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Research Article

Changes in Proximate Composition of Mullet Fish Steaks During Frozen Storage and Cooking Techniques

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Abstract

Cooking techniques were applied on Mullet fish (Mugil cephalous) steaks. Raw Mullet fish steaks were stored at -180C for 180 days to study the changes in the proximate composition during storage period. The proximate composition of raw Mullet fish was affected by cooking techniques. Moisture contents decreased in fried and grilled mullet steaks while protein, fat and ash contents were significant increase in cooked mullet steaks. The loss of moisture in fried samples amounted to the highest levels, also the protein and fat value was proportionally high. The raw and cooked Mullet fish showed a gradual decrease in their contents of moisture, protein and fat as affected by frozen storage period and cooking method while ash contents were increased. Mullet fish steaks maintained their nutritional value until the end of the storage period.

Keywords: Frying; Grilling; Mullet Fish Steaks; Freezing; Proximate Composition

Introduction

Fish is highly nutritious, rich in micronutrients, minerals, polyunsaturated fatty acids and proteins, and represents a valuable supplement in diets lacking these nutrients, essential vitamins and minerals. In many countries, especially developing countries, the average per capita fish consumption may be low, but, even in small quantities, fish can significantly improve the quality of dietary proteins by complementing the essential amino acids that are often present only in low quantities in vegetable-based diets1. Preservation provides a long shelf-life for fish and fish products. Preservation can be defined as the storage of excess fish when they are abundantly caught or produced so they can be consumed as if fresh in times when food is scarce or when transported to long distances. Preservation affects food in two ways:

I. it keeps the original freshness and properties of fish;

II. it changes the original properties of the food and creates new product.

The main purpose of both of these is to prevent spoilage, especially by microorganisms. Several preservation methods have been developed, some of them providing a longer shelf-life than others. The choice of a preservation method depends on the product, properties of the product, availability of energy, the storage facilities, and the costs of the method. It is sometimes necessary to combine methods. Proximate chemical composition generally means percentage composition of basic constituents such as moisture, proteins, fats, carbohydrates and minerals. In recent times, the importance of fishery products as a source of nutrients including high quality proteins, unsaturated lipids, a number of vitamins, and minerals has been realized. Several fishery items have attracted the attention of nutritionists and dieticians as a source of therapeutically important polyunsaturated fatty acids [2]. In the freezing process, the temperature degree lowers to under the freezing point. In this case, most of the water to turn into ice. The freezing point passed on the total soluble solid or substances dissolved in the fluid of the tissue [3]. Fish is processed in different methods such as frying and grilling and roasting. These methods improved the hygienic quality by inactivation of pathogenic microorganisms and enhanced the digestibility and bio-availability of nutrient in the digestive tract [4]. In Egypt, Mullet fish is usually

processed by various cooking methods, such as grilling and frying, before consumption. Thermal processing techniques are widely used to improve eating quality and safety of food products and to extend the shelf life of the products [5]. During cooking process, some physical and chemical changes take place which either impair or improve the nutritional value of food. Therefore, digestibility is increased because of protein denaturation in food while, the content of thermo labile compounds, vitamins or polyunsaturated fatty acids is often reduced [6]. The aim of current study was to follow up the changes which occur in chemical composition of mullet fish steaks by frying and grilling technique during frozen storage period.

Materials and Methods

Sample Preparation

Ten kilogram of fresh Mullets fish (Mugil cephalous) were obtained from one of the fishermen in Wadi El-Rayan Lake, Fayoum Governorate in February 2016. They had been transported in ICE-BOX to the laboratory of Fish Processing Technology, National Institute of Oceanography and Fisheries (NIOF), Fayoum Governorate, Egypt. In laboratory, whole fish were immediately beheaded, gutted and cut into steaks then washed gently with tap water. Steaks samples were divided into four groups. One of them was cooked by frying and grilling methods in the same day of the acquisition of the fish, corresponding to 0 day. The other samples were packed in polyethylene bags with oxygen permeability, stored at -18˚C for six months in domestic freezer, and removed for analysis after 60, 120 and 180 days to cooked.

Experimental Design

The different ingredients included; sunflower oil, table salt, wheat flour, wheat bran, garlic, black pepper, cumin and red pepper were obtained from the local market at Fayoum, Egypt.

Cooking Techniques (Table 1)

Table 1: Cooking techniques.

Steps	Frying	Grilling
1	Frozen Mullet steaks were thawed	Frozen Mullet steaks were thawed
2	Spices mixture was put in the steaks cavity and rubbed with flour.	Rubbed with bran wheat
3	The steaks were fried in sunflower oil heated at 180°C for 5 min for each side of the steaks using electrical fryer pan Moulinex brand, French	Grilled using electrical grill machine at 260°C for 15 min for each side of the steaks.
4	The fried steaks were drained in basket to remove excess oil	The grilled fish samples were spiced for 1 min using spice solution containing red pepper garlic, black pepper and cumin.

Raw Mullet Fish Steaks

Raw Mullet fish steaks were packed in polyethylene bags and stored in deep freezer at -18˚C for 180 days. Samples were withdrawn periodically at intervals of 60 days for analysis and to prepare the fried and grilled fish steaks.

Analytical Methods

4.5.1.Proximate Chemical Composition: Moisture, crude protein, crude fat and ash contents were determined according to [7]. Total carbohydrates were calculated by difference method using the following equation: Total carbohydrates =100% - (% protein + % fat + % ash + % moisture) [8].

Statistical Analysis

Chemical composition data were analyzed statistically using SPSS 16.0 for windows (SPSS Inc., Chicago, USA). least significant difference test (LSD) at ($P \leq 0.05$) and Standard Error (Mean ± SE) were calculated.

Results and Discussion

Effect of Cooking Techniques on Mullet Fish Steaks

The effects of frying and grilling cooking technique on the proximate composition (moisture, protein, lipid, ash and carbohydrates) of Mullet fish are presented in Table 2. Moisture content of raw, fried and grilled steaks of Mullet fish were 71.45±0.83%, 60.23±1.28% and 64.72±1.73%, respectively. There was significant ($p < 0.05$) loss in the moisture content of raw fish due to the cooking process by frying and grilling. It was observed that moisture content was decreased by 11.22 % in the fried steaks and 6.73 % in the grilled samples. This observation agreed with El-Sherif et al. [9] for fried Tilapia fish as well as for some fish species [10]. The protein content in raw Mullet fish was significant increased ($P<0.05$) in the fried and grilled Mullet steaks. Increasing protein content in the cooked fish samples (fried and grilled) due to the water loess during cooking. Protein contents were19.4±0.81, 23.77±0.44 and 22.65±1.15% in raw, fried and grilled Mullet steaks, respectively. Similar data showed that deep-fried fish had the highest protein value comparing other cooking methods [10, 11].

Data given in Table 2 showed that total lipids in raw, fried and grilled Mullet samples were 7.41±0.81, 13.45±0.26 and 10.2±1.15%, respectively. These values were differing significantly ($P<0.05$). The higher lipid content of fried Mullet fish than grilled steaks is mainly due to the absorption of oil and losing moisture during frying process [12]. Ash contents were 1.46±0.27, 2.05±0.29 and 1.98±0.57 in raw, fried and grilled fish steaks, respectively (Table 2). The differences of ash content higher of fried steaks is due to more loss of moisture took place during deep frying cooking comparing with grilling method [11]. The carbohydrates contents of cooked fish steaks showed similar observations. The changes found in the chemical composition of Mullet fish cooked by frying and grilling were similar to several studies carried out in other fish species included Sea bass [10-14].

Table 2: Proximate composition (Wet basis) of raw and cooked Mullet fish steaks.

Parameters	Mullet fish steaks			L.S.D	Sig.
	Raw steaks	Fried steaks	Grilled steaks		
Moisture (%)	71.45±0.8	60.23±1.28	64.72±1.73	.003	3.77
Protein (%)	19.4±0.80	23.77±0.44	22.65±1.15	.026	2.41
Fat (%)	7.41±0.81	13.45±0.25	10.2±1.15	.006	2.34
Ash (%)	1.46±0.26	2.05±0.288	1.98±0.565	.552	1.12
Carbohydrate (%)	0.28±0.01	0.50±0.005	0.45±0.017	.000	0.00

Effect of Cooking Techniques on Pre-frozen Mullet Fish Steaks

The effect of frozen storage on moisture, protein, fat, and ash contents of Mullet fish steaks post-cooked by frying and grilling were studied. The obtained results are tabulated in Tables 3-7.

Moisture

Table 3 showed the effects of storage at -18°C and cooking technique on the moisture contents of raw Mullet fish as well as Mullet fish steaks cooked by frying and grilling. The initial moisture contents of raw, fried and grilled fish samples were 71.45±0.84, 60.23±1.28 and 64.72±1.73 %, respectively. The differences were a gradual decreasing in their contents of moisture as affected by frozen storage period and cooking technique. After two months of storage, moisture contents of raw, fried and grilled fish samples were 70.60±2.07, 59.04±0.6 and 63.45±1.41, respectively. As the storage period extended, the moisture content considerably decreased. At the end of six months storage, moisture of raw, fried and grilled fish samples decreased down to 69.1±2.88, 57.64±1.52 and 60.91±0.525%, respectively. Moisture losses in raw, fried and grilled samples were estimated by 2.35, 2.59 and 3.81%, respectively after six months of frozen storage. The loss of moisture of the pre-frozen fish samples could be attributed to the sublimation of ice in frozen storage and the loss of drip during thawing process in addition to water loss due to heat during frying and grilling processes [15]. Similar findings were reported for other species of fish such as Sea bass fillets [16], Carp fish cutlets [17], Tilapia fillets [18], Labeo rohita [19] and Catla fish cutlet [20].

Table 3: Effect of frozen storage at – 18˚C and cooking techniques on moisture content (%) in Mullet fish steaks.

Storage time	Moisture content (%)			Sig.	L.S.D
(Months)	Raw steaks	Fried steaks	Grilled steaks		
0	71.45±0.83	60.23±1.28	64.72±1.73	0.003	3.77
2	70.60±2.07	59.04±0.60	63.45±1.41	0.004	4.22
4	69.50±1.44	58.38±2.30	62.58±0.91	0.009	4.68
6	69.10±2.88	57.64±1.52	60.91±0.52	0.014	5.39
Sig.	0.828	0.693	0.249	-	-
L.S.D	5.55	4.39	3.49	-	-

Protein

Table 4 showed that effect of storage periods at -18°C and cooking technique on protein contents of raw and cooked Mullet fish products. Protein contents of raw, fried and grilled samples at time zero were 19.4±.81, 23.77±.44and 22.65±0.1.15 %, respectively. The results indicated that protein contents of raw (uncooked) and cooked Mullet fish samples gradually decreased during storage. As shown in Table 5 after six months of frozen storage protein contents of raw, fried and grilled cooked Mullet fish samples decreased to 18.5±2.59, 22.9±.52 and 21.8±1.6%, respectively. Protein decreases were estimated by 2.35, 2.59 and 3.81 % in raw, fried and grilled fish samples, respectively in related to the initial protein content of raw unfrozen sample. Protein loss during frozen storage of fish products had been studied and several mechanisms were suggested to explain this behavior [21] reported that the changes in protein content during frozen storage may be due to the loss of some volatile nitrogenous compounds during frozen storage and protein hydrolysis by enzymes which enhanced the loss of water soluble nitrogen with separated drip [19] attributed protein loss observed during frozen storage of (Labeorohita) to the leaching effect on amino acid and water-soluble protein during thawing, process.

Table 4: Effect of frozen storage at – 18˚C and cooking technique on protein content (%) in Mullet fish steaks.

Storage Time	Protein Content (%, wet basis)			Sig.	L.S. D
(Months)	Raw steaks	Fried steaks	Grilled steaks		
0	19.4±.808	23.77±.444	22.65±0.1.15	0.026	2.41
2	19.00±.577	23.50±1.44	22.30±1.73	0.125	3.79
4	18.8±1.03	23.10±2.30	22.05±.288	0.179	4.16
6	18.5±2.59	22.90±.519	21.80±1.61	0.272	5.06
Sig.	0.977	0.97	0.972	-	-
L.S. D	4.19	3.96	3.74	-	-

Fat

Storage changes in fat content of raw and cooked Mullet fish samples were periodically determined at intervals of two months during frozen storage at -18°C and the results obtained are given in Table 5. Fat content of raw as well as the fried and grilled samples immediately after cooking process were 7.41±.81, 13.45±.26 and 10.2±1.15%, respectively. During storage, fat content slightly decreases down to 7±.58, 13.15±1.24 and 9.95±.548 %, respectively at the end of 180 days storage. The losses in fat contents of Mullet fish samples at the end of storage period were calculated by 5.53, 2.23 and 2.45 % in raw, fried and grilled samples, respectively. In a study made by Gandotra et al. [19] on (Labeo rohita) fish during frozen storage for 21days at -12 ± 2°C the losses in lipids were 5.44, 15.80 and 22.27% after 7, 14 and 21 days of storage. Similar results reported by Arannilewa et al. [22], [18,23]. The decreasing in fat content might be due to oxidation and hydrolysis of lipids which result in the formation of some volatile compounds as aldehydes and ketones [19].

Table 5: Effect of frozen storage at – 18˚C and cooking techniques on fat content (%) in Mullet fish steaks.

Storage Time	Fat Content (%, wet basis)			Sig.	L.S. D
(Months)	Raw Steaks	Fried Steaks	Grilled Steaks		
0	7.41±.814	13.45±.259	10.20±1.15	0.006	2.34
2	7.35±.202	13.30±2.90	10.10±2.73	0.079	4.21
4	7.20±.692	13.00±2.07	10.0±1.44	0.091	4.28
6	7.00±.577	13.15±1.24	9.95±.548	0.007	2.4
Sig.	0.965	0.997	0.999	-	-
L.S. D	1.73	4.36	3.66	-	-

Ash

Changes in ash content of raw and pre-frozen cooked Mullet fish samples during frozen storage at-18°C for 180 days are presented in Table 6. The raw and cooked Mullet samples showed gradual increasing in their contents of ash during frozen storage. The initial ash contents of raw, fried and grilled samples were 1.46±.27, 2.05±.29 and 1.98±.57%, respectively. Ash content gradually increased during frozen storage up to 4.55±.32, 5.61±.69 and 6.49±.75% at the end of storage period, respectively. Similar observation was found during frozen storage of some fish products 19. 23 reported that ash content of fish sausage made from Catfish and Tilapia increased during storage at -18°C for 120days. The increase in ash contents of fish products during frozen storage might be attributed to the loss recorded in protein and fat content which reflected the increasing found in ash contents. On the other hand, some studies showed a decreasing in ash content of fish during frozen storage which was attributed to the drip loss during thawing process [19].

Table 6: Effect of frozen storage at – 18˚C and cooking techniques on ash content (%) in Mullet fish steaks.

Storage Time	Ash content (%, wet basis)			Sig.	L.S. D
(Months)	Raw Steaks	Fried Steaks	Grilled Steaks		
0	1.46±.265	2.05±.288	1.98±.565	0.552	1.12
2	2.62±.935	3.58±.161	3.40±.461	0.533	1.72
4	3.85±1.06	4.74±.427	4.67±.386	0.63	1.97
6	4.55±.317	5.61±.692	6.49±.750	0.165	1.74
Sig.	0.074	0.002	0.003	-	-
L.S. D	2.09	1.24	1.57	-	-

Carbohydrate

The carbohydrate of raw and cooked Mullet fish products during frozen storage were in Table 7. Carbohydrates of raw and cooked Mullet fish sample were determined by difference and therefore the change of it might be due to the change of other constituents mainly as a result of added spices.

Table 7: Effect of frozen storage at – 18˚C and cooking techniques on carbohydrate content (%) in Mullet fish steaks.

Storage time	Carbohydrate content (%, wet basis)			Sig	L.S. D
(Months)	Raw steaks	Fried steaks	Grilled steaks		
0	0.28±.011	0.50±.005	0.45±.017	0	0
2	0.43±.023	0.58±.028	0.75±.034	0.001	0.089
4	0.65±.040	0.78±.046	0.70±.051	0.217	0.126
6	0.85±.057	0.70±.063	0.85±.069	0.237	0.178
Sig.	0	0.007	0.002	-	-
L.S. D	0.103	0.115	0.136	-	-

Conclusion

Proximate composition of Mullet fish steaks showed significant differences between cooked and raw samples and during frozen storage. The loss of moisture in fried samples amounted to the highest levels; also, the protein and fat value was proportionally high. Mullet fish showed a gradual decrease in their chemical composition contents. Mullet fish steaks maintained their nutritional value until the end of the storage period.

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