Abbassa Int. J. Aqua., V0l.4 No.(1) 2011. *14 -26*

EFFECT OF GLAZING OR POLYETHYLENE PACKING OF SILVER CARP *HYPOPHTHALMICHTHYS MOLITRIX* FILLETS AND MINCED ON THE PROTEIN PROPERTIES DURING FROZEN STORAGE

Ibrahim F. Mohamed

Processing and Quality Control Department, Central Laboratory for Aquaculture Research, Agricultural Research Center, Ministry of Agriculture, Egypt.

Received 9/ 3/ 2011 *Accepted 5/ 4/ 2011*

Abstract

The objective of the present work was to study effect of glazing or polyethylene packing of silver carp *hypophthalmichthys molitrix* fillets and minced on the functional protein properties during frozen storage at –20°C, samples were analyzed for water holding 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 silver carp *Hypophthalmichthys molitrix.* Samples were evaluated over a 6-months period during storage at –20°C.

Results showed that WHC, FC and EC gradually decrease in all treatments, also TSN, SPN and SNPN showed slowly decrease in all samples during storage period. But fillets blocks were much more stable than minced blocks, especially that which was 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. There fore, 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 of the underling 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).

Functional properties correlated with protein solubility. Significant variations in protein solubility (PS), emulsifying capacity (EC), water binding capacity (WBC), texture scores and thaw drip values during frozen storage suggested these properties may be valuable indicators for determining alterations in functional characteristics of fish proteins (Reddy and Srikar, 1991). 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. Badii and Howell (2002) studied that, the Changes in the muscle proteins of frozen cod fillets, which a rapid decrease in solubility of proteins, increase in hydrophobicity and decrease in the amino acid content of salt-soluble proteins at −10 compared with −30°C were observed in both species. The results showed that there were no significant differences in the nature of the protein changes between these two species, thus indicating that factors other than formaldehyde were involved in the denaturation of proteins and the formation of aggregates during frozen storage of cod and haddock fillets, especially at −10°C. Abugoch *et al.* (2006) found that, for samples frozen at -18 °C and -30 °C, the protein contents were 23.5 + 0.0 and 25.4 + 1.0%, respectively. The WRC values were 0.45 + 0.1 and 1.59 +/- 0.0 g water/g protein, respectively. The gel forming capacity was only present in the fresh samples, whereas the frozen stored ones only form protein aggregates. The emulsifying capacity was between 960 and 1400 g oil / g protein, and the storage time increased this value. Nopianti *et al.* (2010) reported that, the functional properties of the myofibrillar proteins in the raw surimi deteriorate rapidly during freezing: the freezing process causes ice crystals to form, which results in the dehydration of the myofibrillar protein, a pH decrease and a change in salt concentrations. These three effects, in addition to various hydrophobic interactions, denature and/or aggregate the frozen myofibrillar proteins in surimi. Furthermore, the longer the surimi is frozen, the greater is the degree of protein denaturation .

The primary aim of the present work was study the effect of storage period at –20°C on function properties of silver 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

Samples:

Round fish silver carp *Hypophthalmichthys molitrix* were immediately obtained after catching. 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 3×10×20 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: 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 packaged in polyethylene bags, and stored at –20°C. Function properties were carried out at 0, 1, 2, 3, 4, 5 and 6 months storage.

At the end of every freezing period (one month), samples were withdrawn at random, aseptically thawed at room temperature and were then analyzed. All analysis was run in triplicate.

Analysis:

The water holding capacity (WHC) was determined using the press method according to Volvinskaga 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).

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

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 performed (WHC, FC, EC, TSN, SPN and SNPN) data 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 DESCUSSION

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 color.

The effect of freezing storage on water holding capacity of fillets and minced silver carp blocks packaged in ice-glaze film and polyethylene bags showed in Table (1). 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, while the increase after 90 days of storage period may be due to pH-value changes in the fish muscles.

Generally, the lowest WHC was found for minced blocks packaged in polyethylene, it was 56.0% at the end of storage

period at –20°C compared with the other treatments. The obtained data are in agreement with those reported by Reddy and Srikar (1991); Sarma *et al*. (1999); Suvanich *et al*. (2000) and Abugoch *et al.* (2006).

Table 1. Showed water holding capacity (WHC) levels (%) in silver 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**	62.7±0.1[a]	62.7±0.04[a]	62.7±0.05[a]	62.7±0.07[a]
	1	60.0±0.05[a]	58.5±0.06[b]	59.1±0.07[ab]	57.8±0.09[bc]
	2	57.9±0.02[a]	55.3±0.04[c]	56.4±0.04[b]	54.1±0.06[d]
	3	55.9±0.03[a]	53.1±0.03[c]	54.5±0.05[b]	51.8±0.05[d]
	4	56.7±0.04[a]	54.1±0.05c	55.6±0.06[b]	53.2±0.08[d]
	5	57.8±0.01[a]	55.6±0.03[c]	56.8±0.08[b]	54.9±0.05[cd]
	6	59.6±0.02[a]	57.1±0.04[c]	58.3±0.02[b]	56.0±0.05[b]

[a-d] Means having the same letter in the same raw are significantly different at $p<0.05$.

Foaming capacity (FC):

Results presented in Table (2) showed the effect of storage period at –20°C on Foaming capacity (FC)% of silver carp frame fillets or minced packaged in ice-glaze film or polyethylene bags. The analysis of FC%, indicated a significant decrease ($p<0.05$) in fillets blocks packaged in ice-glaze film at –20°C (99.4%) at the end of 6-months of storage, and followed in order by the minced blocks packaged in ice-glaze film (96.2%); fillets blocks packaged in polyethylene bags (93.3%) and in polyethylene bags (89.2%), 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 Badii and Howell (2002) and Abugoch *et al.* (2006).

Table 2. Showed foaming capacity levels (%) in silver 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**	116.1±0.1^{a}	116.1±0.2^{a}	116.1±0.2^{a}	116.1±0.3^{a}
	1	110.6±0.2^{a}	108.4±0.2^{b}	109.6±0.3^{ab}	107.5±0.2^{bc}
	2	107.6±0.1^{a}	104.5±0.2^{bc}	105.7±0.3^{b}	102.3±0.1^{c}
	3	104.8±0.2^{a}	101.2±0.3^{bc}	102.4±0.2^{b}	98.5±0.3^{c}
	4	102.7±0.3^{a}	97.9±0.2^{c}	99.6±0.3^{b}	95.2±0.2^{d}
	5	101.1±0.2^{a}	95.6±0.2^{c}	97.7±0.2^{b}	92.1±0.3^{d}
	6	99.4±0.1^{a}	93.3±0.2^{c}	96.2±0.3^{b}	89.2±0.2^{d}

$^{a-d}$ Means having the same letter in the same raw are significantly different at $p<0.05$.

Emulsifying capacity (EC):

The emulsifying capacity EC levels (ml. Oil/g) affected by all treatments presented in Table (3). 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, 36.4ml oil/g. at the end of 6-months. While the highest level of EC was fillets blocks packaged in ice-glaze film at –20°C 40.6ml oil/g. at the end of storage period (6-months). Suggesting that the different in EC was due to the solubilised proteins. These results are in harmony with those obtains by Reddy and Srikar (1991); Sarma *et al*. (1999) and Abugoch *et al.* (2006).

Table 3. Showed emulsifying capacity (EC) levels (ml. Oil/g.) in silver 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	47.4±0.1^{a}	47.4±0.1^{a}	47.4±0.1^{a}	47.4±0.2^{a}
	1	45.2±0.2^{a}	44.3±0.1^{b}	44.8±0.2^{ab}	43.9±0.2^{bc}
	2	44.0±0.1^{a}	41.7±0.1^{b}	43.2±0.2^{ab}	41.8±0.2^{bc}
	3	42.8±0.2^{a}	41.3±0.2^{b}	41.8±0.1^{ab}	40.2±0.3^{c}
	4	42.0±0.1^{a}	40.0±0.1^{bc}	40.7±0.3^{b}	38.9±0.2^{c}
	5	41.3±0.2^{a}	39.0±0.3^{bc}	39.9±0.1^{b}	37.6±0.4^{c}
	6	40.6±0.1^{a}	38.1±0.1^{c}	39.3±0.2^{b}	36.4±0.2^{d}

$^{a-d}$ Means having the same letter in the same raw are significantly different at $p<0.05$.

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

Data obtained in Table (4, 5, & 6) indicated a significant slow and gradual decrease ($p<0.05$) in 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 Reddy and Srikar (1991); Suvanich *et al*. (2000); Badii and Howell (2002) and Nopianti *et al.* (2010) supported the present results. The decrease in proteins extractability could be attributed to a denaturation in proteins. These results means 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 that the TSN, SPN and SNPN for fresh samples 3.6%, 1.66% and 1.94%, respectively. After 6-months of storage reached to 2.51, 3.04, 2.76 and 3.30% for TSN; 0.35, 0.77, 0.53, and 0.99% for SPN and 2.16, 2.27, 2.23, and 2.31% for SNPN in 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 4. Showed total soluble nitrogen (TSN) levels (%) in silver 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**	3.60 ± 0.02^{a}	3.60 ± 0.04^{a}	3.60 ± 0.02^{a}	3.60 ± 0.05^{a}
	1	3.41 ± 0.01^{bc}	3.50 ± 0.03^{ab}	3.45 ± 0.02^{b}	3.54 ± 0.03^{a}
	2	3.22 ± 0.03^{c}	3.41 ± 0.05^{ab}	3.30 ± 0.01^{b}	3.48 ± 0.02^{a}
	3	3.04 ± 0.03^{d}	3.32 ± 0.04^{b}	3.16 ± 0.03^{c}	3.43 ± 0.04^{a}
	4	2.86 ± 0.01^{d}	3.23 ± 0.01^{b}	3.02 ± 0.01^{c}	3.38 ± 0.02^{a}
	5	2.68 ± 0.02^{d}	3.14 ± 0.03^{b}	2.89 ± 0.01^{c}	3.34 ± 0.01^{a}
	6	2.51 ± 0.01^{d}	3.04 ± 0.03^{b}	2.76 ± 0.02^{c}	3.30 ± 0.02^{a}

$^{a-d}$ Means having the same letter in the same raw are significantly different at $p<0.05$.

Table 5. Showed soluble protein nitrogen (SPN) levels (%) in silver 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	1.66±0.01^{a}	1.66±0.01^{a}	1.66±0.02^{a}	1.66±0.02^{a}
	1	1.40±0.02^{ab}	1.45±0.02^{a}	1.42±0.01^{ab}	1.48±0.03^{a}
	2	1.17±0.01^{bc}	1.31±0.01^{ab}	1.22±0.01^{b}	1.35±0.01^{a}
	3	0.95±0.02^{bc}	1.17±0.03^{ab}	1.03±0.01^{b}	1.24±0.03^{a}
	4	0.74±0.01^{cd}	1.04±0.01^{b}	0.85±0.02^{c}	1.14±0.02^{a}
	5	0.54±0.01^{d}	0.91±0.01^{b}	0.68±0.01^{c}	0.83±0.01^{a}
	6	0.35±0.01^{d}	0.77±0.01^{b}	0.53±0.02^{c}	0.99±0.02^{a}

$^{a-d}$ Means having the same letter in the same raw are significantly different at $p<0.05$.

Table 6. Showed soluble non protein nitrogen (SNPN) levels (%) in silver 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	1.94±0.02^{a}	1.94±0.03^{a}	1.94±0.03^{a}	1.94±0.04^{a}
	1	2.01±0.01^{a}	2.05±0.02^{a}	2.03±0.01^{a}	2.06±0.02^{a}
	2	2.05±0.02^{ab}	2.10±0.03^{a}	2.08±0.01^{ab}	2.13±0.03^{a}
	3	2.09±0.01^{b}	2.15±0.01^{ab}	2.13±0.01^{ab}	2.19±0.01^{a}
	4	2.12±0.01^{b}	2.19±0.02^{ab}	2.17±0.01^{ab}	2.24±0.02^{a}
	5	2.14±0.02^{b}	2.23±0.01^{ab}	2.21±0.01^{ab}	2.28±0.01^{a}
	6	2.16±0.01^{b}	2.27±0.02^{ab}	2.23±0.02^{ab}	2.31±0.03^{a}

$^{a-b}$ Means having the same letter in the same raw are significantly different at $p<0.05$.

REFERENCES

Abugoch, L.; V. Quitral; M.A. Larraín; J. Vinagre; A. Kriukov and G. Chávez. (2006). Study of the reineta protein modifications (Brama australis), put under freezing and storage to -18 degrees C and -30 degrees C. Arch Latinoam Nutr. Dec., 56 (4): 350-5.

Badii, F. and N.K. Howell. (2002). A comparison of biochemical changes in cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*) fillets during frozen storage. Journal of the Science of Food and Agriculture, 82: 87–97.

Beuchat, L.R.; J.P. Cherry and M.R. Quinn (1975). Physicochemical properties of peanut flour as affected by proteolysis, J. Agri. Food Chem., 23 (4): 617.

Careche, M.; A. M. herrero; A. Rodriguez-Casado; M. L. Del Mazo and P. Carmona (1999). Structural changes of hake *Merluccius merluccius L.* Fillets: Effects of freezing and frozen storage. J. Agric. Food Chem., 47: 952-959.

Duncan, D.B. (1955). Multiple range and F test. Biometrics, 11: 1-42.

Kline, R.W. and G.F. Stewart (1949). Glucose protein reaction in dried egg albumen. Ind. Eng. Chem.; 40: 919.

Lowhon, J.T.; C.M. Cater and K.F. Mattil (1972). A comparative study of the whipping potential of an extract from several oilseed flours. Cereal Sci. Today, 17: 240.

Nopianti, R.; N. Huda and N. Ismail. (2010). A review on the loss of the functional properties of proteins during frozen storage and the improvement of gel-forming properties of surimi. Am. J. Food Technol., 6: 19-30.

Reddy, G.V. and L. Srikar. (1991). Preprocessing Ice Storage Effects on Functional Properties of Fish Mince Protein. Journal of Food Science, 56 (4): 965–968.

Sarma, J.; L.N. Srikar and R. G. Vidyasagar (1999). Effect of ice storage on the functional properties of pink perch and oil sardine meat. J. of the Sci. of Food and Agriculture, 79 (2): 160-172.

SAS (2000). SAS User's Guide: statistics, SAS Institute INC., Cary, NC.

Suvanich, V.; M. Jahncke and D. Marshall. (2000). Changes in Selected Chemical Quality Characteristics of Channel Catfish Frame Mince During Chill and Frozen Storage. Journal of Food Science, 65 (1): 24–29.

Volvinskaga, V. and B. Kelman (1960). Determination of water-sorption capacity of meat. Maysvaya. Ind. S.S.S.R.: 31, 47. (C.F.: C.A.: 157089, 1961).

تاثير التغليف بالتزجيج او البولى اثيلين لشرائح ومفروم سمك المبروك الفضى *Hypophthalmichthys molitrix* على خواص البروتين خلال التخزين بالتجميد

ابراهيم فؤاد محمد

قسم بحوث مراقبة الجودة والتصنيع– المعمل المركزى لبحوث الثروة السمكية– مركز البحوث الزراعية – وزارة الزراعة – مصر

الملخص العربى

أجريت هذه الدراسة لتقييم الخواص الطبيعية والوظيفية لبروتين سمك المبروك الفضى. حيث تم 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 الفضى 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 انخفاض بمعدل قليل فى كل من مستويات النيتروجين الكلى الذائب، النيتروجين البروتينى الذائب والنيتروجين الغير بروتينى الذائب فى كل المعاملات المختلفة سالفة الذكر خلال فترة التخزين على – ٢٠°م لمدة ستة أشهر. من هذه النتائج اتضح أن بلوكات الشرائح كانت أكثر ثباتاً من بلوكات مفروم المبروك الفضى ، خاصة بلوكات الشرائح المحاطة بطبقة رقيقة من الثلج (التزجيج) مقارنة بتلك المغلفة بالبولى إثيلين.