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Quality Assessment of Egyptian Catfish (*Clarias gariepinus*) Fillet During Frozen Storage

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ABSTRACT

Biochemical assay, microbial load determination**,** and sensory evaluation of Egyptian Catfish fillets were examined during frozen storage at -18 ºC up to 12 months. The initial chemical composition of Catfish fillet was moisture 73.01%, protein 80.96%, Crude oil 09.52%, crude ash 7.30%, and total carbohydrate 2.11%. The frozen storage process showed a significant effect on the chemical composition of studied Catfish fillets. pH and WHC values were decreased significantly whereas the TVBN and TBA values significantly increased in Catfish fillets with prolong of storage period. The microbial activities decreased during frozen storage. The total bacterial counts were 4.10, 2.11 and 2.71 (cfu×10^3/g) in the zero, 6 and 12 months for frozen Catfish fillets, respectively. All sensory characteristics except taste and overall acceptability were significantly decreased at the end of the storage period. This study is highly significant to fulfil the consumer issue concerning the time it takes to preserve Catfish fillets without damaging public health in domestic freezers.

keywords: Egyptian Catfish, fish fillet, frozen storage, quality attributes.

INTRODUCTION

Egypt is the largest aquaculture industry in any African country with a production of around 705.490 tons in 2009, and it is the eleventh largest country in terms of world fish production. Aquaculture contributes significantly to the country's income, food safety, and employment. The highest price fish in Egypt is Mullet, followed by Tilapia, and Catfish. Egyptian Catfish (*Clarias gariepinus*) have a significant aquaculture potential because of their capacity to grow, common disease resistance, and omnivorous diet. A sustainable aquaculture of Catfish can be achieved by expanding their use by adding value (FAO, 2020). The growth in fish production involves increasing the use of fish flesh as an alternative to animal meat, as fish are seen as nutritious foods with an adequate supply of animal protein (FAO/WHO, 1974).

In current days, value added is the most frequently spoken word for fishery processing since the export and unit value of such goods are more realized. Fish fillet is one such value-added product. Only lateral muscles are separated so as to eliminate the belly fats, bone, viscera from the fish body. Proper frozen storage minimizes the decline and enhances fish quality (Solomon & Oluchi, 2018). Fish fillets are highly vulnerable to numerous forms of spoilage because fish muscles are exposed to air and bacteria directly.

The main purpose of this study is to examine the effect of frozen storage up to 12 months on the quality characteristics of Egyptian Catfish (*Clarias Gariepinus*) fillet.

MATERIALS AND METHODS

Materials

Study duration and area

The experiment was conducted at the Laboratory of Food Technology, Department of Food Industries, Damietta University, Egypt. during the period of April 2018 to April 2019.

Sample collection

Egyptian Catfish (*Clarias gariepinus*) were obtained from the National Institute of Oceanography and Fisheries, Fish Research Station "TAFTEESH ELSERW" of the Branch of Al-Qanater. Immediately after purchasing the fish, it was put into an isothermal icebox (Brand: Orocan, 15 kg capacity) at 3 ± 1◦C and transported to the laboratory of Laboratory of Food Technology, Department of Food Industries, Faculty of Agriculture, Damietta University, Egypt. The average size of the Catfish were 400 g and average length 45 cm (Fig 1).

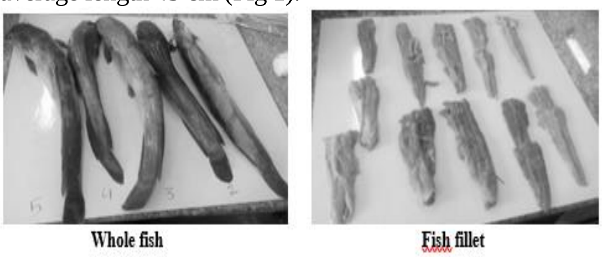

Fig .1. Egyptian Catfish (*Clarias gariepinus*)

Chemicals

Sigma Aldrich company at Cairo- Egypt has obtained all of the chemicals used in this present study

Microbial strains and cultivation media

All microbial strains and cultivation media were obtained from the Departments of Plant Microbiology, Faculty of Agriculture, Damietta University, Egypt.

Methods

Preparation of fish fillet

Egyptian Catfish was gently washed with tap water, beheaded, skinned, eviscerated, and deboned manually. The

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obtained fish flesh had been washed and drained properly. Each fish fillet piece was separated from the other using polyethylene layer before packaging in foam trays wrapped inside polyethylene bags. All fish fillet samples were stored in freezer at -18 ± 1ºC up to 12 months.

Quality analysis of Catfish fillet

Samples in three replicates randomly were subjected to biochemical assay, microbial load determination, and sensory evaluation initially and periodically after zero, 6 and 12 months of frozen storage at -18 ± 1ºC.

Biochemical assay

Proximate chemical composition (moisture, crude protein, crude oil, ash, and total carbohydrate), Water Holding Capacity (WHC), pH, Total Volatile Base Nitrogen (TVBN), and Thiobarbituric acid (TBA) of fish fillet were tested according to the methods described by AOAC, (2016). Total carbohydrates were calculated by differences (FAO/WHO, 1974).

Microbial load determination

The standard plate count (SPC) was calculated by use of a continuous decimal plate dilution procedure. Approximately 10g of fish fillet have been placed in a 200 ml of peptone-based mixer (0.2 % peptone) and homogeneous blended adequately with peptone. Aliquots 0.1 ml of successive dilutions have been piped off and aseptically put to the agar plates. The samples had been distributed throughout the medium using L-shaped glass rods until the samples had dried up. The plates were then incubated at 30°C and counted for 24-48 hours in the incubator (Özogul *et al.*, 2006).

Sensory evaluation of frozen fish fillets

Sensory evaluations of cooked Catfish fillets were constituted by 15 trained panellists at laboratory of Food Technology, Department of Food Industries, Faculty of Agriculture, Damietta University, Egypt. After a 10-point hedonic scale, the panellists evaluated the fillet for taste, colour, odour, texture and general acceptability as 10 for "excellent", and 1 for "bad" (Tokur *et al*., 2004). The fish fillets were retrieved from frozen storage and kept at 3ºC for thawing at each sensory analysis. Frozen fish fillets were cooked in sunflower oil and handed to each panellist in order to assess each sensory characteristic.

Statistical analysis

The data was reported as means of triplicate s± Standard Deviation (SD). For statistical analysis, the differences between the group of sensory and biochemical data were assessed using the SPSS 11.5 at a degree of significance of $P < 0.05$. The difference between the storage durations has been determined by analysis of variance (ANOVA).

RESULTS AND DISCUSSION

Changes in Proximate Composition

The changes in proximate chemical composition of studied Catfish fillets during frozen storage (-18°C) period up to 12 months were given in Table 1. The frozen storage process showed a significant ($p<0.05$) effect on the chemical composition of the studied Catfish fillets. The results showed that the initial chemical composition of Catfish fillet was as follow: moisture 73.01%, protein80.96%, Crude oil 09.52%, crude ash 7.30%, and Carbohydrate 2.11% (DW).

A significant (p<0.05) reduction in moisture and protein content was recorded as a function of frozen storage period up to 12 months in all the studied Catfish fillets samples. The significant decrease in fish protein content during frozen storage period may be due to the occurrence of protein denaturation, which causes a change and breaks in its chemical composition. There are many factors that can contribute to protein denaturation, such as storage temperature, slow freezing, and various storage conditions (Emire & Gebremariam, 2010).

While frozen storage process led to a significant increase (p<0.05) in the frozen Catfish fillet content of ash, and carbohydrates. These results were in agreement with Arannilewa *et al*., (2005) and Ali *et al.,* (2019) who reported that fish ash content rises during freezing storage. Meanwhile these results differ with the study of Emire & Gebremariam (2010), who found a decrease in ash content of fish fillet during frozen storage.

No significant differences ($p<0.05$) were observed in the crude oil content of frozen fish fillets during frozen storage period up to 12 months. These findings are alignment with those of Beklevik *et al*., (2005); and Tokur (2000) who reported an increase in the oil content of Rainbow Trout fish during frozen storage at -18°C.

In general, these results were consistent with previous studies by Rani *et al.,* 2017; Famurewa *et al*., 2017; and Abou-Taleb, 2018, who found the same effect of the frozen storage on fish fillets and minced fish flesh.

Table 1. Changes in proximate chemical composition of frozen Egyptian Catfish fillets

Factor (%)	Storage period (month)		
	Zero	6	12
Moisture*	73.01^{a} ±0.25	72.46^{a}±0.52	71.84^{b} ±0.18
Protein**	80.96^{a}±0.55	77.47^{b}±1.03	73.94^{c}±0.98
Crude oil**	09.52^{a}±1.01	10.66^{a}±0.66	10.89^{a}±0.38
Crude ash**	07.30^{b}±0.57	07.66^{b}±0.57	09.33^{a}±0.57
Carbohydrate**	02.11^{b}±0.46	04.18^{ab}±1.22	05.82^{ab}±0.50

Values are shown as mean± standard deviations, n=3.
*** =fresh weight basis ** = dry weight basis**
Means in a raw not followed by the same letter differ significantly (p<0.05)

Changes in Physicochemical Properties

PH, WHC, TVBN, and TBA are considered markers of the quality and freshness of fish flesh (Rathod & Pagarkar, 2013). The changes of pH and WHC (water holding capacity) values in Catfish fillets during frozen storage period showed significant (p<0.05) decreasing trends with prolong of storage period (Figure 2). The pH value decrease from 6.80 to 6.64% in frozen Catfish fillet during the storage period up to 12 months. The decrease in pH and WHC might be due to several factors like enzymatic activities, lipid oxidation, protein denaturation, and microbial activities (Nagarajarao, 2016).

TVBN is a group of nitrogen-containing compounds, including NH_3 and amines, originated from protein degradation by bacteria and enzymes activities (Aksnes & Brekken, 1988). According to the European Union standards, fish is considered spoiled and unfit for human consumption if it exceeds 25–35 mg N/100 g for TVN in fish muscles depending on the species of fish (Ninan *et al*. 2010). The initial value for control sample 22.02 mg N/100g was increased to 24.27mg N/100g during frozen storage up to 12 months of Catfish fillet. Statistical analysis showed a significant ($p < 0.05$) difference in TVN values between control and frozen stored samples up to 12 months. This indicates that frozen storage (-18°C) period up to 12 months stands behind spoilage of fish and protein degradation. The rise in TVN during frozen storage was a result of microbial action on non-protein and protein nitrogenous compounds (Viji *et al*., 2015; El-Dengawy *et al*., 2017).

TBA values usually determined as an index of lipid oxidation in fish, which could impact on product sensory properties and customer acceptance. A change in the smell and taste of fish tissues occurs if the value of 2 mg malonaldehyde/kg sample (Connell, 1990). Changes of TBA values in fish fillets during frozen storage period showed significant ($p<0.05$) increasing trends with prolong of storage period (Fig 2). The significant increase in TBA values in fish tissues during frozen storage might be occurred because of the breakdown of primary oxidation products into secondary oxidation products, spoilage bacteria and endogenous enzymes (Özogul *& Özogul*, 2006). The enzymatic activity led to the production of compounds such as ammonia, monomethylamine, dimethylamine, and trimethylamine, which allow the formation of off flavors in fish tissues (Debevere & Boskou, 1996). Asgharzadeh *et al.*, (2010) reported that the increase in TVBN and TBA during frozen storage might be due to lipid hydrolysis, chemical pro-oxidant molecules (hem-proteins and metal- ions) which caused lipid oxidation, and also to ice crystals formation in tissues which could injure the cell and cause the release of pro-oxidant enzymes (peroxidases and lipoxygenases).

In general, the previous outcomes were consistent with previous studies by Subbaiah *et al*., (2015); El-Dengawy *et al*., (2017); Famurewa, *et al*., (2017); Maurya *et al*., (2018); Solomon & Oluchi, (2018), who found the same effect of the frozen storage process on fish fillets and minced fish flesh.

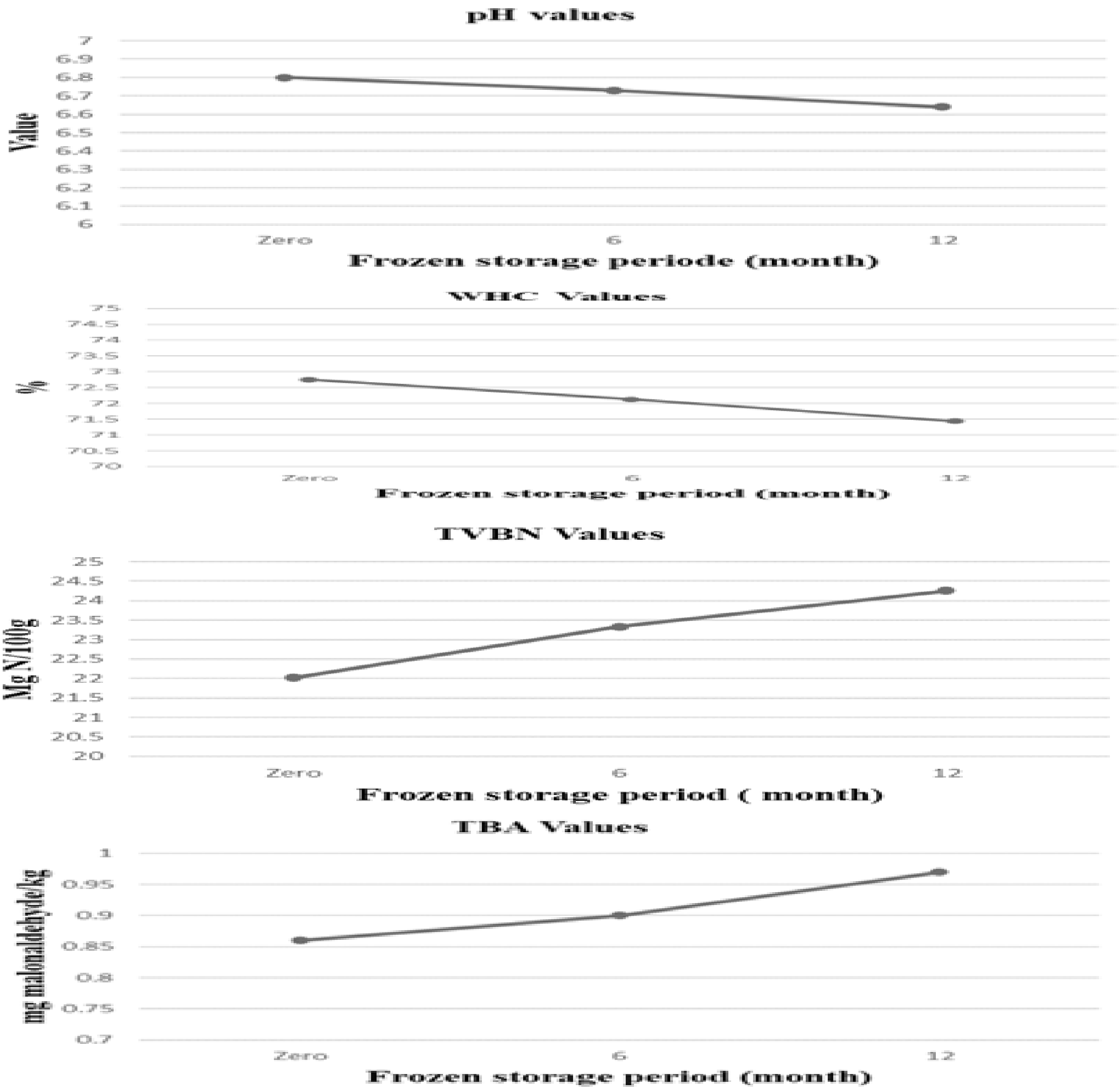

Fig .2.Changes in physicochemical properties of frozen Catfish fillets

Antimicrobial Activities

Microbial activity is generally responsible for the deterioration of fish. The key reasons for the pathogenic bacteria of fish are contaminants of the raw flesh from the environment and manufacturing steps and storage conditions (pH, temperature, water and microbial interactions) that have an effect on bacterial growth (Løvdal, 2015).

Total bacterial count is used as an acceptability index for fish fillets and its products due to the impact of bacteria on fish spoilage. Total bacterial counts shown in Table 2 was 4.10, 2.11 and 2.71 (cfu×10^3/g) at zero, 6 and 12 months for frozen Catfish fillets, respectively. In addition, there were significant differences ($p<0.05$) between 6 and 12 months of frozen storage. These decreases might be due to the impact of frozen storage (Alam *et al*, 2005; Mahmoud, 2004).

Enterobacteriaceae counts are also used to evaluate the overall quality of the food and the temperature record of the product during manufacturing. These bacteria can stay alive under micro-aerophilic conditions and cause unwanted odors or discoloration in fish products (Tsiligianni *et al*., 2012). Human bacterial pathogens *Pseudonyms, Salmonella and Shigella spp*, were observed only in the control samples with total count of 1.68 and 3.51 cfu×10^3/g for Catfish fillets. These findings were in accordance with those of Tokur, (*2000*). Coliform bacteria, Clostridium bacteria, and *E-coli* had not been detected in frozen storage (-18±3°C) for up to 12 months. The lack of *E-coli* in samples of fish fillets confirms that the samples were not contaminated with human or animal faeces (Girija *et al*. 2012). However, *Staphylococcus spp*. was only identified only in the control samples with total count of 3.25 cfu×10^3/g for Catfish fillets, and not detected during frozen storage up to 12 months. The detection of *Salmonella spp, Shigella spp,* and *Staphylococcus spp* in control samples might become due to cross contamination during the handling process (Emikpe *et al*., 2011).

The previous outcomes were consistent with previous studies by Emire *et al*., (2010); Obemeata *et al*., (2011); Rokibul *et al*., (2013); El-Dengawy *et al*. (2017).

Table 2. Antimicrobial activities of selected Egyptian Catfish fillets under frozen storage

Surface Examination	Storage period (month)		
(cfu ×10^3/g)	Zero	6	12
Total Bacterial Count	4.10^a±0.122	2.11^b±0.044	2.71^b±0.269
Pseudonyms	1.68^a±0.425	ND	ND
Clostridium	ND	ND	ND
Coliform bacteria	ND	ND	ND
E-coli	ND	ND	ND
Salmonella and shigella spp.	3.51^a±0.347	ND	ND
Staphylococci spp.	3.25^a±0.262	ND	ND

Values are shown as mean± standard deviations, n=3.
ND= not detected
Means in a raw not followed by the same letter differ significantly (p<0.05)

Sensory Evaluation of Catfish Fillets

Cooked Catfish fillets were examined for sensory evaluation attributes (colour, taste, odour, texter, and overall acceptability) as shown in Figure 3. Sensory assessment of fish products is increasingly used in quality assurance marketing research, and product development (Gould & Peters, 1971). During frozen storage, all sensory characteristics except taste and overall acceptability were significantly($p>0.05$) reduced. Colour and texture have a "6" scoring. The previous outcomes were consistent with previous studies by Tokur *et al*., (2004) and Mohmaudzadeh *et al*., (2010). The current study found that Catfish fillet may be efficiently used to produce value-added goods like fish fillets. Catfish fillets can be stored in freezing condition for a duration of 12 months. By creating such profit items from low-value fish such as Catfish, fish fillets may be appropriately utilized, allowing fishermen to earn higher returns on their catch. Consumers will also benefit from higher-quality and more economical fish items to fit their fast-food lifestyle.

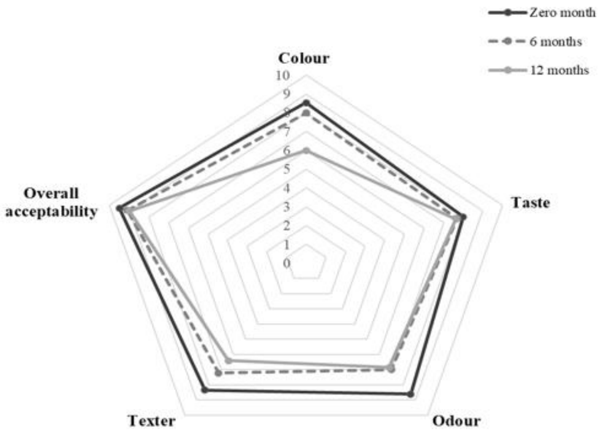

Fig .3. Sensory attributes of cooked Catfish fillets during frozen storage for 12 months

CONCLUSION

The quality characteristics (biochemical assay, microbial load determination, and sensory evaluation) of Catfish fillets had been determined during frozen storage up to 12 months. The findings indicates that Catfish fillet shelf life may be up to 12 months at -18°C. Scientific understanding of quality variations in frozen storage Catfish fillets will serve as a basis for the delivery of premium products. The current study shown that fillet prepared from Catfish (low-cost) would provide a technique for proper use of this fish, especially during the peak of the fish harvest seasons. This study is extremely important for satisfying the customer question about the shelf life of Catfish fillets may be stored in household freezers without any spoilt to improve public health.

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تقييم جودة فيليه سمك القراميط المصرى (*Clarias gariepinus*) اثناء التخزين المجمد

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تم تقدير التركيب الكيماوى والنشاط الميكروبي والخصائص الفيزوكيميائية وكذلك التقييم الحسي لفيليه سمك القراميط المصرى أثناء التخزين المجمد عند -١٨ درجة مئوية حتى ١٢ شهرًا. كان التركيب الكيميائي المبدئى لفيليه سمك القراميط المصرى كالتالى الرطوبة 73.01٪ ، بروتين 80.96٪ ، زيت خام 09.52٪ ، رماد خام 7.30٪ ، كربوهيدرات 2.11٪. وقد كان لعملية التخزين المجمد تأثيراً معنوياً على التركيب الكيميائي لفيليه سمك القراميط المصرى. انخفضت قيم الأس الهيدروجيني و قدرة اللحم على مسك الماء بشكل كبير بينما زادت قيم النتروجين الكلى المتطاير و حمض الثيوبيوتاريك بشكل معنوى مع إطالة فترة التخزين. بينما انخفض النشاط الميكروبيى بشكل عام أثناء التخزين المجمد. قل المحتوى الكلى البكتيرى لفيليه سمك القراميط المصرى من ٤,١٠ للعينة الكنترول الى ٢,٧١بعد التخزين التجميدى لمدة ١٢ شهر. فى حين قلت جميع الخصائص الحسية بشكل معنوى باستثناء الطعم والتقبل العام للفيليه المجمد في نهاية فترة التخزين. تعتبر هذه الدراسة مهمة للغاية للاجابة على قضية المستهلك المتعلقة بتحديد فترة صلاحية شرائح فيليه سمك القراميط المصرى المحفوظ فى المجمدات المنزلية دون التأثير على جودة السمك و الإضرار بالصحة العامة للمستهلك .