CHANGES IN CHEMICAL COMPOSITION, MICROBIOLOGICAL AND SENSORY CHARACTERISTICS OF SURIMI PROCESSED FROM CATFISH *CLARIAS GARIEPINUS* DURING FROZEN STORAGE

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(Manuscript received 1st October 2006)

Abstract

Freezing is an important method of fish preservation. Due to the lower market price and less quality attributes catfish *Clarias gariepinus*, it is not desirable for Egyptian consumers. The chemical, microbiological and organoleptic properties of surimi processed from catfish during 6 months of frozen storage at (-20°C) were investigated. The results showed decrease in, moisture, protein, fat, pH-value, and water holding capacity (WHC) of surimi during frozen storage. While ash, total solids, total volatile bases nitrogen (TVBN), trimethylamine nitrogen (TMAN), peroxide value (Pv) and thiobarbituric acid (TBA) of surimi resulted in an increase during frozen storage. The total bacterial count (TBC) and Psychrophylic bacterial count (PsBC) of surimi increased during frozen storage, while Coliform bacterial count don't found in the surimi processed from catfish at any time during storage at –20°C for 6 months.

Organoleptic evaluation scores of color, flavor, texture and overall acceptability showed a significant decrease ($P<0.05$) during storage at–20°C for 6 months, surimi was acceptable at the end of 6 months of storage period.

INTRODUCTION

Surimi is prepared by washing minced fish flesh several times with cold water to remove water soluble proteins and other materials. It is then dewatering, mixed with cryoprotectants such as sucrose, sorbitol and sodium tripolyphosphate, frozen and stored until used (Buck and Fafad, 1985). It was found that approximately 37% of the minced flesh was lost during washing and dewatering process. 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 minces fish flesh (Park and Morrissey (2000). Added that, the average values for yield of washed mince, dewater washed mince, and surimi of red hake fish were 32%, 20% and 21% respectively.

Wetterskog and Undeland (2004) reported that, washed mince fish showed significantly better textural colour and flavour properties than unwashed mince. On the other hand, reduced redness was indicated that washing cycles removed pigments such as myoglobin, residual hemoglobin, fat and other nitrogenous compounds. Singh

and Balange (2005) studied, the biochemical, microbiological and organoleptic properties of pink perch (Nemipterus japonicus) surimi during 36 weeks of frozen storage (-20°C). The results showed that, the total volatile bases nitrogen (TVBN), trimethyl amine nitrogen (TMAN), peroxide value (PV) and total bacterial plate count of surimi increased gradually during frozen storage and the values were within the acceptable limits. Moisture, crude protein, total nitrogen, pH and gel strength of surimi decreased during frozen storage and surimi was acceptable at the end of the 36 weeks of storage period. Chaijan *et al.* (2004) reported that, a large amount of myoglobin was removed in the first washing cycle and only a small amount was removed in the second washing cycle. The highest removal of myoglobin was achieved when the mince was washed with 0.2% NaCl and 0.5% NaCl respectively. Washing media showed the marked effect on the color, expressible drip and textural properties of sardine and mackerel mince gels. The breaking force of directly heated and kamaboko gels from both sardine and mackerel mince with NaCl solution was higher than that of un washed mince and water washed mince. Washing also resulted in an increased in whiteness and lowered expressible moisture. In general sardine surimi showed the superior gel forming ability and whiteness to mackerel surimi. Dutta *et al.* (2004) reported that, the changes in chemical and organoleptic properties of fish balls prepared from minced rohu meat treated with sorbitol (4%), sucrose (4%) and sodium-tri-polyphosphate (0.3%) occurred during storage. The results indicated that, the values for salt soluble nitrogen, free fatty acid, total volatile bases nitrogen and organoleptic attributes during storage period were within the acceptable limits. However, the product prepared from the samples treated with cryoprotective had a better acceptability over the control sample.

The present work was planned to study the effect of storage period at –20°C on the chemical, microbiological and organoleptic properties of surimi processed from catfish during 6 months of frozen storage.

MATERIALS AND METHODS

Fresh catfish was transferred directly from El- Abbassa farm to the laboratory, the fish was washed, scaled, headed, eviscerated, and hand filleted. The fillets were minced using Malounix mincer, HV6 France.

The fish mince was washed three times (at pH 7.0, 4°C) for 10 min each cycle at a ratio of mince: water 1:3 (W:V). first washing step was undertaken by using 0.2%$NaHco_3$ solution. The washing with each solution was carried out using mechanical stirrer for 10 min. After each stage of washing the mince was filtered and

strained twice at 5° C by manual pressing, first in cheese then in nylon cloths. The obtained mince was mixed with Cryoprotectants (4% sucrose, 4%sorbitol and 0.2% sodium tripolyphosphate on weight basis), at 5°C using Moulinex mincer, HV6 France. The obtained surimi was shaped into 1Kg.-block, then packed in polyethylene bags and frozen in altradeepfreezer (Revco-Altra Deepfreezer –80°C model B65099A, USA) at -20°C until using.

Analytical methods:

Homogeneous mixtures of mince surimi (3-5gm) were dried at 105°C to constant weight by standard methods (AOAC, 2000) for moisture determination. Total protein was determined by kjeldahl procedure using a 6.25 conversion factor, Ash was determined by burning at 550°C using a muffle furnace, Total solids were calculated by subtracting the moisture content of each sample from 100 and Peroxid value (PV): was determined according to the standard titration method (AOAC, 2000). Total lipids were determined by extraction of from a 2-g of dried samples for surimi by Bligh and Dyer (1959). Total volatile bases nitrogen (TVBN), and Trimethylamine nitrogen (TMAN) were determined according to the method recommended by the AMC (1979). Thiobarbituric acid (TBA): was assessed according to the method described by Tarlagis *et al.* (1960). pH Was estimated according to the method mentioned by Aitken *et al.* (1962), using pH-meter (Orion Research Digital Ion analyzer, Model 420 a). The water holding capacity (WHC) was determined using the press method according to Volvinskaga and Kelman (1960). Total bacterial count (TBC): was detected according to the method described by Frazier and Foster (1959). Psychrophilic bacterial count (PsBC): was detected according to the method described by Sharf (1966). Coliform bacterial count: was detected according to the method described by Mossel (1975). Organoleptic properties: were evaluated for colour, flavour, texture and overall acceptability every month during storage and for deep fried in corn oil at 176°C for 5 minutes. A group of 10 jadges were always called upon for scoring begining grads ranging from zero to 10 as ascribed by Teeny and Miyauchi (1972) according to the following scheme:

Score	Description	Score	Description
10	Ideal	4	Fair
9	Excellent	3	Poorly fair
8	Very good	2	Poor
7	Good	1	Very poor
6	Fairly good	0	Repulsive
5	Acceptable		

Statistical Analysis:

Three replicates of each trial were performed for each parameters using ANOVA and the means were separated by Duncan' test (1955) at a probability level of $P<0.05$ (SAS, 2000).

RESULTS AND DESCUSSION

Table (1) showed a decrease in moisture, protein and fat content of surimi processed from catfish during storage period for 6 months at –20°C. The moisture, protein and fat content values recorded 84.10, 83.14 and 8.7 respectively at zero time, while at the end of storage period were 82.0, 81.79 and 7.79% respectively. While the ash content of the surimi was 5.5% at zero time and at the end of storage period for 6 months at –20°C was 6.7%. The decrease in crude protein during storage resulted from the decomposition and degradation of nitrogen substances which may be due to the activity of microorganisms and proteolytic enzymes while the decreasing of fat contents may be attributed to the activity of microorganisms and lipolytic enzymes which lead to breakdown of fatty acids. But the increment in ash content could be mainly due to addition of Cryoprotectants (4% sucrose, 4%sorbitol and 0.2% sodium tripolyphosphate) in surimi. These results coincide with those given by Singh and Balange (2005).

Data illustrated in Table (2) represent the effect of storage at -20°C for 6 months on Total volatile bases nitrogen (TVBN), Trimethylamine nitrogen (TMAN), Peroxid value (PV) and Thiobarbituric acid (TBA) levels of surimi processed from catfish. Results given in Table (2) indicated a slight significant increase ($p<0.05$) in TVBN, TMAN, PV and TBA in all samples up to the end of storage period. The increment in TVBN, TMAN, PV and TBA during storage could be the result of decomposition and degradation of nitrogen substance which may be due to the activity of microorganisms and proteolytic enzymes. These results are in line with those obtained by Dutta *et al.* (2004) and Singh and Balange (2005). They reported that, perfectly fresh fish had 3.37 mg./100 g. of TMA, good grade fish showed 3.79-5.90 mg./100 g., fair fish had 12.65-16.02 mg./100 g. while spoiled fish contained as high as 59.01 mg./100 g. This level was not obtained after the end of storage period of our treated samples.

Table (3) show a decrease in pH and water holding capacity (WHC) values of the surimi. The pH were 6.79 at the beginning of storage period and reached to 6.35 and WHC value was 65.28% at the beginning of storage period and reached to

61.19% at the end of storage period at–20°C. While the total solids of surimi were 15.90% but at the end of storage period were 18.00%.

Decreases in pH and WHC values may be due to the microbial enzyme and autolysis producing organic acids or the treatment of the mince with mixtures of sucrose, sorbitol and sodium tripolyphosphate. Large amounts of water are used to remove the sarcoplasmic proteins, blood, fat and other nitrogenous compound from the minced fish flesh These results agree with those reported by Park and Morrissey (2000), Chaijan *et al.* (2004), Dutta *et al.* (2004) and Singh and Balange (2005).

The results presented in Table (4) showed the effect of storage on the total bacterial count (TBC), psychrophilic bacterial count (PsBC) and Coliform count (Log 10 CFU/g) of surimi processed from catfish. Results indicated that, a slight significant increase ($p<0.05$) in total bacterial count and psychrophilic bacterial count (Log 10 CFU/g) in all samples up to the end of storage period, while, the total bacterial count and psychrophilic bacterial count recorded 4.68 and 3.56 (Log 10 CFU/g), respectively at zero time, but at the end of storage period were 4.95 and 3.87 (Log 10 CFU/g). On the other hand, the changes in Coliform bacterial count (Log 10 CFU/g) of surimi processed from catfish during storage at –20°C for 6 months were found to be free from Coliform bacterial count at any time during storage at –20°C for 6 months. The high contents of psycrophilic bacteria during storage period may be suggested the presence of psychrophilic spore forming bacteria which is again activated by freezing. These results are in line with those obtained by Boknaes *et al.* (2000), Suvanich *et al.* (2000) and Singh and Balange (2005).

From table (5) data indicated, the changes in color, flavor, texture and overall acceptability scores of surimi processed from catfish during storage at –20 °C for 6 months. The statistical analysis of the grades, showed that the scores were significantly decreased ($p<0.05$) during storage period which may be attributed to the protein denaturation, hydrolysis and fat oxidation which are the major factors of changes in organoleptic properties during storage. These results are in agreement with those obtained by Boknaes *et al.* (2000), Gokoglu *et al.* (2000), Dutta *et al.* (2004) and Wetterskog and Undeland, (2004).

From the results obtained in the present study, it may be recommended that, the surimi processed from catfish was acceptable at the end of 6 months of storage period at –20°C.

Table 1. Changes in Moisture, Protein, Fat and Ash content of surimi processed from catfish *Clarias gariepinus* during storage at –20°C for 6 months (*% on dry weight basis).

Constituent		Moisture %	Protein %*	Fat %*	Ash %*
Storage period months	0	84.10 ± 0.01 ^{a}	83.14 ± 0.1 ^{a}	8.70 ± 0.02 ^{a}	5.50 ± 0.02 ^{a}
	1	83.86 ± 0.02 ^{a}	82.98 ± 0.2 ^{a}	8.60 ± 0.05 ^{a}	5.64 ± 0.01^{a}
	2	83.58 ± 0.03 ^{ab}	82.80 ± 0.1 ^{ab}	8.48 ± 0.03 ^{ab}	5.81 ± 0.03 ^{ab}
	3	83.26 ± 0.04 ^{ab}	82.59 ± 0.3 ^{ab}	8.34 ± 0.02 ^{b}	6.00 ± 0.01 ^{b}
	4	82.87 ± 0.04 ^{ab}	82.38 ± 0.1 ^{b}	8.18 ± 0.05 ^{b}	6.25 ± 0.03 ^{b}
	5	82.47 ± 0.03 ^{b}	82.10 ± 0.3 ^{b}	8.01 ± 0.04 ^{bc}	6.49 ± 0.03 ^{bc}
	6	82.00 ± 0.02 ^{bc}	81.79 ± 0.2 ^{bc}	7.79 ± 0.05 ^{c}	6.70 ± 0.04 ^{c}

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

Table 2. Changes in Total volatile bases nitrogen (TVBN mg/100g), Tri methyl amine nitrogen (TMANmg/100g), Peroxide value (PV milliequivalents peroxide/ kg. of lipid) and Thiobarbituric acid (TBA mg. Malonldehyde / Kg.) content of surimi processed from catfish *Clarias gariepinus* during storage at –20 °C for 6 months.

Constituent		TVBN	TMAN	PV	TBA
Storage period months	0	9.76 ± 0.05 c	2.81 ± 0.07 ^{c}	5.92 ± 0.03 ^{c}	0.87 ± 0.01 ^{c}
	1	10.15 ±0.06 ^{bc}	2.96 ± 0.05 ^{c}	7.02 ± 0.03 ^{bc}	0.92 ± 0.03 ^{c}
	2	10.66 ±0.07 ^{bc}	3.14 ± 0.06 ^{bc}	8.33 ± 0.02 ^{b}	1.07 ± 0.01 ^{bc}
	3	11.26 ± 0.07 ^{b}	3.35 ± 0.05 ^{b}	9.87 ± 0.03 ^{b}	1.34 ± 0.02 ^{b}
	4	11.90 ±0.06 ^{b}	3.64 ± 0.07 ^{ab}	11.56 ±0.02^{ab}	1.65 ± 0.01 ^{ab}
	5	12.76 ±0.05 ^{ab}	4.00 ± 0.05 ^{a}	13.44 ± 0.04 ^{a}	1.94 ± 0.02 ^{a}
	6	13.56 ± 0.05 ^{a}	4.39 ± 0.06 ^{a}	15.34 ± 0.03 ^{a}	2.36 ± 0.01 ^{a}

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

Table 3. Changes in pH-value, Water Holding capacity (WHC) levels (%),and Total solids (%) content of surimi processed from catfish *Clarias gariepinus* during storage at –20 °C for 6 months.

Constituent		pH	WHC	Total solids
Storage period months	0	6.79 ± 0.01 ^{a}	65.28 ± 0.01 ^{a}	15.90 ± 0.01 ^{a}
	1	6.75 ± 0.01 ^{a}	64.68 ± 0.05 ^{b}	16.41 ± 0.02 ^{b}
	2	6.69 ± 0.02 ^{ab}	63.99 ± 0.02 ^{c}	16.42 ± 0.01 ^{b}
	3	6.62 ± 0.02 ^{b}	63.28 ± 0.03 ^{c}	16.74 ± 0.03b^{c}
	4	6.53 ± 0.01 ^{b}	62.53 ± 0.04^{cd}	17.13 ± 0.02 ^{c}
	5	6.43 ± 0.03 ^{b}	61.97 ± 0.01 ^{d}	17.35 ± 0.03 ^{c}

	6	6.35 ± 0.01 [bc]	61.19 ± 0.01 [d]	18.00 ± 0.01[d]

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

Table 4. Changes in Total bacterial count (TBC), Psychrophylic bacterial count (PsBC) and Coliform bacterial count (Log 10 CFU / g.) content of surimi processed from catfish *Clarias gariepinus* during storage at –20 °C for 6 months.

Constituent		**TBC**	**PsBC**	**Coliform bacterial count**
Storage period months	**0**	4.68 ± 0.01 [a]	3.56 ± 0.02 [a]	-
	1	4.72 ± 0.01 [a]	3.59 ± 0.02 [a]	-
	2	4.77 ± 0.02 [ab]	3.63 ± 0.03 [ab]	-
	3	4.81 ± 0.02 [b]	3.68 ±0.02 [b]	-
	4	4.86 ± 0.01 [b]	3.73 ± 0.03 [b]	-
	5	4.90 ± 0.03 [bc]	3.80 ± 0.02 [c]	-
	6	4.95 ± 0.01 [c]	3.87 ± 0.02 [c]	-

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

Table 5. Changes in Colour, Flavour, Texture and Overall acceptability of surimi processed from catfish *Clarias gariepinus* during storage at –20 °C for 6 months.

Constituent		**Colour**	**Flavour**	**Texture**	**Overall acceptability**
Storage period months	**0**	8.8 ± 0.01 [a]	9.0 ± 0.02 [a]	8.7 ± 0.01 [a]	88.3 ± 0.05 [a]
	1	8.5 ± 0.02 [a]	8.7 ± 0.02 [a]	8.4 ± 0.03 [a]	85.3 ± 0.06 [a]
	2	8.0 ± 0.01 [a]	8.3 ± 0.01 [a]	8.0 ± 0.01 [ab]	81.0 ± 0.05 [a]
	3	7.5 ± 0.01 [b]	7.7 ± 0.01 [b]	7.5 ± 0.02 [b]	75.6 ± 0.07 [b]
	4	6.9 ± 0.02 [bc]	7.1 ± 0.02 [b]	6.8 ± 0.01 [c]	69.3 ± 0.06[c]
	5	6.4 ± 0.01 [c]	6.5 ± 0.03 [c]	6.3 ± 0.02 [c]	64.0 ± 0.05 [c]
	6	5.8 ± 0.02 [cd]	6.0 ± 0.01 [c]	5.6 ± 0.02 [d]	58.0 ± 0.05 [d]

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

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التغير فى الخواص الكيميائية، الميكروبيولوجية والحسية للسوريمى المصنع من اسماك القراميط خلال التخزين بالتجميد

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قسم التصنيع ومراقبة الجودة- المعمل المركزي لبحوث الثروة السمكية - مركز البحوث الزراعية- وزارة الزراعة- الدقى- الجيزة.

يعتبر التجميد من أهم طرق حفظ الأسماك. ونظرا لان القراميط من الأسماك الغير تسويقية وذات جودة منخفضة لذا فهي غير مقبولة لدى المستهلك المصري، حيث تم دراسة التغير فى الخواص الكيميائية ،الميكروبيولوجية ،الحسية للسوريمى المجهز من اسماك القراميط خلال ستة أشهر من التخزين بالتجميد (-٢٠م°).

أوضحت النتائج حدوث انخفاض تدريجي في كل من الرطوبة ، البروتين ، الدهن ، الpH ، القدرة على ربط الماء للسوريمى المصنع بينما حدثت زيادة فى الرماد ، المواد الصلبة الكلية ، القواعد النيتروجينية الكلية الطيارة ، النيتروجين الأميني ثلاثي الميثيل ، رقم البيروكسيد ، حمض الثيوباربتيوريك. أوضحت النتائج أيضا زيادة فى محتوى السوريمى من العدد الكلى للبكتريا والبكتريا المحبة للبرودة وكانت خاليه تماما من بكتريا مجموعة القولون خلال من التخزين بالتجميد (-٢٠م°) لمدة ستة اشهر.

كما أظهرت قيم الخواص الحسية (اللون، الطعم، القوام والقابلية العامة) أعلى درجاتها للعينات بعد التصنيع مباشرة ، بينما أظهرت انخفاضا معنويا خلال التخزين بالتجميد (-٢٠م°) لمدة ستة أشهر.