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Effect of Frozen Storage Periods on Quality Indices of some Processed Fishery Products.

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ABSTRACT

This study was designed to investigate the effect of frozen storage periods at-18ºC for 6 month on some physico-chemical quality indices of processed fishery products. Two fish species; Tilapia (Oreochromis niloticus) as freshwater fish and big eyed snapper (Latjenus spp.) as marine fish were purchased from Benha fish market. Raw whole fish samples were carefully washed, glazed, packed in foam dishes covered with polyethylene sheet and stored under freezing conditions. Frying, grilling, microwave cooking and boiling techniques were applied. Results showed that all quality indices were affected by storage periods as well as cooking techniques applied. pH values recorded a high decrease at the end of storage; 90 and 180 days for big eyed snapper and tilapia samples, respectively. Values of total volatile basic nitrogen (TVB), trimethylamine (TMA), and thiobarbituric acid (TBA) were increased with prolonging storage periods and fluctuated. Concerning effect of cooking techniques, it was found that pH values decreased in cooked tilapia products and increased in cooked snapper products. However, values of TVB, TMA and TBA were increased in all studied products. In conclusion, based on our results, it could be concluded that snapper fish samples were lower in freshness grade than tilapia samples. Freezing process has been affected chemically quality indices especially at the end of storage. Fluctuation in quality indices are due to fish spp., freshness degree, handling processes and frozen storage periods. Besides, different cooking techniques are affected quality indices investigated according to thermal conditions used.

Keywords: Quality indices, fish and frozen storage.

INTRODUCTION

Fish contains a good selection of minerals, and the proteins contain the essential amino acids in the right proportions. Although the amount of protein in fish varies a little from species to species and on occasion, with in species, the protein content for meat and fish is roughly comparable (FAO, 2001). Freezing is a preferred technique to preserve fish and fish products for long time.

It permits to preserve the flavor and the nutritional properties better than storage above the initial freezing temperature. It also has the advantage of minimizing the microbial and enzymatic activities (Martino *et al*., 1998).

In addition, it should take place as soon as possible after the fish is slaughtered preferable before onset of rigor mortis. All intermediate storage will result in lower quality and reduced shelf-life after freezing. If immediate freezing for some reason, such as transport, filleting and processing, is not possible, chilling should take place immediately after catching and product temperatures below 0°C should quickly be reached. Concern cooking methods, fish is usually cooked in different ways such as boiling, baked, frying and grilling. These cooking methods result in enhancing flavor, taste and improve the digestibility and inactivate the pathogenic microorganisms (Kocatepe *et al*., 2011). During cooking of fish, some chemical and physical reactions take place such as protein denaturation that increases its digestibility and improves the nutritional value. Meanwhile, the contents of thermo labile compounds, fat-soluble vitamins or polyunsaturated fatty acids are often reduced (Alizade *et al*., 2009). With regard to chemical quality indices, seafood was evaluated as 'very good', if total volatile basic base-nitrogen (TVB-N) value is lower than 25 mg/100 g; 'good', if TVB-N value is between 25-30 mg/100 g, 'marketable', if TVB-N value is between 30-35 mg/100 g and 'spoiled', if TVB-N value is 35 mg/100 g or higher than this value (Connell and Shewan., 1980; Varlik *et al*., 1993 and Pearson, 1997). TBA the most important limiting factor during frozen storage of fish (especially fatty species) is the oxidation of lipids stored in muscle tissue of fish (Pearson., *et al* 1983).

Increases and decreases in the value of TBA, particularly during long-term storage, are observed as the secondary products of lipid oxidation (Melton, 1983; Regenstein and Regenstein (1991). Therefore, this study investigates the effect of frozen storage periods at -18ºC for 180 days on quality indices of frozen and some processed Nile tilapia (Oreochromis niloticus) and big eye snapper (Latjenus spp.) products.

MATERIALS AND METHODS

Materials

Two fish species of Nile Tilapia (Oreochromis niloticus) and big eyed snapper (Latjenus spp.) were purchased from Benha fish market, ELqalubia Governorate, during June ,2019. They were transported immediately using ice box to Fish Processing Technology

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Laboratory, Elqanater ELkhiria fish research station, National Institute of Oceanography and Fisheries, Egypt, during June 2019. Average weight recorded 150 to500g and 112 to 550 g for tilapia and big eyed snapper fishes, respectively.

Ingredients; sunflower oil, spices mixture (black pepper, cumin, and garlic) and sodium chloride were purchased from Banha local market.

Technological processes of fish samples

Nile tilapia and marine big eyed snapper sample were glazed and frozen at - 18ºC. Then scales, fins, tail, and viscera were removed. Gutted samples were rewashed and then immersed in 10% NaCl solution for 10 minutes, rinsed, drained for a few minutes and spiced with mixture composed of 25% black pepper powder, 25%cumin powder and 50% garlic paste (Saaba-Nargis, 1989) were added. Spiced tilapia and snapper were divided randomly into four batches for processing; deep-fat frying (Stainless steel pan at 165±5°C after they were thinly coated with wheat flour (72% extraction), boiling (6 min for tilapia and 6-10 min for snapper), microwave (Samsung model M 1932 at 600 watt for 10 min for tilapia and 12-15min for snapper) and grilling (hot surface at 160ºC for 20 min for tilapia and 30-35 min for snapper) after they were coated with wheat bran. All products were left under room temperature till cooled and analyzed.

Analytical methods

The pH value was measured according to (AOAC, 2002) using pH meter with combined electrode. Total volatile basic-nitrogen was determined by macro-distillation method as described by (Pearson, 1991) and the results obtained were expressed as mg TVB-N/100 g fresh sample. TMA-N content was determined colorimetrically using the spectrophotometer (model Digital readout and UV/visible wavelength range, Cat NO.332279) according to the procedures of the AOAC (2000). Thiobarbituric acid (TBA) as Malonaldehyde value was calorimetrically determined as described by (Tarladgis *et al*., 1960) and the results were expressed as mg Malonaldhye/kg.

Statistical analysis

The results obtained were statistically analyzed and expressed as mean of duplicates and ±SD using SPSS (Ver.10).

RESULTS AND DISCUSSION

Effect of storage periods at -18º C FOR 6 month and cooking methods on pH value of fish products.

Data from Table (1) describes the effect of frozen storage at -18ºC for 180 days on pH value of tilapia fish. Results show that pH was stable up to 90days and then it decreased gradually till the end of storage. Concerning, the effect of cooking methods, it was clearly found that the microwave sample had the highest values 7.03 compared with other one. In addition, the pH values of all cooked products were slightly decreased up to 135 days storage except in case of grilled and boiled products. On the other side, the effect of both frozen storage and cooking methods on big eyed snapper fish are presented in the same table. The initial pH value was 6.88 and decreased to 6.22 during the frozen storage period at -18ºC for 90 days.

Table 1. Effect of both storage period at -18ºC for 6months and cooking methods on pH value of processed products tilapia and big eyed snapper fish flesh.

Storage period (day)	Control	Cooked tilapia products			
		Fried	Grilled	Microwave	Boiled
0	6.85	6.81	6.73	7.01	6.81
45	6.88	6.86	6.70	6.82	6.81
90	6.87	6.79	6.94	6.85	6.93
135	6.68	6.43	7.03	6.01	6.52
180	6.26	6.40	6.34	6.42	6.42
Big eyed snapper (Morgan)					
Storage period (day)	Control	Cooked bigeyed snapper products			
		Fried	Grilled	Microwave	Boiled
0	6.71	7.01	7.02	7.3	7.03
45	6.16	6.23	6.31	6.41	6.47
90	6.22	5.90	5.97	5.91	5.96
135	R	R	R	R	R

***R: rejected (off flavor)**

The pH value was increased in all cooked fish products reached to 7.30, 7.03, 7.02 and 7.01 for microwave, boiled, grilled and fried, respectively. These data are agreement with Abo-Taleb and Ibrahim (2002) whose reported that the pH increasing might be due to the formation of some proteinous components through heating processes., variation in pH values of cooked fishery products is due to the fish *spp.*, catch location, cooking conditions and others. In general cooking methods are limited factors affect pH values of fish products. The pH value showed slightly increase after cooking process which may be due to the formation of some basic compounds as a result of amino acid degradation Hafez (1982).

Effect of storage periods at -18º Cfor 6 month and cooking methods on TVB-N value of fish products

Data in Table (2) demonstrated the effect of frozen storage period at -18ºC for 180 days on TVB of tilapia fish. The elementary TVB value was 18.2 and increased to 22.40 mg/100g sample at the end of storage period. Also, it could be observed that the TVB-N decreased after 45 dyes to 12.60 mg/100g sample. After 90, and 135 days of frozen storage, it was increased to 26.60 mg/100g sample, respectively.

Table 2. Effect of both storage period at -18ºC for 6months and different cooking methods on TVB-N(mg/100g) value of tilapia and big eyed snapper fish flesh.

Storage period(day)	Control	Cooked tilapia products			
		Fried	Grilled	Microwave	Boiled
0	18.2±2.85	29.4±0.00	22.4±0.98	19.6±0.97	19.6±0.96
45	12.60±1.98	28.00±0.00	21.00±5.39	16.80±5.93	14.00±0.00
90	26.60±3.96	35.70±2.9	31.50±4.95	31.50±4.95	39.90±4.59
135	35.00±0.00	41.30±3.91	36.90±1.17	25.70±4.67	29.00±0.00
180	22.40±1.98	32.90±2.96	23.80±3.95	32.90±0.99	27.30±0.99
Big eyed snapper (Morgan)					
Storage period (day)	Control	Cooked Big eyed snapper products			
		Fried	Grilled	Microwave	Boiled
0	42.00±0.00	37.8±0.59	43.00±0.11	39.2±1.97	35.00±0.98
45	35.00±0.01	30.80±0.57	47.60±0.14	42.00±0.71	39.20±0.28
90	39.90±0.13	70.00±0.23	49.00±0.21	55.30±0.25	49.00±0.30
135	R	R	R	R	R

R:rejected (off flavore)

This increase occurred in TVB of frozen fish is due to fish susceptible to autolysis, oxidation, and hydrolysis of fat and microbial spoilage and even at low temperature storage some form of chemical conversion reactivity may be going on (Horsfall *et al.*, 2005). Furthermore, the TVB as affected by different cooking methods of tilapia is presented in the same table. The original TVB value was 18.2 and increased to 29.40 and 22.4mg/100g sample for fried and grilled samples, respectively. It was stable for microwave and boiled samples (19.6mg/100g), then it was irregularly increased during frozen storage period and as affected by cooking methods applied as reported by (El-Lahamy *et al*., 2018).Concerning the effects of both frozen storage at -18ºC for 90 days and different cooking methods on TVB of big eyed snapper fish also presented in Table(2). Data showed that the initial TVB was 42mg/100g samples. It was decreased during storage to 39.90, the rate of decreasing was5% with regard to the effect of freezing storage on TVB content, low temperature caused increase in its content especially at 45 days till 90 days. From the same table, cooking method led to decrease in TVB level for microwave, boiled and fried samples. With advanced storage periods, it was sharply increased in all studied cooked samples in particular fried sample (70.00mg/100g).

Generally, it could be concluded that both frozen storage and cooking methods used in this work caused increase in TVB content.

Effect of storage periods at -18º C for 6 month and cooking methods on TMA-N value of fish products

Table (3) shows the effect of both frozen storage at -18ºC for 180 days and cooking methods on TMA content for tilapia. Results revealed that TMA content was increased slightly throughout different storage periods up to 180 days to reach 0.49mg/ 100g sample compared with initial content.

In addition, the highest content of TMA was found at 135 days storage. Concern the effect of cooking methods on TMA data shows that the TMA content ranged between 0.34-0.49mg/100g sample in cooked sample. After 45 days storage, it was decreased in all cooked fish products. Based on these results, it could be concluded that the grilling was more effective to reduce of TMA-N followed by boiling and frying methods.

Table 3. Effect of both storage period at -18ºC for 6months and different cooking methods on (TMA-N) value of tilapia and big eyed snapper fish flesh.

Storage period (day)	Control	Cooked tilapia products			
		Fried	Grilled	Microwave	Boiled
0	0.41±0.01	0.53±0.01	0.37±0.02	0.374±0.02	0.322±0.00
45	0.57±0.04	0.58±0.02	0.08±0.00	0.33±0.02	0.16±0.00
90	1.07±0.04	1.27±0.02	3.87±0.01	3.95±0.09	3.71±0.07
135	2.28±0.02	0.87±0.06	0.20±0.01	0.37±0.04	1.02±0.00
180	0.49±0.07	1.85±0.00	1.16±0.04	1.59±0.03	0.53±0.05
Big eyed snapper (Morgan)					
Storage period (day)	Control	Cooked Big eyed snapper products			
		Fried	Grilled	Microwave	Boiled
0	1.49±0.02	0.394±0.01	0.768±0.01	1.31±0.01	1.81±0.01
45	1.39±0.04	1.34±0.01	0.90±0.02	1.21±0.04	1.55±0.02
90	0.92±0.01	3.14±0.03	2.74±0.07	1.32±0.01	1.38±0.06
135	R	R	R	R	R

On the other hand, data in Table (3) shows the content of TMA-N in big eyed snapper which increased in the frozen storage beginning and decreased at the end of storage periods (90 days). In general, frozen storage caused an increase in TMA content of fish samples .This increase is due to the TMA oxide (TMAO) is broken down in to DMA and formaldehyde (FA). Concern the effect of different cooking methods on TMA content ,it increased markedly in all cooked fish products to range between 1.32 to 3.14mg/100g. Thus, effect of investigated cooking methods on TMA is based on the following order, boiling, frying, microwave and grilling processes. In conclusion, the values of TMA were high lower than the documented limit; 10g/100g fish muscle as set by Egyptian slandered specification (ESS, 1988) for frozen fish.

Effect of storage periods at -18º C for 6 month and cooking methods on TBA value of fish products

Data in table (4) showed that TBA value gradually increased with extend frozen storage up to 180 days.

However, it was decreased after 90 days to record 0.36 mg MA/kg sample. In general, frozen storage condition led to increase in TBA values but it does not increase than the permissible limit (4.7mg MA/kg sample) for frozen fish (ESS, 1988). This increase in TBA value in fish flesh during frozen storage is due to microbial activity which affecting lipid hydrolysis under low temperature. Our results are in agreement with those findings by Ibrahim and EL-Shreif (2008). Also, Regenstein and Regenstein(1991)reported that increases and decreases in the value of TBA, particularly during long-term storage, are observed as the secondary products of lipid oxidation.

Table 4. Effect of both storage period at -18°C for 6months and different cooking methods on TBA value of tilapia and big eyed snapper fish flesh.

Storage period(day)	Control	Cooked tilapia products			
		Fried	Grilled	Microwave	Boiled
0	0.35±0.01	0.72±0.2	0.67±0.3	1.17±0.31	1.15±0.01
45	0.88±0.01	0.06±0.00	0.20±0.03	0.53±0.01	1.98±0.01
90	0.36±0.00	0.73±0.27	0.68±0.00	1.68±0.18	2.18±0.11
135	1.05±0.00	2.79±0.03	2.31±0.03	3.41±0.06	1.08±0.00
180	1.34±0.13	0.48±0.01	0.74±0.00	0.39±0.00	0.59±0.00
Big eyed snapper (Morgan)					
Storage period (day)	Control	Cooked Big eyed snapper products			
		Fried	Grilled	Microwave	Boiled
0	0.76±0.06	4.04±0.03	3.96±0.5	6.51±0.01	3.45±0.07
45	2.14±0.20	6.13±0.32	2.27±0.06	3.23±0.01	5.09±0.24
90	0.61±0.04	0.45±0.001	0.48±0.001	0.64±0.02	0.64±0.00
135	R	R	R	R	R

With regard to cooking methods, the TBA values of all cooked products were ranged between 0.72 to 1.17mg MA/kg samples. Thus, its value was slightly increased in all cooking samples. After that, values of TBA were decreased in all cooked samples which pre-stored for 45 days except in case of boiled sample (1.98 mg MA/kg sample). A decrease in TBA value in fried and grilled products is due to the MAD eventually formed could be lost either by dissolution in the frying oil or due to formation of adducts with protein.

While, increase in its value in boiled and microwave-cooked sample is refer to high temperature that promoted lipid peroxidation, increasing MA levels (Weber *et al*., 2008). On the other hand, the effect of both frozen and cooking methods on TBA values of big eyed snapper fish are described in the same table. TBA value is taken the similar trend that found in case of frozen tilapia. Thus, it's increased after 45days storage and decreased sharply after 90 days. With regard to the effect of cooking methods on TBA value, it was increased after 45 days storage in both fried and boiled products to record 6.13 and 5.09 mg MA/kg sample whereas, it reduced in both grilled and microwave-cooked products. In conclusion, frozen storage led to increase in TBA value at 45 days, decreased after 90 days and increased gradually up to 180days for investigated fishes. In addition, some cooking methods such as frying and grilling caused a decrease in TBA value while others increased its value such as microwave and boiling. The obtained results are in parallel with those finding by El-Sherif *et al*., (2011) and El-Lahamy *et al*., (2018).

CONCLUSION

Freezing process has been affected chemically quality indices especially at the end of storage. Fluctuation in quality indices is due to fish *spp*., freshness degree, handling processes and frozen storage periods. Besides, different cooking techniques affected values of quality indices investigated according to thermal conditions used.

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تأثير التخزين بالتجميد وطرق الطهى المختلفة على دلائل الجودة فى الاسماك

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يهدف هذا البحث الى دراسة تأثير كلا من التخزين بالتجميد على درجة -18° م لمدة 6 شهور وكذلك عمليات الطبخ المختلفة (التحمير- الشي- الطهو بالميكروويف- السلق) على دلائل الجودة (القواعد الكليه المتطايرة TVB-N –التراي ميثايل امين TMA- حامض الثيوبارباتيوريك TBA- والأس الهيدروجينى pH) لكلا من أسماك البلطي النيلي والمرجان. أظهرت النتائج أن كل دلائل الجودة قد تأثرت تأثيرا واضحا بمدة التخزين وكذلك بطرق الطبخ المستخدمة. حيث أظهرت قيم pH ارتفاعا ملحوظا فى نهاية فترة التخزين لكلا من أسماك البلطى والمرجان، وكذلك قيم القواعد الكلية المتطايرة والتراي ميثيل أمين وحامض الثيوباربتيوريك حيث زادت بمستويات متفاوتة حتى نهاية فترة التخزين لكلا النوعين. وبالنسبة لعمليات الطبخ وجد أن قيم رقم الحموضة انخفضت فى اسماك البلطي وسجلت ارتفاعا فى أسماك المرجان. فى حين أن قيم القواعد الكلية المتطايرة والتراي ميثيل أمين وكذلك حامض الثايوباربائيوريك ارتفعت فى كل المعاملات لكلا النوعين. وتخلص النتائج إلى أن أسماك المرجان كانت منخفضة فى درجة الطزاجة مقارنة بأسماك البلطي النيلي. كان للتخزين بالتجميد تأثير واضح وخصوصا فى نهاية فترة التخزين. ويمكن القول بأن التفاوت الحادث فى قيم دلائل الجودة يرجع إلى درجة الطزاجة، عمليات النقل، مدة التخزين بجانب درجات الحرارة المستخدمة أثناء عمليات الطبخ.