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EFFECT OF SOME TECHNOLOGICAL PROCESSES ON THE QUALITY OF MINCED GRASS CARP DURING FREEZING STORAGE

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Abstract

Some physico-chemical, chemical, microbiological and organoleptical changes of minced grass carp (*Ctenopharyngodon idella)* during washed, pre-fried and storage period for 3 months at -20 °C were investigated.

Results showed that a decrease in moisture, crude protein, fat and ash of grass carp balls produced from unwashed mince and washed mince before and after additives (salt, sugar, wheat flour, cumin, onion, garlic powder, black pepper and thyme). and the decreasing were clear in unwashed mince and washed mince after additives, respectively. Data indicated that, the content of saturated fatty acid, monounsaturated fatty acid and polyunsaturated fatty acid dominant were (C16:0), (C18:1) and (C18:2) from unwashed mince and washed mince before and after additives, respectively. Results showed a decrease in pH-values, total bacterial count (TBC) and scores of color, flavor, appearance and overall acceptability during storage period. While samples showed an increase in total volatile bases nitrogen (TVBN), trimethyl amine nitrogen (TMAN), thiobarbituric acid (TBA) and psychrophilic bacterial count (Log_{10} CFU/g) content of minced grass carp (*Ctenopharyngodon idella)* during washed, pre-fried and storage period for 3 months at -20 °C.

The results showed that, the grass carp balls produced from washed mince and pre-fried were best compared with the unwashed mince (without fried and pre-fried) during storage period at -20 °C for three months.

INTRODUCTION

Grass carp (*Ctenopharyngodon idella*) is one of the main freshwater fish species farmed in Southern Brazil. The increase in the intensive production of grass carp has raised concerns over the quality of the cultured products. Therefore, investigations on the freshness quality during handling, distribution and storage in ice are of considerable interest (Scherer *et al.*, 2004).

Carp is one of the most widely cultured and traded species over all the world due to its fast growth rate, easy cultivation, high feed efficiency ratio and high nutritional value. However, fish are perishable foods, which generally spoil faster than other muscle foods. Frozen storage is a general preservation method, used to control or decrease biochemical changes in fish that occur during storage.

Nevertheless, frozen storage does not completely inhibit microbial and chemical reactions that lead to quality deterioration of fish as fish muscle is abundant in proteins and unsaturated fatty acids (Wenjiao *et al.,* 2009).

Freezing is an excellent method for preserving the organoleptic attributes and protein functionality of flesh fish during prolonged periods of storage. Furthermore, measurement of sensory, chemical and physical changes have been shown the deterioration of fish quality continues to some extent during frozen storage. (Careche *et al.,* 1999).

Freezing and frozen storage have largely been employed to retain fish quality before it is consumed or used in other technological processes. However, the presence in fish muscle of both a highly unsaturated lipid composition and a relevant prooxidant compound content can facilitate an important enzymatic and non-enzymatic rancidity development, this leading to sensory, physical and nutritional quality losses. (Jaime *et al.,* 2009).

Frozen storage of shellfish is an important preservation method; however deterioration in texture, flavor, and color of muscles frequently occurs with poor conditions during the process. Freezing slows enzyme activity and inhibits microorganism growth. However, lipid hydrolysis and oxidation still occur. The extent of quality loss of marine frozen food is dependent upon many factors, which include storage temperature and time, packaging, rate of freezing–thawing, and temperature fluctuations and freeze–thaw abuse. Prolonged frozen storage of Egyptian shore crabs (*Carcinus maenas*) at -10 °C affected the chemical characteristics of crab meat. (Soottawat and Nuntapol 2009).

Washing is one of the most critical steps in surimi manufacturing. Large amounts of water are used to remove the sarcoplasmic proteins, blood, fat and other nitrogenous compounds from the minced fish flesh Additionally, a considerable quantity of soluble material is lost through processing. (Park and Morrissey 2000).

Nowsad *et al.* (2000) reported that, washed mince showed significantly better textural properties than un washed mince. On the other hand, reduce redness was indicated that washing cycles removed pigments such as myoglobin, residual

hemoglobin, fat and other nitrogenous compounds (Wetterskog and Undeland 2004).

Fish and shellfish provide an almost unlimited variety of fatty acids with beneficial roles in human health. The overall net effect of the consumption of fish and fish oils appears to reduce the risk of coronary heart disease The potential health benefits related to fish consumption are due to the presence of proteins, unsaturated essential fatty acids (PUFAs), minerals and vitamins. Additional health benefits from the consumption of fish or fish lipids may be related with PUFAs especially ω3 PUFAs (Sidhu, 2003).

It has been reported that the type and amount of fatty acids in fish tissues vary mainly with feeding of the fish, but other factors may also influence their fatty acid composition. For example, size or age, reproductive status, geographic location, and season all influence fat content and composition of fish muscle. The fatty acid profile of fish is certainly influenced by temperature (Saito *et al.,* 1999).

The shelf life reflects susceptibility of the fish to deterioration. The quality of fish can be estimated by sensory tests, microbial methods or by chemical methods such as measuring volatile compounds, lipid oxidation, determination of ATP breakdown products and the formation of biogenic amines. Gülsün *et.al.* (2009).

Fish lipids have been intensely investigated since their protective effect on cardiovascular diseases was first studied. Fish oils are rich in long-chain polyunsaturated fatty acids (LC-PUFA), namely eicosapentaenoic (EPA) and docosahexaenoic (DHA), which reduce some risk factors associated with arteriosclerosis (Calder, 2004).

Raw fish products that have been stored under refrigeration, then frozen and thawed can be expected to undergo a nearly one log reduction in viable counts due to the freeze–thaw cycle. Plate counts will only reveal the number of viable cells per gram. There is therefore a need for a rapid and reliable method for determining the total numbers of viable and dead bacterial cells following refrigerated or iced storage and before sale, in order to prevent the distribution of poor quality fish products to consumers, and to reveal the truebacterial history of such products. (Jung-Lim and Robert, 2006).

Quality deterioration of frozen fatty fish has been attributed to both changes in lipids and loss of protein functionality. Loss of protein functionality during frozen storage is due to protein aggregation and this is promoted by presence of formaldehyde (FA), (Natseba, *et al.*, 2005).

The present work was carried out to investigate some physico-chemical, chemical, microbiological and organoleptical properties of grass carp balls produced from unwashed mince (without fried and pre-fried) (UWM) and washed mince (without fried and pre-fried) (WM) during storage period at - 20 °C for three months.

MATERIALS AND METHODS

Samples and experimental design:

Grass carp (*Ctenopharyngodon idella*) was immediately obtained after catching from Abbasa Farm in Sharkia Governorate, Egypt. Each sample weighted 10 Kg, while the mean of individual weight of grass carp fish was about 2.5 Kg. The fish samples were washed using tap water, then the head, scales and all fins of grass carp fish were removed using a sharp knife. The internal viscera were removed by hand, then washed the fish using tap water. The fish samples were cut to fillets. The fillets were minced with a kitchen meat mincer, using a 3 mm diameter holes plate. Minced fish was washed in ice cold water (2 °C) with a ratio of 1.5:2 (mince fish to water), to eliminate any odor and strained using a cheese cloth in a refrigerator at 2 °C for 8 hours. Afterwards, the samples were dewatered by squeezing manually.

The grass carp balls mince included 92.5 % grass carp mince, 2.25 % salt, 1 % sugar, 3 % wheat flour, 0.25 % cumin, 0.25 % onion, 0.25 % garlic powder, 0.25 % pepper and 0.25 % thyme. The ingredients were homogenized with a kitchen blender. The batter and breading materials were purchased from local market in Sharkia Governorate. After the batter application, it was also covered with conventional breading crumbs and pre-fried at 180 °C for 30 s. Then, the same procedure was conducted for the production of washed grass carp balls mince. The total weights of grass carp balls produced from unwashed mince (without fried and pre-fried) (UWM) and washed mince (without fried and pre-fried) (WM) were 2.0 kg and 1.8 kg, respectively. Grass carp balls were packaged in a foam plate and

wrapped with cling film. They were quick-frozen at - 40 °C for 4 hours and then stored at - 20 °C for three months.

Analytical methods:

Moisture content, total protein, lipids and ash were determined according to the methods described in AOAC (2000). pH-value analysis, muscle was homogenized in distilled water 1:1, (w/v) and the measurement was made with a model DMPH-2 Digimed pH-meter at room temperature (Pastoriza and Sampedro, 1994). The constituent fatty acids present in the lipid extracted from each sample was measured by gas-liquid chromatography after liberated and esterified by a modification of AOAC (2000). Total volatile bases nitrogen (TVB-N) was determined in flesh by the method of Kjeldahl described by Furuichi *et al.* (1997), and trimethylamine nitrogen (TMAN) analysis was carried out according to the method proposed by Dyer (AOAC, 2000). Thiobarbituric acid value (TBA) was estimated as described by Tarladgis *et al.* (1960). Total bacterial count (TBC) and psychrophilic bacterial count (PsBC): were detected according to the method described by Swanson *et al.* (1992). Sensory evaluation of samples were organoleptically evaluated for appearance, color, flavor and over all acceptability of grass carp balls produced from unwashed mince (without fried and pre-fried) (UWM) and washed mince (without fried and pre-fried) (WM) during storage at - 20°C as described by Teeny and Miyauchi (1972).

Statistical analysis:

Three replications of each trial were analyzed using Analysis of Variance (ANOVA) and the means were separated by Duncan' test (1955) at a probability level of $P<0.05$ (SAS, 2000).

RESULTS AND DISCUSSION

The obtained data of chemical composition (moisture, protein, fat and ash) contents of unwashed grass carp mince (UWM) and washed mince (WM) before and after additives are shown in Table 1. Results showed significant differences ($P<0.05$) between treatments [unwashed mince (UWM) and washed mince (WM) before and after additives]. The highest percentages of moisture content in washed mince (WM) before additives; 75.16%. While, the lowest levels of moisture content were in unwashed mince (UWM) after additives; 71.25 %. While the highest levels

of crude protein fat and ash were in unwashed mince (UWM) before additives representing 70.50, 18.80 and 9.97%, respectively. While, the lowest levels of crude protein fat and ash content were in washed mince (WM) after additives which were 65.70, 16.86 and 8.53% respectively. Those results agree with these achieved by Park and Morrissey (2000).

Table1. Proximate composition of grass carp balls produced from unwashed mince (UWM) without fried and pre-fried and washed mince (WM) without fried and pre-fried.

Treatments	Unwashed mince		Washed mince	
	Before additives	After additives	Before additives	After additives
Moisture content (%)	72.86 ± 0.22 [c]	71.25 ± 0.21 [d]	75.16 ± 0.25[a]	73.36 ± 0.23 [b]
Protein content (%)	70.50 ± 0.23 [a]	66.57 ± 0.20 [c]	69.65 ± 0.22[b]	65.70 ± 0.21 [d]
Fat content (%)	18.80 ± 0.16 [a]	17.48 ± 0.14 [b]	18.13 ± 0.15[ab]	16.86 ± 0.14 [c]
Ash content (%)	9.97 ± 0.13 [a]	9.27 ± 0.12 [b]	9.17 ± 0.12[b]	8.53 ± 0.11[c]

[a-c] Means within a raw with the same superscript significantly different (P<0.05).
Values are expressed as Mean ± SD.

Data in Table (2) showed the fatty acids composition (saturated fatty acids, monounsaturated fatty acids (MUFAs) and polyunsaturated fatty acids, (PUFAs) of grass carp balls produced from unwashed mince (UWM) without fried and pre-fried and washed mince (WM) without fried and pre-fried. Data showed the saturated fatty acids, (MUFAs) and (PUFAs) for all samples. On the other side, the predominant fatty acids were C16:0, C16:1, C18:1 and C18:2 in the grass carp balls for all samples. The difference between the samples due to unwashed and washed mince. Also the different amounts of the fatty acids were absorbed during frying. These results agree with those reported by Sidhu, (2003), Calder (2004) and Gülsün *et al.* (2009).

Table 2. Fatty acids composition (% w/w of total fatty acids) of grass carp balls produced from unwashed mince (without fried and pre-fried) (UWM) and washed mince (without fried and pre-fried) (WM).

Treatments	Unwashed mince		Washed mince	
	Before additives	After additives	Before additives	After additives
C14:0	2.09	2.24	1.50	1.75
C16:0	14.6	16.6	15.7	15.8
C18:0	5.20	4.00	4.17	4.29
C20:0	1.58	1.74	2.16	2.40
C22:0	0.36	0.30	0.09	0.34
C23:0	0.610	0.510	0.550	0.456
C24:0	0.22	1.13	0.15	0.96
ΣSFA	24.66	26.52	24.32	23.58
C16:1	11.2	5.11	8.54	13.2
C18:1	15.1	15.4	20.3	19.6
C20:1	2.01	1.09	1.48	1.20
C22:1	0.19	0.15	0.19	0.11
ΣMUFA	28.5	21.75	30.51	34.11
C 18:2	7.83	8.32	10.5	3.64
C 18:3	4.30	2.66	3.52	1.57
ΣPUFA	12.13	8.98	14.02	5.21

Changes in total volatile bases nitrogen (TVBN) and trimethylamine nitrogen (TMAN) (mg/100g) content of grass carp (*Ctenopharyngodon idella)* balls produced from unwashed mince (without fried and pre-fried) (UWM) and washed mince (without fried and pre-fried) (WM) during storage for 3 months at -20 °C are presented in Table (3). The obtained results indicated a significant increase ($P<0.05$) in total volatile bases nitrogen (TVBN) and trimethylamine nitrogen (TMAN) (mg/100g) content in samples up to 3 months of storage period at -20 °C. However, the change rate was higher in all unwashed and without pre-fried samples stored at -20 °C than in washed and pre-fried samples. The increment in TVBN and TMAN during storage could be due to the decomposition and degradation

of nitrogenous compounds as a result of microbial action. These findings are in line with those obtained by Khuntia *et al.* (1993).

Table 3. Changes in total volatile bases nitrogen (TVBN) and trimethylamine nitrogen (TMAN) (mg/100g) content of grass carp (*Ctenopharyngodon idella)* balls during storage for 3 months at -20 °C.

Treatments		Total volatile bases nitrogen (TVBN) (mg/100g)				Trimethylamine nitrogen (TMAN) (mg/100g)			
		Unwashed mince		Washed mince		Unwashed mince		Washed mince	
		With out fried	Pre-fried	With out fried	Pre-fried	With out fried	Pre-fried	With out fried	Pre-fried
Storage period months	0	10.36 ± 0.12 ^{a}	9.89 ± 0.11 ^{ab}	8.94 ± 0.12 ^{b}	8.63 ± 0.11 ^{bc}	1.97 ± 0.03 ^{a}	1.81 ± 0.02 ^{a}	1.72 ± 0.02 ^{a}	1.59 ± 0.01 ^{a}
	1	16.76 ± 0.13 ^{a}	11.18 ± 0.11 ^{c}	12.19 ± 0.12 ^{b}	9.80 ± 0.10 ^{d}	4.88 ± 0.08 ^{a}	2.14 ± 0.02 ^{c}	3.75 ± 0.03 ^{b}	1.97 ± 0.02 ^{c}
	2	21.80 ± 0.12 ^{a}	13.19 ± 0.13 ^{c}	17.62 ± 0.14 ^{b}	11.50 ± 0.11 ^{d}	8.73 ± 0.06 ^{a}	2.59 ± 0.02 ^{c}	7.05 ± 0.06 ^{b}	2.33 ± 0.05 ^{c}
	3	27.7 ± 0.17 ^{a}	15.78 ± 0.15 ^{c}	24.30 ± 0.20 ^{b}	13.75 ± 0.13 ^{d}	13.30 ± 0.12 ^{a}	3.09 ± 0.07 ^{c}	10.50 ± 0.09 ^{b}	2.73 ± 0.06 ^{c}

$^{a-d}$ Means within a raw with the same superscript significantly different ($P<0.05$).
Values are expressed as Mean ± SD.

Results presented in Table (4) showed the effect of storage period at -20°C on pH and thiobarbituric acid TBA value content of grass carp (*Ctenopharyngodon idella)* balls produced from unwashed mince (without fried and pre-fried) (UWM) and washed mince (without fried and pre-fried) (WM) during storage for 3 months at -20 °C. The analysis of variance for pH-values during storage period, showed that the pH-values slowly significantly decreased ($P<0.05$). The decrement in pH-values during storage period may be attributed to protein denaturation formation of amino acid nitrogen and free fatty acids which were produced in different amounts. These results are in line with those reported by Bello and Granados (1996).

Respecting the thiobarbituric acid TBA value used as an index for lipid oxidation taking place in fish and fish products, fish and fish products of good quality will have a TBA value less than 2.0, while, poorer quality fish will have TBA

value ranging between 3 and 27. Moreover, fish with TBA number greater than 27 will probably smell and taste rancid (Bonnell, 1994). Results shown in Table 3 indicated a significant increase in TBA value up to 3 months at -20 °C. The TBA value in the unwashed and without pre-fried samples significantly increased from 0.19 to 1.88 but in unwashed and pre-fried significantly increased from 0.13 to 0.83. While the TBA value in the washed and without pre-fried samples significantly increased from 0.11 to 1.39 and in washed and pre-fried significantly increased from 0.07 to 0.45 during frozen storage, respectively ($p < 0.05$) (Table 4). The increasing of the TBA value during frozen storage has been demonstrated by Bonnell, 1994.

Table 4. Changes in thiobarbituric acid values (TBA) (mg.malonldehyde / Kg.) and pH content of grass carp (*Ctenopharyngodon idella)* balls during storage for 3 months at -20 °C.

Treatments		Thiobarbituric acid values (TBA) (mg.malonldehyde / Kg.)				pH			
		Unwashed mince		Washed mince		Unwashed mince		Washed mince	
		With out fried	Pre-fried	With out fried	Pre-fried	With out fried	Pre-fried	With out fried	Pre-fried
Storage period months	0	0.19 ± 0.013 ^{a}	0.13 ± 0.012 ^{ab}	0.11 ± 0.010 ^{b}	0.07 ± 0.005 ^{bc}	6.55 ± 0.06 ^{a}	6.65 ± 0.05 ^{a}	6.60 ± 0.06 ^{a}	6.72 ± 0.05 ^{a}
	1	0.64 ± 0.016 ^{a}	0.32 ± 0.014 ^{c}	0.49 ± 0.015 ^{b}	0.19 ± 0.012 ^{d}	6.44 ± 0.05 ^{c}	6.59 ± 0.04 ^{ab}	6.50 ± 0.05 ^{b}	6.67 ± 0.04 ^{a}
	2	1.24 ± 0.021 ^{a}	0.55 ± 0.015 ^{c}	0.89 ± 0.017 ^{b}	0.31 ± 0.014 ^{d}	6.30 ± 0.04 ^{b}	6.51 ± 0.05 ^{ab}	6.38 ± 0.04 ^{b}	6.61 ± 0.05 ^{a}
	3	1.83 ± 0.042 ^{a}	0.83 ± 0.017 ^{c}	1.39 ± 0.031 ^{b}	0.45 ± 0.015 ^{d}	6.11 ± 0.03 ^{d}	6.42 ± 0.04 ^{b}	6.25 ± 0.02 ^{c}	6.53 ± 0.03 ^{a}

$^{a-d}$ Means within a raw with the same superscript significantly different ($P<0.05$).
Values are expressed as Mean ± SD.

Microbiological evaluation:

The achieved results presented in Table (5) showed the changes in total bacterial count TBC and psychrophilic bacterial count PsBC (Log_{10} CFU/g) of grass carp (*Ctenopharyngodon idella)* balls produced from unwashed mince (without fried and pre-fried) (UWM) and washed mince (without fried and pre-fried) (WM) during storage for 3 months at -20 °C. Results indicated that, the lowest levels of TBC 2.25 Log_{10} CFU/g was observed in washed, pre-fried minced grass carp (*Ctenopharyngodon idella)* after three months of storage period. However, the results showed significant decrease ($P<0.05$) in TBC in all samples up to 3 months of storage.

Table 5: Changes in total bacterial count (TBC) and psychrophilic bacterial count (Log_{10} CFU/g) content of grass carp (*Ctenopharyngodon idella)* balls during storage for 3 months at -20 °C.

Treatments		Total bacterial count (TBC) (Log10 CFU/g)				Psychrophilic bacterial count (Log10 CFU/g)			
		Unwashed mince		Washed mince		Unwashed mince		Washed mince	
		With out fried	Pre-fried	With out fried	Pre-fried	With out fried	Pre-fried	With out fried	Pre-fried
Storage period months	0	3.91 ± 0.033 ^{a}	3.50 ± 0.031 ^{c}	3.68 ± 0.032 ^{b}	3.37 ± 0.030 ^{cd}	1.20 ± 0.015 ^{a}	0.97 ± 0.014 ^{bc}	1.05 ± 0.014 ^{b}	0.86 ± 0.013 ^{c}
	1	3.45 ± 0.031 ^{a}	3.09 ± 0.025 ^{c}	3.32 ± 0.027 ^{b}	3.07 ± 0.024 ^{c}	1.51 ± 0.016 ^{a}	1.25 ± 0.012 ^{bc}	1.35 ± 0.013 ^{b}	1.06 ± 0.009 ^{c}
	2	3.07 ± 0.023 ^{a}	2.75 ± 0.021 ^{b}	2.93 ± 0.024 ^{ab}	2.69 ± 0.021 ^{bc}	1.92 ± 0.017 ^{a}	1.55 ± 0.013 ^{bc}	1.67 ± 0.014 ^{b}	1.34 ± 0.011 ^{c}
	3	2.60 ± 0.020 ^{a}	2.33 ± 0.017 ^{bc}	2.46 ± 0.018 ^{b}	2.25 ± 0.015 ^{c}	2.40 ± 0.021 ^{a}	1.95 ± 0.017 ^{bc}	2.10 ± 0.019 ^{b}	1.72 ± 0.015 ^{c}

$^{a-c}$ Means within a raw with the same superscript significantly different ($P<0.05$).
Values are expressed as Mean ± SD.

On the other side, PsBC showed significant increase ($P<0.05$) with the progress of storage time. The fresh samples recorded 1.20 and 0.97 (Log_{10} CFU/g) for unwashed (without fried and pre-fried) and 1.05 and 0.86 (Log_{10} CFU/g) for washed (without fried and pre-fried), respectively, at the beginning of storage

period. Although, the count of psychrophilic bacteria was significant increase ($P<0.05$) by storage. On the other side, count for unwashed (without fried and pre-fried) were 2.40 and 1.95 (Log_{10} CFU/g), and 2.10 and 1.72 (Log_{10} CFU/g) for washed (without fried and pre-fried) respectively, after the end of storage period at –20°C.

Generally, the reduction in numbers of microorganisms as indicated previously may be due to the mechanical damage of bacterial cell caused by freezing and thawing on the microflora contaminating flesh fish samples.

However, the psycrophilic bacteria gave high values throughout storage period which may be due to the presence of psycrophilic spors forming bacteria which are again activated by freezing. These results are in agreement with those obtained by Boknaes *et. al* (2000). and Aaraas *et al* (2004).

Sensory Evaluation:

The sensory scores of color and flavor of grass carp (*Ctenopharyngodon idella)* balls produced from unwashed mince (without fried and pre-fried) (UWM) and washed mince (without fried and pre-fried) (WM) during storage for 3 months at -20 °C are illustrated in Table (6). The color and flavor scores decreased significantly ($P<0.05$) with each increase in the storage period. The washed and pre-fried received higher scores than the other treatments during storage period at -20 °C.

From Table (7), data indicated that the effect of storage at –20°C for 3 months on appearance and overall acceptability scores of grass carp (*Ctenopharyngodon idella)* balls produced from unwashed mince (without fried and pre-fried) (UWM) and washed mince (without fried and pre-fried) (WM). The analysis of the grades, showed that the scores were significantly decrease ($P<0.05$) during storage period. Unwashed and without pre-fired minced grass carp (*Ctenopharyngodon idella)* had lowest scores of sensory properties, they had 7.0 it's actually evaluated as "Good". The gradual decrease in color, flavor, appearance and overall acceptability during storage period at -20 °C could be attributed to the protein hydrolysis and its degradative products; total volatile basis nitrogen (TVBN), and fat oxidation which are considered as major factors of changes in organoleptic properties. Kyung *et al.* (2002) reported similar results.

Table 6: Changes in color and flavor of grass carp (*Ctenopharyngodon idella)* balls during storage for 3 months at -20 °C.

Treatments		Color				Flavor			
		Unwashed mince		Washed mince		Unwashed mince		Washed mince	
		With out fried	Pre-fried	With out fried	Pre-fried	With out fried	Pre-fried	With out fried	Pre-fried
Storage period months	0	8.5 ± 0.11 ^{c}	9.2 ± 0.12 ^{ab}	9.0 ± 0.012 ^{b}	9.6 ± 0.012 ^{a}	8.7 ± 0.11 ^{c}	9.2 ± 0.12 ^{ab}	9.0 ± 0.11 ^{b}	9.5 ± 0.12 ^{a}
	1	8.0 ± 0.09 ^{c}	8.9 ± 0.08 ^{ab}	8.6 ± 0.07 ^{b}	9.3 ± 0.011 ^{a}	8.3 ± 0.11 ^{c}	8.8 ± 0.08 ^{ab}	8.5 ± 0.07 ^{b}	9.3 ± 0.11 ^{a}
	2	7.4 ± 0.07 ^{c}	8.5 ± 0.08 ^{ab}	8.1 ± 0.08 ^{b}	8.9 ± 0.09 ^{a}	7.7 ± 0.06 ^{c}	8.5 ± 0.07 ^{b}	8.0 ± 0.07 ^{bc}	9.0 ± 0.09 ^{a}
	3	6.6 ± 0.05 ^{c}	7.8 ± 0.07 ^{b}	7.5 ± 0.06 ^{bc}	8.5 ± 0.07 ^{a}	7.0 ± 0.07 ^{d}	8.1 ± 0.07 ^{b}	7.5 ± 0.06 ^{c}	8.6 ± 0.07 ^{a}

$^{a-c}$ Means within a raw with the same superscript significantly different (P<0.05).
Values are expressed as Mean ± SD.

Table 7: Changes in appearance and over all acceptability of grass carp (*Ctenopharyngodon idella)* balls during storage for 3 months at -20 °C.

Treatments		Appearance				Over all acceptability			
		Unwashed mince		Washed mince		Unwashed mince		Washed mince	
		With out fried	Pre-fried	With out fried	Pre-fried	With out fried	Pre-fried	With out fried	Pre-fried
Storage period months	0	8.1 ± 0.07 ^{d}	9.0 ± 0.08 ^{b}	8.5 ± 0.07 ^{c}	9.5 ± 0.08 ^{a}	84.3 ± 0.9 ^{d}	91.3 ± 1.1 ^{b}	88.3 ± 0.9 ^{c}	95.3 ± 1.5 ^{a}
	1	7.8 ± 0.06 ^{c}	8.6 ± 0.07 ^{b}	8.3 ± 0.07 ^{bc}	9.2 ± 0.08 ^{a}	80.3 ± 0.7 ^{d}	87.6 ± 0.9 ^{b}	84.6 ± 0.8 ^{c}	92.6 ± 1.2 ^{a}
	2	7.5 ± 0.06 ^{c}	8.2 ± 0.07 ^{b}	7.8 ± .06 ^{bc}	8.7 ± 0.07 ^{a}	75.3 ± 0.6 ^{d}	84.0 ± 0.9 ^{b}	79.6 ± 0.7 ^{c}	88.6 ± 1.0 ^{a}
	3	7.0 ± 0.06 ^{c}	7.7 ± 0.07 ^{b}	7.4 ± 0.06 ^{bc}	8.4 ± 0.07 ^{a}	68.6 ± 0.6 ^{d}	81.6 ± 0.8 ^{b}	74.6 ± 0.7 ^{c}	85.0 ± 0.9 ^{a}

$^{a-d}$ Means within a raw with the same superscript significantly different (P<0.05).
Values are expressed as Mean ± SD.

Accordingly, the operations of washing and pre-frying affect the quality of minced fish used in the production of fish balls, as the washing and frying of minced was the best transaction in relation to others unwashed during storage, and hance the possibility of using minced of grasse carp in the prodution of balls fish acceptable consumption with a high degree.

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تأثير بعض العمليات التكنولوجية على جودة مفروم سمك مبروك الحشائش خلال التخزين بالتجميد

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الملخص العربى

تمت هذه الدراسة لتقييم التغيرات فى بعض الخواص الفيزيوكيميائية، الكيميائية، الميكروبيولوجية والحسية لكرات السمك المجهزة من مفروم سمك مبروك الحشائش (بدون غسيل وكذلك المفروم المغسول) التى تم تخزينها على صورتين (بدون قلى، قلى اولى) لمدة ثلاثة اشهر بالتجميد على – ٢٠ م°.

وقد أظهرت النتائج انخفاض فى كل من محتوى الرطوبة، البروتين الخام، الدهن، الرماد لمفروم سمك مبروك الحشائش الغير مغسول والمفروم المغسول وكان الانخفاض واضحا بعد الاضافات (ملح، سكر، دقيق، كمون، بصل، ثوم، فلفل اسمر، زعتر) التى تم اضافتها للمفروم سواء الغير مغسول او المغسول. كما أوضحت النتائج ان السائد من الأحماض الدهنية المشبعة (C16:0) بينما السائد من الأحماض الدهنية احادية عدم التشبع (C18:1) كذلك السائد من الأحماض الدهنية عديدة عدم التشبع (C18:2) فى عينات المفروم الغير مغسولة والمغسولة قبل وبعد الإضافات. كما أوضحت النتائج أنه خلال فترة التخزين انخفاض قليل فى قيم الـpH ، العدد الكلى للبكتريا ودرجات التقييم الحسى (اللون والرائحة والمظهر والقابلية العامة). بينما حدث ارتفاع فى كل من المركبات النيتروجينية الكلية الطيارة، مستوى الأمين ثلاثى الميثيل، حمض الثيوباربتيوريك وعدد البكتريا المحبة للبرودة فى كل العينات حتى نهاية فترة التخزين بالتجميد على -٢٠ م° لمدة ثلاثة أشهر.

وقد عكست تلك النتائج، أن افضل المعاملات خلال فترة التخزين بالتجميد على -٢٠ م° لمدة ثلاثة أشهر كانت لكرات السمك المغسولة والمقلية قلى اولى مقارنة بالمعاملات الأخرى.