	29.54	68.81	69.05
C20:1	0.310	0.120	0.110	0.120	0.860	0.870
C22:1	0.620	0.380	1.240	1.620	----	----
Σ MUFA	37.65	32.20	31.91	31.81	83.85	84.15
C18:2	25.73	44.35	43.69	44.22	0.900	0.630
C18:3	5.040	1.950	1.950	1.780	0.600	0.410
Σ PUFA	30.77	46.30	45.64	46.00	1.500	1.040
U/S Ratio	2.170	3.650	3.450	3.500	5.83	5.75

Storage of the fried Nile tilapia fillets at 5±1°C and –10±2°C (Table 3) also slowly increased in SFA during storage for one week and one month, respectively. While, MUFA and PUFA decreased slowly during storage at 5±1°C and –10±2°C for one week and one month,

respectively, compared with the fillets after frying directly. Whereas, U/S ratios were 3.45 and 3.50% during storage at 5±1°C and –10±2°C, respectively.

Fresh sunflower oil had very slowly changes after using in the frying process, Whereas, U/S ratios were 5.83 and 5.75% for fresh and used of sun flower oil, respectively. These results coincide with those given by Castrillon *et al.* (1997); Aro *et al.* (2000); Ansorena *et al.* (2010) and Mnari *et al.* (2010)

Chemical quality

Changes in total volatile bases nitrogen (TVBN) and trimethylamine nitrogen (TMAN)

Production of total volatile bases nitrogen (TVBN) and increment in trimethylamine nitrogen (TMAN) in fish muscles during storage could be used as indicator of bacterial activity. TVBN and TMAN are considered a valuable tool in the evaluation of fish quality during storage because it's rapid accumulation in muscles under storage conditions.

Table 4. Chemical quality of fresh Nile tilapia fillets, pan-fried "A" and reheated fried Nile tilapia fillets after storage for one week at 5±1°C "B" and for one month at -10±2°C "C". (On wet weight basis).

Constituent		TVBN mg/100g.	TMAN mg/100g.	TBA mg/kg.	PV mequi./kg.
Fresh fillets		13.40±0.5^{c}	1.02±0.02^{c}	0.28±0.02^{c}	4.50±0.3^{c}
Storage period of Fried fillets	**A**	9.50±0.3^{d}	0.79±0.03^{c}	0.36±0.01^{bc}	5.90±0.2^{bc}
	B	17.80±0.4^{a}	5.60±0.04^{a}	1.06±0.03^{a}	7.80±0.4^{a}
	C	14.90±0.2^{b}	4.68±0.05^{b}	0.79±0.01^{b}	6.20±0.1^{b}

$^{a-d}$ Means within a column with the same superscript significantly different (P<0.05).

In this study TVBN and TMAN decreased (P<0.05) during frying (Table, 4), initial average values were 13.4±0.5 and 1.02±0.02 mg/100g muscles for TVBN and TMAN, respectively. The final values of TVBN and TMAN in Nile tilapia fillets after frying were 9.5±0.3 and 0.79±0.03 mg/100g muscles, respectively. Indicating a reduction in both measures is due to losses in TVBN and TMAN via volatilization during heating.

From results of Table (4) it could be noticed that the TVBN and TMAN of fried Nile tilapia fillets stored at 5±1°C and –10±2°C were significant higher (P<0.05) as compared with the samples at zero time (after frying directly). These results agree with those reported by Darweash (1996) and Dalgaard and Jorgensen (2000).

Changes in thiobarbituric acid (TBA) and **peroxide value (PV)**

Thiobarbituric acid (TBA) and peroxide value (PV) index are the most used indicators for advanced lipid oxidation. Results presented in Table (4) indicated that the formation of TBA as malonaldhyde (mg/kg) and PV as milliequivalents peroxide/ kg lipid were affected by frying of Nile tilapia fillets. Results indicated significant increases (P<0.05) in TBA-value and PV-value during frying process. This indicates the occurrence of some oxidation in lipids by the thermal treatment. Also, significant increases (P<0.05) were observed in TBA and PV during storage period of fried Nile tilapia fillets for one week at 5±1°C and one month at –10±2°C.

From the foregoing results, the increment in TBA and PV during storage could be resulted from lipid oxidation; these results are in harmony with those obtained by Darweash (1996); Raju *et al.* (1999) and Aro *et al.* (2000).

Organoleptic evaluation

Organoleptic evaluation scores of colour, taste, flavour, juiciness and overall acceptability estimated for pan-fried Nile tilapia fillets and

reheated after storage for one week at 5±1°C and one month at –10±2°C are presented in Table (5). Samples after frying directly showed the highest scores, which were 9.0 (excellent), 8.7 (very good), 9.5 (excellent), 9.1 (excellent) and 9.0 (excellent) for colour, taste, flavour, juiciness and overall acceptability, respectively, compared with the samples of Nile tilapia fillets fried after storage period for one week and month at 5±1°C and –10±2°C, respectively. The scores of colour, taste, flavour, juiciness and overall acceptability showed a significant decreases (P<0.05) after storage periods. However, Nile tilapia fillets fried after storage period for one week at 5±1°C showed the lowest scores, having 7.5 (good), 6.4 (fairly good), 7.0 (good), 6.5 (fairly good) and 6.8 (fairly good) for colour, taste flavour, juiciness and overall acceptability, respectively.

Table 5. Average of organoleptic scores of pan-fried fillets "A" and reheated fried Nile tilapia fillets after storage for one week at 5±1°C "B" and for one month at -10±2°C "C".

Constituent		Colour	Taste	Flavour	Juiciness	Overall acceptability
Storage period of Fried fillets	A	9.0±0.2^{a} (E.)	8.7±0.1^{a} (V.G.)	9.5±0.3^{a} (E.)	9.1±0.1^{a} (E.)	9.0±0.1^{a} (E.)
	B	7.5±0.1^{b} (G.)	6.4±0.3^{c} (F.G.)	7.0±0.1^{c} (G.)	6.5±0.3^{c} (F.G.)	6.8±0.2^{c} (F.G.)
	C	8.0±0.1^{b} (V.G.)	7.5±0.2^{b} (G.)	7.8±0.3^{b} (G.)	8.0±0.2^{b} (V.G.)	7.8±0.2^{b} (G.)

$^{a-c}$ Means within a column with the same superscript significantly different (P<0.05).
E= Excellent. V.G.= Very good. G= Good. F.G.= Fairly good.

Therefore, it could be concluded that, the gradual decrease in colour, taste, flavour, juiciness and overall acceptability scores throughout the storage period at different temperatures, could be attributed to the protein denaturation, hydrolysis and fat oxidation, which are the major factors of changes in organoleptic properties during storage

periods. These results are in agreement with those given by Darweash (1996); Schubring (1996) and Raju *et al.* (1999).

From the results obtained in the present study, it may be recommended that, the best consumption of fried Nile tilapia fillets is after processing directly, followed by storage at –10±2°C for one month and at 5±1°C for one week, respectively.

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التغيرات فى الصفات الكيميائية والحسية لشرائح سمك البلطى النيلى *Oreochromis niloticus* المقلية خلال التخزين بالتبريد والتجميد

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الملخص العربى

تمت دراسة التغيرات في التركيب الكيميائي، الأحماض الدهنية، مركبات الجودة الكيميائية وكذلك التقييم الحسي لشرائح سمك البلطى الطازجة، بعد قليها في زيت عباد الشمس لمدة ٤ دقائق وكذلك بعد إعادة التسخين (في فرن عادى على ٨٠°م لمدة ١٥ق) لتلك الشرائح المقلية والمخزنة لمدة أسبوع على درجة حرارة ٥±١°م ولمدة شهر على درجة حرارة – ١٠±٢°م.

أوضحت النتائج، أن عملية القلى لشرائح البلطى النيلى لها تاثيرا هاما على كل من التركيب الكيميائى (الرطوبة ، البروتين، الدهن والرماد) ، المحتوى من الاحماض الدهنية، ومركبات الجودة الكيميائية (القواعد النيتروجينية الكلية الطيارة، والنيتروجين الأميني ثلاثي الميثيل، وحمض الثيوباربتيوريك، ورقم البيروكسيد) وكذلك الخواص الحسية. بالاضافة الى تاثيرها الهام فى اطاله فترة الصلاحية لشرائح البلطى النيلى المقلية خلال حفظها بالتبريد على درجة حرارة ٥±١°م او بالتجميد على درجة حرارة –١٠±٢°م.