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EVALUATION OF THE PROTEIN QUALITY OF FROZEN COMMON CARP (*CYPRINUS CARPIO* L.)

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Abstract

Common carp fillets and minced samples were periodically withdrawn and analyzed for water hading capacity WHC, Foaming capacity FC, Emulsification capacity EC, Total soluble protein TSP, Soluble protein nitrogen SPN and Soluble non protein nitrogen SNPN as quality criteria for common carp *Cyprinus carpio L.* Fillets and machine minced flesh blocks packaged in ice-glaze film or polyethylene bags were evaluated over a 6-months period during storage at –20°C. Results showed that WHC, FC and EC gradually decreased in all treatments, also, TSN, SPN and SNPN showed slowly decrease in all samples during storage period. Fillets blocks were much more stable than minced blocks, especially, those which were packaged in ice-glaze film compared with those packaged in polyethylene bags.

INTRODUCTION

Freezing is an excellent method for preserving the organoleptic attributes and protein functionality of fish flesh during prolonged periods of time. Depending on intrinsic factors such as species and season and technological factors such as handling practices previous to freezing, freezing rate, temperature of storage, or presence of protective barriers against oxidation, the practical storage life of frozen fish may vary substantially. Therefore, the quality of fish found on sale is not always good, due to reasons ranging from unsuitable raw material to bad handling practices or storage conditions. This is also a problem for processing industries that have to purchase fish stocks of irregular quality, which may deteriorate at different rates during processing and retail sale. Although good handling and storage practices are broadly known, sometimes, due to technological or economical factors, they cannot be completely followed. The end of practical storage life is reflected as a fibrous, dry product which becomes tough and which has lost important functional properties. Understanding the underlying mechanisms involved in the deterioration of fish, flesh and the interactions among them would lead one to find parameters to establish fish quality and also help predict

practical storage life for each stock, with subsequent economic advantage for the fisheries sector and consumers (Careche *et al.*, 1999).

When hake *Merluccius spp* fillet or mince is frozen and cold stored, unfavorable changes take place in the texture and appearance. Toughness increases and water binding capacity decreases (Shenouda, 1980).

Matsumoto (1980) and Owusu-Ansah & Hultin (1992) revealed that the differential insolubilization observed in both sarcoplasmic and contractile proteins may be important in textural deterioration of red hake. Sarcoplasmic proteins are nonstructural proteins and, therefore, not generally considered to contribute to textural deterioration of fish muscle. However, by becoming insoluble either by adsorption onto insoluble structural proteins or by denaturation, water soluble proteins might significantly affect the texture of fish.

Owusu-Ansah (1984) showed that protein cross linking could, occur in and among sarcoplasmic and contractile proteins. Proteins would more readily react with formaldehyde (HCHO) based on their inherent susceptibility due to exposed side chains and/or to their location relative to where the HCHO is produced.

Li-Chan *et al.* (1985) reported that properties of proteins in salt extracts from rockfish fillet changed upon freezing, freezing decreased dispersibility, increased surface hydrophobicity and slightly decreased sulfhydryl content. Emulsifying and fat binding properties followed parallel trends, being improved under conditions favouring.

Sarma *et al.* (1999) investigated the effects of ice storage on functional properties of pink perch *Nemipterus japonicus* and Indian oil sardine *Sardinella longiceps* proteins, and declared decreased emulsifying capacity EC, relative viscosity RV and water binding capacity WBC, as well as, an increase in cook loss CL in both fish species; water and salt-soluble proteins also decreased during ice storage. Significant ($P<0.05$) correlations between the various functional properties analyzed indicated their interdependence on changes in soluble proteins.

Suvanich *et al.* (2000) demonstrated that salt soluble protein SSP decreased during frozen storage, while, expressible moisture increased during frozen storage, quality changes of fish muscle are normally due to autolytic chemical reactions, microbial proliferation, and physical property alterations that consequently cause functionality of end products and reduce shelf life.

The primary aim of the present work was study the effect of storage period at

–20°C on function properties of common carp frame fillets or minced packaged in ice-glaze film or polyethylene bags for 6-months. This could help to determine and predict the commercial quality of the fish.

MATERIALS AND METHODS

Preparation of samples

Sample lots of round fish common carp *Cyprinus carpio L.* were immediately obtained after catching from Abbassa fish farm at Sharkia governorate, Egypt. Intact flesh separated by hand filleting was obtained from thoroughly washed, eviscerated and beheaded, minced a half of lots flesh. Fillets and minced flesh were placed in 3x10x20 cm stainless steel trays and frozen into blocks at –30°C for twelve hours. The blocks were removed from the freezer and a half of fillets and minced flesh blocks were ice glazed received two replicate short exposures to ice water allowing for approximately one hour at –30°C between exposures. All treatments included : 1) fillets blocks packaged in ice-glazed film, 2) fillets blocks packaged in polyethylene bags, 3) minced blocks packaged in ice- glazed film, 4) minced blocks were packaged in polyethylene bags, and stored at –20°C. Sensory evaluations, microbiological count and chemical analysis were carried out at 0, 1, 2, 3, 4, 5 and 6 months storage.

At the end of every freezing period (30 days), samples were withdrawn at random, aseptically thawed at room temperature, cut into small pieces, mixed and chopped in electric meat chopper and were then analyzed. All analysis was run in triplicate.

Analysis:

The water holding capacity (WHC) was determined using the press method according to Volvinskaya and Kelman (1960). Foaming capacity (FC) was measured in two grams material blended with 100ml distilled water in an electric blender for 3 min. The blend was poured slowly into a 250ml measuring cylinder, and the volume was recorded after 10 sec. FC was calculated as described by Lowhon *et al.* (1972).

$$\text{Foaming capacity} = \frac{\text{Volume after whipping - Volume before whipping}}{\text{Volume before whipping}} \times 100$$

Emulsification capacity (EC) was determined according to Beuchat *et al.* (1975). EC was expressed as ml oil emulsified by grams of flesh mince. Total soluble nitrogen

(TSN), Soluble protein nitrogen (SPN) and Soluble non-protein nitrogen (SNPN) were determined according to the method described by Kline and Stewart (1949).

Statistical Analysis

Three replications of each trial were performed WHC, FC, EC, TSN, SPN and SNPN data were analyzed using ANOVA and means were separated by Duncan at a probability level of < 0.05 (SAS, 2000).

RESULTS AND DISCUSSION

Water holding capacity (WHC)

One of the most important features of flesh fish quality is its water holding capacity, which is closely related to tenderness and other properties of flesh fish quality as taste, juiciness and colour.

Results given in Table 1 showed the effect of freezing storage on water holding capacity of fillets and minced common carp blocks packaged in ice-glaze film and polyethylene bags. Data showed the WHC significantly and gradually decreased ($p<0.05$) throughout the storage period till 90 days, where after an increase was observed. The decrement in WHC during freezing storage may be attributed to the mechanical loose of the muscle tissue by the formation of ice-crystals inside the cells.

Generally, the lowest WHC was found for minced blocks packaged in polyethylene. It was 56.1% at the end of storage period at –20°C compared with the other treatments. The obtained data are in agreement with those reported by Sarma *et al.* (1999) and Suvanich *et al.* (2000).

Foaming capacity (FC)

Our results presented in Table 2 showed the effect of storage period at –20°C on Foaming capacity (FC)% of common carp frame fillets or minced packaged in ice-glaze film and polyethylene bags. The analysis of FC%, indicated a significant decrease ($p<0.05$) in fillets blocks packaged in ice-glaze film at –20°C (95.7%) at the end of 6-months of storage, and followed in order by the fillets blocks packaged in polyethylene bags (92.5%); minced blocks packaged in ice-glaze film (89.6%) and in polyethylene bags (85.5%), respectively. The differences in FC of the treatments may be due to the nature of the protein and the relative abilities of these proteins to denature and lower the surface tension at the air-liquid interface of the foam. These results are in line with those obtained by Kinsella, (1979) and Vghela and A. Kilara (1996).

Emulsifying capacity (EC)

Results presented in Table 3 indicated that the emulsifying capacity EC levels (ml. Oil/g) were affected by all treatments. Results indicated significantly a gradual decrease ($p<0.05$) in EC up to 6-months of storage period. Data showed that the lowest level of EC was found in minced blocks packaged in polyethylene bags at –20°C, 35.3ml oil/g. at the end of 6-months. The highest level of EC was fillets blocks packaged in ice-glaze film at –20°C 39.5ml oil/g at the end of storage period (6-months), suggesting that the difference in EC was due to the solubilised proteins. These results are in harmony with those obtains by Li-Chan *et al.* (1985), Vghela and A. Kilara (1996) and Sarma *et al.* (1999).

Total soluble nitrogen (TSN), Soluble protein nitrogen (SPN) and Soluble non-protein nitrogen (SNPN)

Data obtained in Tables 4, 5, & 6 indicated a significant slow and gradual decrease ($p<0.05$) in both TSN and SPN, as well as, a significant and gradual increase ($p<0.05$) in SNPN observed throughout the 6-months storage at –20°C. The data of Careche and Tejada (1990), De-Koning and Mol (1991), Owusu-Ansah and Hultin (1992), Vghela and Kilara (1996), Sarma (1999) and Suvanich *et al.* (2000) supported the present results. The decrease in proteins extractability could be attributed to a denaturation in proteins. These results mean that the proteolytic enzymes are still active under freezing storage, and that led proteins under breakdown simpler compounds under the effect of the complex enzymatic systems.

Data illustrated in Tables 4, 5 & 6 revealed the results of TSN, SPN and SNPN for fresh samples 3.2%, 1.45% and 1.75%, respectively. After 6-months of storage they reached to 2.7, 2.85, 2.8 and 2.9% for TSN, 0.73, 0.77, 0.76, and 0.78% for SPN and 1.97, 2.08, 2.04, and 2.12% for SNPN for fillets blocks packaged in ice-glaze film or polyethylene bags, minced blocks packaged in ice-glaze film and polyethylene bags, respectively.

It is of interest to announce that dissection and loss of water, especially at surface layers of flesh fish cuts enhanced the denaturation and protein insolubility.

From the results, the data reflected that the intact fillets blocks packaged in ice-glaze can possess good quality during storage period for 6-months at –20°C, compared with quality characteristics in fillets blocks packaged in polyethylene bags and minced blocks packaged in ice-glaze film or polyethylene bags stored at the same conditions.

Table 1. Water Holding capacity (WHC) levels (%) in common carp fillets and minced blocks, packaged in ice-glaze film or polyethylene bags during storage at –20°C for 6-months.

Parameter		W.H.C. (%)			
Flesh form		Fillets		Minced	
Packaging		Ice-glaze	Polyethylene	Ice-glaze	Polyethylene
Storage period (Months)	0	a 61.2 ± 0.01 A	a 61.2 ± 0.05 A	a 61.2 ± 0.04 A	a 61.2 ± 0.07 D
	1	a 58.6 ± 0.05 B	b 57.7 ± 0.07 B	b 57.1 ± 0.06 B	c 56.4 ± 0.09 B
	2	a 56.5 ± 0.02 C	b 55.0 ± 0.04 C	c 53.9 ± 0.04 C	cd 52.7 ± 0.06 C
	3	a 54.6 ± 0.03 D	b 53.2 ± 0.05 D	c 51.8 ± 0.03 D	d 50.5 ± 0.05 D
	4	a 55.4 ± 0.04 CD	b 54.3 ± 0.06 C	c 52.8 ± 0.05 CD	cd 51.9 ± 0.08 C
	5	a 56.6 ± 0.01 C	ab 55.8 ± 0.08 BC	c 54.4 ± 0.03 C	bc 53.7 ± 0.05 BC
	6	a 58.4 ± 0.02 B	ab 57.7 ± 0.02 B	b 56.9 ± 0.04 B	b 56.1 ± 0.05 B

[a-d] Means within a raw with the same superscript are significantly different ($p<0.05$).

[A-D] Means within a column with the same superscript are significantly different ($p<0.05$).

Table 2. Foaming capacity levels (%) in common carp fillets and minced blocks, packaged in ice-glaze film or polyethylene bags during storage at –20°C for 6-months.

Parameter		Foaming capacity (%)			
Flesh form		Fillets		Minced	
Packaging		Ice-glaze	Polyethylene	Ice-glaze	Polyethylene
Storage period (Months)	0	a 110.7 ± 0.1 A	a 110.7 ± 0.2 A	a 110.7 ± 0.2 A	a 110.7 ± 0.3 A
	1	a 105.6 ± 0.2 B	ab 104.6 ± 0.5 B	b 103.4 ± 0.3 B	bc 102.5 ± 0.5 B
	2	a 102.9 ± 0.1 BC	b 101.0 ± 0.3 BC	c 99.8 ± 0.2 B	d 97.6 ± 0.4 C
	3	a 100.3 ± 0.2 C	b 97.9 ± 0.2 C	b 96.7 ± 0.3 C	c 94.0 ± 0.3 C
	4	a 98.5 ± 0.3 C	b 95.4 ± 0.3 D	c 93.7 ± 0.4 CD	d 91.0 ± 0.5 D
	5	a 97.1 ± 0.2 CD	b 93.7 ± 0.4 D	c 91.6 ± 0.2 D	d 88.1 ± 0.3 D
	6	a 95.7 ± 0.1 D	b 92.5 ± 0.3 DE	c 89.6 ± 0.2 DE	d 85.5 ± 0.4 E

[a-d] Means within a raw with the same superscript are significantly different ($p<0.05$).

[A-E] Means within a column with the same superscript are significantly different ($p<0.05$).

Table 3. Emulsifing capacity (EC) levels (ml. Oil/g.) in common carp fillets and minced blocks, packaged in ice-glaze film or polyethylene bags during storage at –20°C for 6-months.

Parameter		EC (ml. Oil/g. mince)			
Flesh form		Fillets		Minced	
Packaging		Ice-glaze	Polyethylene	Ice-glaze	Polyethylene
Storage period (Months)	0	a 45.7 ± 0.01 A	a 45.7 ± 0.01 A	a 45.7 ± 0.01 A	a 45.7 ± 0.02 A
	1	a 43.6 ± 0.02 B	a 43.2 ± 0.02 B	ab 42.7 ± 0.01 B	b 42.3 ± 0.02 B
	2	a 42.5 ± 0.01 BC	ab 41.7 ± 0.02 C	b 41.2 ± 0.01 C	c 40.3 ± 0.02 C
	3	a 41.4 ± 0.03 C	b 40.4 ± 0.04 CD	bc 39.9 ± 0.02 CD	c 38.8 ± 0.03 CD
	4	a 40.7 ± 0.01 CD	b 39.4 ± 0.03 D	bc 38.7 ± 0.01 D	c 37.6 ± 0.02 D
	5	a 40.1 ± 0.02 D	b 38.7 ± 0.05 DE	bc 37.8 ± 0.03 DE	c 36.4 ± 0.04 DE
	6	a 39.5 ± 0.01 D	b 38.2 ± 0.02 E	c 37.0 ± 0.01 E	d 35.3 ± 0.02 E

[a-d] Means within a raw with the same superscript are significantly different ($p<0.05$).
[A-E] Means within a column with the same superscript are significantly different ($p<0.05$).

Table 4. Total soluble nitrogen (TSN) levels (%) in common carp fillets and minced blocks, packaged in ice-glaze film or polyethylene bags during storage at –20°C for 6-months.

Parameter		TSN %			
Flesh form		Fillets		Minced	
Packaging		Ice-glaze	Polyethylene	Ice-glaze	Polyethylene
Storage period (Months)	0	a 3.2 ± 0.002 A	a 3.2 ± 0.004 A	a 3.2 ± 0.002 A	a 3.2 ± 0.005 A
	1	ab 3.03 ± 0.001 A	a 3.08 ± 0.003 A	a 3.06 ± 0.002 A	a 3.1 ± 0.003 A
	2	a 2.96 ± 0.003 AB	a 3.02 ± 0.005 A	a 3.0 ± 0.001 A	a 3.05 ± 0.002 A
	3	a 2.9 ± 0.003 B	a 2.97 ± 0.004 AB	a 2.94 ± 0.003 B	a 3.0 ± 0.004 A
	4	ab 2.85 ± 0.001 BC	ab 2.92 ± 0.001 B	ab 2.89 ± 0.001 BC	a 2.96 ± 0.002 AB
	5	b 2.81 ± 0.002 C	ab 2.88 ± 0.003 BC	b 2.84 ± 0.001 C	a 2.92 ± 0.001 B
	6	c 2.7 ± 0.001 D	ab 2.85 ± 0.003 BC	b 2.8 ± 0.002 C	a 2.9 ± 0.002 B

[a-c] Means within a raw with the same superscript are significantly different ($p<0.05$).
[A-D] Means within a column with the same superscript are significantly different ($p<0.05$).

Table 5. Soluble protein nitrogen (SPN) levels (%) in common carp fillets and minced blocks, packaged in ice-glaze film or polyethylene bags during storage at –20°C for 6-months.

Parameter		SPN %			
Flesh form		Fillets		Minced	
Packaging		Ice-glaze	Polyethylene	Ice-glaze	Polyethylene
Storage period (Months)	0	a 1.45 ± 0.001 A	a 1.45 ± 0.001 A	a 1.45 ± 0.002 A	a 1.45 ± 0.002 A
	1	a 1.21 ± 0.002 B	a 1.22 ± 0.002 B	a 1.22 ± 0.001 B	a 1.23 ± 0.003 B
	2	a 1.1 ± 0.001 BC	a 1.11 ± 0.001 BC	a 1.11 ± 0.001 BC	a 1.11 ± 0.001 BC
	3	a 1.0 ± 0.002 C	a 1.01 ± 0.003 C	a 1.0 ± 0.001 C	a 1.0 ± 0.003 C
	4	a 0.92 ± 0.001 CD	a 0.92 ± 0.001 CD	a 0.91 ± 0.002 CD	a 0.91 ± 0.002 CD
	5	a 0.86 ± 0.001 CD	ab 0.84 ± 0.001 CD	ab 0.82 ± 0.001 CD	ab 0.83 ± 0.001 CD
	6	ab 0.73 ± 0.001 D	a 0.77 ± 0.001 CD	a 0.76 ± 0.002 CD	a 0.78 ± 0.002 CD

[a-b] Means within a raw with the same superscript are significantly different ($p<0.05$).

[A-D] Means within a column with the same superscript are significantly different ($p<0.05$).

Table 6. Soluble non protein nitrogen (SNPN) levels (%) in common carp fillets and minced blocks, packaged in ice-glaze film or polyethylene bags during storage at –20°C for 6-months.

Parameter		SNPN %			
Flesh form		Fillets		Minced	
Packaging		Ice-glaze	Polyethylene	Ice-glaze	Polyethylene
Storage period (Months)	0	a 1.75 ± 0.002 B	a 1.75 ± 0.003 BC	a 1.75 ± 0.003 BC	a 1.75 ± 0.004 C
	1	ab 1.82 ± 0.001 B	a 1.86 ± 0.002 B	ab 1.84 ± 0.001 BC	a 1.87 ± 0.002 BC
	2	a 1.86 ± 0.002 AB	a 1.91 ± 0.003 B	a 1.89 ± 0.001 B	a 1.94 ± 0.003 BC
	3	ab 1.9 ± 0.001 AB	a 1.96 ± 0.001 AB	ab 1.94 ± 0.001 B	a 2.0 ± 0.001 B
	4	b 1.93 ± 0.001 AB	ab 2.0 ± 0.002 AB	ab 1.98 ± 0.001 AB	a 2.05 ± 0.002 AB
	5	ab 1.95 ± 0.002 A	ab 2.04 ± 0.001 AB	ab 2.02 ± 0.001 A	a 2.09 ± 0.001 A
	6	b 1.97 ± 0.001 A	ab 2.08 ± 0.002 A	b 2.04 ± 0.002 A	a 2.12 ± 0.003 A

[a-b] Means within a raw with the same superscript are significantly different ($p<0.05$).

[A-C] Means within a column with the same superscript are significantly different ($p<0.05$).

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تقييم جودة بروتين المبروك العادى المجمد

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أجريت هذه الدراسة لتقييم الخواص الطبيعية والوظيفية لبروتين سمك المبروك العادى المأخوذ من مزارع المعمل المركزى لبحوث الثروة السمكية بالعباسة - محافظة الشرقية. حيث تمت دراسة القدرة على ربط الماء ، سعة الرغوة ، سعة الاستحلاب ، النيتروجين الكلى الذائب ، النيتروجين البروتينى الذائب والنيتروجين الغير بروتينى الذائب كمقياس لجودة شرائح أو مفروم المبروك العادى المخزن بالتجميد لمدة ستة أشهر على صورة بلوكات مغلفة إما بطبقة رقيقة من الثلج (التزجيج) أو بغلاف من البولى إثيلين. أوضحت النتائج حدوث انخفاض تدريجى فى كل من مستويات القدرة على ربط الماء ، سعة الرغوة وكذلك سعة الاستحلاب خلال فترة التخزين. أظهرت النتائج أيضاً انخفاضاً بمعدلٍ قليل فى كل المعاملات المختلفة سالفة الذكر خلال فترة التخزين على درجة - ٢٠°م لمدة ستة أشهر. من هذه النتائج أيضاً اتضح أن بلوكات شرائح المبروك كانت أكثر ثباتاً من بلوكات مفروم المبروك العادى ، خاصة بلوكات الشرائح المحاطة بطبقة رقيقة من الثلج (التزجيج) مقارنة بتلك المغلفة بالبولى إثيلين.