

CHANGES IN CHEMICAL COMPOSITION, FATTY ACIDS PROFILE, AND CHEMICAL & SENSORY QUALITY OF FRIED CATFISH FILLETS *CLARIAS GARIEPINUS*

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Abstract

Modifications in proximate composition, fatty acids, chemical quality, as well as changes in organoleptic traits, were studied in raw catfish fillets *Clarias gariepinus*, pan-fried fillets in sun flower oil for 4 minutes and reheated fried catfish 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 -20±2°C. After frying of catfish fillets, the moisture, saturated fatty acids (SFA), mono unsaturated fatty acids (MUFA), total volatile basis nitrogen (TVBN) and trimethylamin nitrogen (TMAN) were reduced, while, protein, fat, ash, polyunsaturated fatty acids (PUFA), thiobarbituric acid (TBA) and peroxide value (PV) were increased.

Due to chilling and frozen storage of fried catfish fillets, the gross chemical composition showed no significant changes ($P>0.05$), whereas, slow increase in SFA and slow decrease in MUFA and PUFA was found. All chemical quality (TVBN, TMAN, TBA and PV) of catfish fillets fried and stored at 5±1°C and -20±2°C were higher ($P<0.05$), as compared with the samples after frying directly.

Organoleptic evaluation scores of colour, taste, flavour, juiciness and overall acceptability were highest for samples after fried directly, while, it showed a significant decrease ($P<0.05$) after storage at 5±1°C and at -20±2°C for one week and one month, respectively.

INTRODUCTION

Precooked and frozen food reheated immediately before their 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 are 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.

Chemically, conventional cooking methods (deep-fat-frying and baking) appeared to 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 its *n-6/ n-3* ratio can 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 but the highest fat content.

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 4-5 min 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 catfish fillets.

MATERIALS AND METHODS

Samples preparation

Catfish *Clarias gariepinus* was used in this study. An initial batch was directly obtained from Central Laboratory for Aquaculture Research (CLAR), Abbassa Abu-Hammad Sharkia, after catching in March, 2000. All fish (8.0 kg.) were transported to the laboratory, immediately washed with tap water and slaughtered. 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 150g 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-flower, and then, one of the three groups was immediately analyzed. The second group (of the three groups) was frozen to $-20\pm 2^{\circ}\text{C}$ for one month, while, the last group (of the fried groups) was stored at $5\pm 1^{\circ}\text{C}$ for one week. On the other hand, the two groups of fried and stored at freezing and at shilling temperature were reheated after packing of fillets with an aluminum wrapper in a conventional oven for 15 minutes at 80°C .

Analytical techniques

Protein was determined by kjeldahl procedure using a 6.25 conversion factor according to the method described in AOAC (1990), the moisture was determined by oven drying at 105°C to constant weight as mentioned in AOAC (1990). Total fat was measured by extraction using chloroform: methanol method (2:1, v/v) as described by Bligh and Dyer (1959). Ash was determined by heating at 550°C using a muffle furnace according to method AOAC (1990). 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). Peroxide value (PV) was determined according to the standard titration method (AOAC, 1990).

Organoleptic evaluation

Samples were organoleptic evaluated for colour, taste, odour, juiciness and overall acceptability. Scoring the organoleptic properties of the samples was carried out by giving grades ranging from zero to 10 according to Teeny and Miyauchi (1972) as estimated by the following scheme:

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 at a probability level of $P < 0.05$ (SAS, 2000).

RESULTS AND DISCUSSION

Gross chemical composition of raw and fried catfish fillets

From Table 1, it could be observed that, due to frying of catfish 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 shelling and frozen storage of fried catfish fillets resulted in significant changes ($p > 0.05$) of gross chemical composition compared with the fried catfish fillets at zero time. In general, by storage at chilling temp. $5 \pm 1^\circ\text{C}$ and freezing $-20 \pm 2^\circ\text{C}$, 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 water, protein, fat and ash occurred, as reported by Wen-Hsin and Lillard (1998), Puwastien *et al.* (1999) and Santerre *et al.* (2000).

Fatty acids composition

Data presented in Table 2 revealed that the oil fatty acid contents in raw catfish 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 catfish filets, 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 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 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 catfish filets, percentages of monounsaturated fatty acids (MUFA) were higher than the percentages of saturated fatty acids (SFA) and double the percentages of polyunsaturated fatty acids (PUFA). Frying in sun-flower oil produced a noteworthy change in fatty acid contents. In fact, the total SFA content decreased to 25.2%, the MUFA content decreased to 33.1%, while, the PUFA content increased to reach 39.9%.

Storage of the fried catfish filets at $5\pm 1^\circ\text{C}$ and $-20\pm 2^\circ\text{C}$ (Table 2) also, slowly increased in SFA during storage for one week and one month, respectively, while, MUFA and PUFA decreased slowly during storage at $5\pm 1^\circ\text{C}$ and $-20\pm 2^\circ\text{C}$ for one week and one month, respectively. These results coincide with those given by Castrillon *et al.* (1997) and Aro *et al.* (2000).

Chemical quality

Changes in Total volatile nitrogen bases (TVNB) and Trimethylamine nitrogen (TMAN)

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

In this study, TVNB and TMAN decreased ($P<0.05$) during frying (Table 3). Initial average values were 14.1 ± 0.5 and 1.05 ± 0.02 mg/100g muscle for TVNB and TMAN, respectively. The final values of TVNB and TMAN in catfish fillets after frying were 10.2 ± 0.3 and 0.81 ± 0.03 mg/100g muscles, respectively, indicating a reduction in both measures due to losses in TVNB and TMAN via volatilization during heating.

From Table 3, it could be noticed that the TVNB and TMAN of fried catfish fillets stored at $5\pm 1^\circ\text{C}$ and $-20\pm 2^\circ\text{C}$ were 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 3 indicated that the formation of TBA as malonaldehyde (mg/kg) and PV as milliequivalents peroxide/ kg lipid were affected by frying of catfish fillets. Results indicated significant increase ($P<0.05$) 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 catfish fillets for one week at $5\pm 1^\circ\text{C}$ and one month at $-20\pm 2^\circ\text{C}$.

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 catfish fillets and reheated after storage for one week at $5\pm 1^\circ\text{C}$ and one month at $-20\pm 2^\circ\text{C}$ are presented in Table 4. Samples after frying directly showed the highest scores, which were 8.8 (very good), 8.5 (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 catfish fillets fried after storage period for one week and month at $5\pm 1^\circ\text{C}$ and $-20\pm 2^\circ\text{C}$, respectively. The scores of colour, taste, flavour, juiciness and overall acceptability showed a significantly

decrease ($P < 0.05$) after storage periods. However, catfish fillets fried after storage period for one week at $5 \pm 1^\circ\text{C}$ showed the lowest scores, they were 7.2 (good), 6.1 (fairly good), 6.6 (fairly good), 6.1 (fairly good) and 6.5 (fairly good) for colour, taste flavour, juiciness and overall acceptability, respectively.

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 catfish fillets after processing directly, is followed by storage at $-20 \pm 2^\circ\text{C}$ for one month and at $5 \pm 1^\circ\text{C}$ for one week, respectively.

Table 1. Proximate composition of raw catfish fillets, pan-fried "A" and reheated fried catfish fillets after storage for one week at $5\pm 1^\circ\text{C}$ "B" and for one month at $-20\pm 2^\circ\text{C}$ "C". (% on weight basis).

Constituent	Moisture%	Protein%	Fat%	Ash%
Raw catfish	77.80 \pm 1.5 a	16.59 \pm 0.7 b	3.49 \pm 0.3 b	1.30 \pm 0.05 b
Storage period fried fillets	A	62.00 \pm 0.9 b	28.44 \pm 0.5 a	7.60 \pm 0.5 a
	B	61.40 \pm 1.0 b	28.19 \pm 0.3 a	7.50 \pm 0.2 a
	C	61.10 \pm 0.5 b	28.10 \pm 0.9 a	7.31 \pm 0.2 a
				1.80 \pm 0.02 ab

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

Table 2. Fatty acids composition % of raw catfish fillets, pan-fried "A" and reheated fried catfish fillets after storage for one week at $5\pm 1^\circ\text{C}$ "B" and for one month at $-20\pm 2^\circ\text{C}$ "C".

Samples Carbon No.	Raw catfish	Storage period fried fillets			Sun-flower oil	
		A	B	C	Unused	Used
C14	0.4	0.1	0.8	0.3	-	-
C16	26.0	18.9	18.7	18.4	7.6	8.1
C18	8.6	5.1	5.0	4.8	5.1	5.0
C20	2.0	1.1	1.8	2.5	-	-
Σ SFA	37.0	25.2	26.3	26.0	12.7	13.1
C16'	9.1	2.6	2.5	2.3	-	-
C18'	26.3	29.0	27.8	27.3	30.3	31.2
C20'	2.5	1.0	0.9	1.0	-	-
C22'	0.8	0.5	1.6	2.1	-	-
Σ MUFA	38.7	33.1	32.8	32.7	30.3	31.2
C18''	18.1	38.7	38.5	38.3	55.4	54.3
C18'''	3.1	1.2	1.2	1.1	-	-
Σ PUFA	21.2	39.9	39.7	39.4	55.4	54.3

Table 3. Chemical quality of raw catfish fillets, pan-fried "A" and reheated fried catfish fillets after storage for one week at $5\pm 1^\circ\text{C}$ "B" and for one month at $-20\pm 2^\circ\text{C}$ "C". (On weight basis).

Constituent		TVNB mg/100g	TMAN mg/100g	TBA mg/kg	PV mequi./kg
Raw catfish		14.10±0.5 c	1.05±0.02 c	0.32±0.02 c	5.60±0.3 c
Storage period fried fillets	A	10.20±0.3 d	0.81±0.03 c	0.4±0.01 bc	7.00±0.2 b
	B	1.70±0.7 a	5.63±0.07 a	1.10±0.03 a	8.90±0.4 a
	C	15.60±0.2 b	4.71±0.05 b	0.83±0.01 b	7.30±0.1 b

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

Table 4. Average of organoleptic scores of pan-fried "A" and reheated fried catfish fillets after storage for one week at $5\pm 1^\circ\text{C}$ "B" and for one month at $-20\pm 2^\circ\text{C}$ "C".

Constituent		Colour	Taste	Flavour	Juiciness	Overall acceptability
Storage period fried fillets	A	8.8±0.2 a (V.G.)	8.5±0.1 a (V.G.)	9.5±0.3 a (E.)	9.1±0.1 a (E.)	9.0±0.1 a (E.)
	B	7.2±0.1 b (G.)	6.1±0.3 c (F.G.)	6.6±0.1 c (F.G.)	6.1±0.3 c (F.G.)	6.5±0.2 c (F.G.)
	C	7.7±0.1 b (G.)	7.3±0.2 b (G.)	7.5±0.3 b (G.)	7.6±0.2 b (G.)	7.5±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.

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التغيرات في التركيب الكيميائي، الأحماض الدهنية والجودة الكيميائية والحسية لشرائح القراميط *Clarias gariepinus* المقلية

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المعمل المركزي لبحوث الثروة السمكية بالعباسة - مركز البحوث الزراعية - وزارة الزراعة - الدقى - الجيزة.

تمت دراسة التغيرات في التركيب الكيميائي، الأحماض الدهنية، مركبات الجودة الكيميائية وكذلك التقييم الحسي لشرائح سمك القراميط الطازجة، بعد قليها في زيت عباء الشمس لمدة 4 دقائق وكذلك بعد إعادة التسخين (في فرن عادى على 180°م لمدة 10ق) لتلك الشرائح المقلية والمخزنة لمدة أسبوع على درجة 15±°م ولمدة شهر على درجة 20±°م.

أوضحت النتائج أنه بعد القلي مباشرة حدث انخفاض في كل من الرطوبة، الأحماض الدهنية المشبعة، الأحماض الدهنية أحادية الروابط الزوجية، القواعد النيتروجينية الكلية الطيارة والنيتروجين الأميني ثلاثي الميثيل. بينما لوحظت زيادة في كل من البروتين، الدهن، الرماد، الأحماض الدهنية عديدة الروابط الزوجية، حمض الثيوباريتيوريك ورقم البيروكسيد.

لم يحدث تغير معنوي في التركيب الكيميائي نتيجة التخزين بالتبريد والتجميد لشرائح القراميط المقلية، كذلك حدثت زيادة بمعدل منخفض في الأحماض الدهنية المشبعة بينما كان الانخفاض قليلا في الأحماض الدهنية أحادية وعديدة الروابط الزوجية. كما أوضحت النتائج أن قيم مركبات الجودة الكيميائية (القواعد النيتروجينية الكلية الطيارة والنيتروجين الأميني ثلاثي الميثيل، حمض الثيوباريتيوريك ورقم البيروكسيد) لشرائح القراميط المقلية والمخزنة على 15±°م، 20±°م كانت مرتفعة مقارنة بالعينات بعد القلي مباشرة.

كما أظهرت قيم الخواص الحسية (اللون، الطعم، الرائحة، العصرية والقابلية العامة) أعلى درجاتها للعينات بعد القلي مباشرة، بينما أظهرت انخفاضا معنويا بعد التخزين على 15±°م، 20±°م لمدة أسبوع وشهر، على الترتيب.