ASSESSMENT OF NUTRITIONAL VALUE OF SURIMI AND SHRIMP-ANALOGUES PROCESSED FROM CATFISH FLESH *CLARIAS GARIEPINUS*

ATEF E.E. IBRAHIM; SAMYA I. A. HASANIN AND MOHAMED I. SALAMA

Central Laboratory for Aquaculture Research, Abbassa, Agriculture Research Center, Ministry of Agriculture, Dokki, Giza.

(Received 25/ 8/ 2007 Accepted 5/ 10/ 2007)

Abstract

Due to catfish *Clarias gariepinus* lower market price and its less quality attributes, it is not desirable for Egyptian consumers. This work was carried out to study the utilization of catfish flesh for production surimi and shrimp-imitation. Raw materials (catfish flesh and shrimp), surimi and the analogues were evaluated for chemical, physical, sensory and microbiological properties.

Results showed that, surimi had the highest quality grades compared with the raw materials used in the production. Chemical, physical, microbiological and sensory evaluations of Shrimp analogues characteristics were similar with those of their identical natural seafood products. Shrimp analog ≥10% are the best treatments compared with the shrimp analog <10% treatments. Surimi and seafood imitation (shrimp-analogues) are a convenient way to improve the quality of catfish flesh.

INTRODUCTION

Surimi is stabilized myofibrillar protein from fish muscle. More simply, it is mechanically deboned fish flesh that has been washed with water and blended with cryoprotectants to ensure a good frozen shelf life. This intermediate product is used to manufacture a variety of surimi seafood, from the traditional kamaboko products in Japan to the shellfish substitutes now popular in Western countries. Prior to the development of stabilized surimi as we know it today, washed fish mince was made and used within a few days as a refrigerated raw material because freezing induced protein denaturation and poor functionality of the muscle proteins (Park and Lanier, 2000). Park (1994) reported that, the surimi production grew to over 500,000 MT in 1992. Japanese direct involvement decreased with the increased surimi production in the United States, Present market growth is about 3 to 5 percent every year. In the United States and other Western countries surimi-based seafood products have expanded their markets in food service applications, in the retail deli, and in salad bars. The success of these surimi-based crab, shrimp, lobster, and scallop products is mainly due to their low price compared to that of their natural counterparts.

Wetterskog and Undeland (2004) reported that, washed mince fish showed significantly better textural colour and flavor 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 unwashed mince and water washed mince. Washing also resulted in an increase in whiteness and lowered expressible moisture. In general sardine surimi showed the superior gel forming ability and whiteness to mackerel surimi. Chinabhark *et al.* (2007) studied the effects of the pH and protein content on the properties and compositional changes of imitation films. The acidic and alkaline conditions had no effect on water vapor permeability of the films obtained. However, the film prepared at acidic condition was more yellowish than that prepared at alkaline pH. Protein content influenced the mechanical properties and color of films.

The present work was planned to study the possibility of utilization of catfish *Clarias gariepinus* for the production of seafood imitation, and to study the effect of processing steps on some chemical, microbiological and organoleptic properties of surimi and surimi-based products processed from catfish flesh, by mixing with shellfish (shrimp) flesh and other components.

MATERIALS AND METHODS

Sampling

Fresh catfish was transferred directly from El- Abbassa farm to the laboratory, the fish was washed, headed, eviscerated, and hand filleted (fig.1-A). The fillets were minced using Moulinex mincer, HV6 France (fig.1-B). 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, second, using distilled water and the last wash contained 0.5% NaCl.. 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 5ºC by manual pressing, first in cheese then in nylon cloths.

Treatments

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 0.5 Kg.-block, then packed in polyethylene bags and frozen in ultra-deep freezer (Revco-Altra Deep freezer –80ºC model B65099A, USA) at -20°C until using (fig.1-C).

The obtained frozen surimi was thawed (5°C). Thereafter, surimi were divided randomly into represent three treatments for surimi-based imitation seafood products (pink shrimp 5, 10 and 15%) with three replicates for each. The shrimp was prepared by mixing surimi with the other following ingredients using Moulinex mincer HV 6 France as follows in Table (1). The obtained paste of each analog was shaped using plastic forms and heated at 90°C for 40min, then were immediately cooled in running tap water for 20min. After that, the shrimp analogous were packaged in perforated foam plastic plates then covered with polyethylene sheets under vacuum. The packaged analogous were frozen at −30°C in Altra deep freezer overnight, and stored at −20°C for different analyzed (fig.1-D).

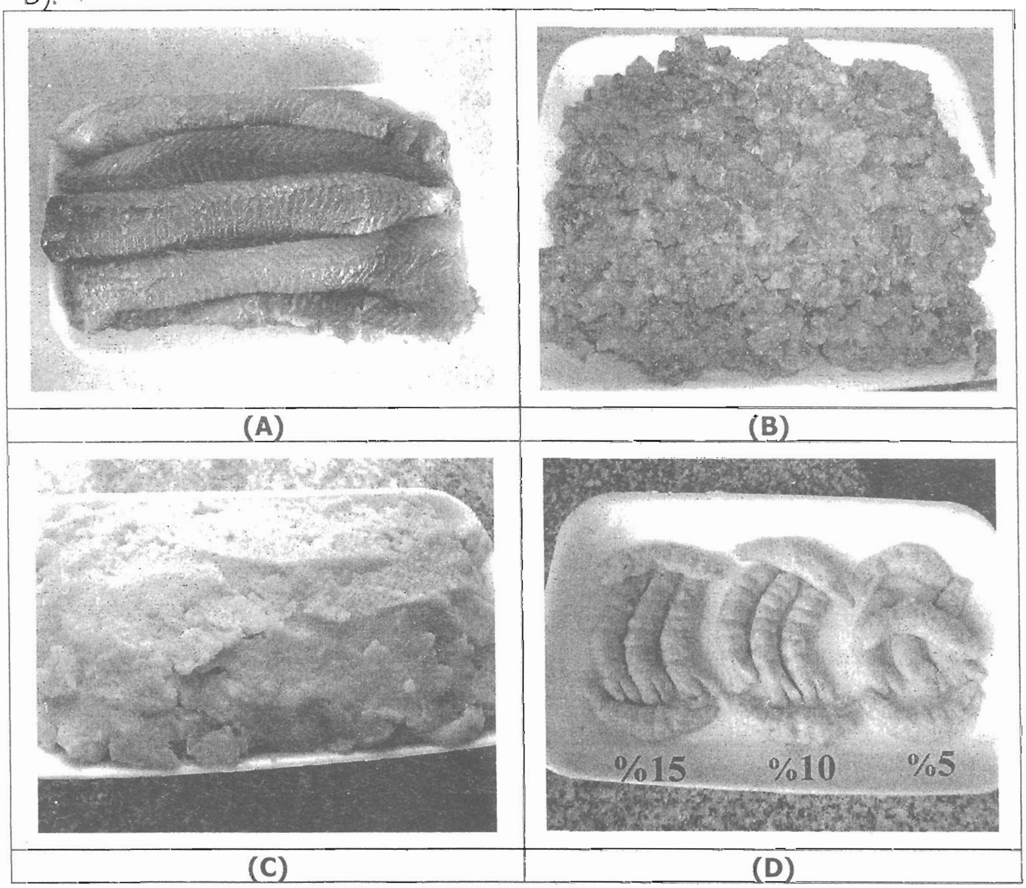

Fig. 1. Surimi and shrimp-analogous processing from catfish flesh.

Table 1. Formulation processing for surimi-based imitation seafood (shrimp analogous).

Ingredients	Shrimp analog %		
	5	10	15
Surimi	65.0	65.0	65.0
Fresh egg white	7.0	7.0	7.0
Corn starch	6.0	6.0	6.0
Sorbitol	0.2	0.2	0.2
Salt	0.5	0.5	0.5
Sugar	0.5	0.5	0.5
Shrimp mince	5.0	10.0	15.0
Corn oil	2.5	2.5	2.5
Water	13.3	8.3	3.3
Total	100.0	100.0	100.0

Analytical methods

Homogeneous mixtures of mince surimi (3-5gm) were dried at 105°C to constant weight for moisture content, total protein, ash, peroxide value (PV) and total lipids were determined as described by AOAC (2000). Carbohydrates were calculated by difference according to Egan *et al.* (1981) as follow: Carbohydrates % = 100 - (% moisture + % crude protein + % total lipids + % ash). Fatty acids percentage in the lipid extract was measured by gas-liquid chromatography after liberated and esterified with some modification as described by AOAC (2000). 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 Tarladgis *et al.* (1960). pH was estimated according to the method mentioned by Özogul *et al.* (2005), 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 soluble nitrogen (TSN) and soluble protein nitrogen (SPN): Were determined according to the method described by (AOAC, 2000). Total bacterial count (TBC) and Psychrophilic bacterial count (PsBC): were detected according to the method described by Swanson *et al.* (1992). Coliform group: was detected according to the method described by Hitchins *et al.* (1995). Organoleptic properties were evaluated for colour, flavor, texture and overall acceptability during processing steps. A group of 10 judges were always called for scoring grads which ranging from zero to 10 as follows (Table, 2), as ascribed by Teeny and Miyauchi (1972).

Table 2. Description of organoleptic properties scores.

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

Changes in some chemical and physicochemical properties

The obtained data of chemical composition of raw materials (catfish and shrimp), surimi and surimi-based products are shown in Table 3. Results showed significant differences ($P<0.05$) between raw materials, surimi and surimi-based products in the moisture, protein, fat, ash and carbohydrate contents. The highest percentages of moisture were 82.10 in surimi, while, ash and carbohydrate were, 8.52 and 28.53%, respectively, for surimi-based products mixed with 5% shrimp. Also, the highest levels of protein (85.17%) and fat (9.20) in raw shrimp and surimi-based product mixed with 15% shrimp, respectively. These results coincide with those given by Singh and Balange (2005) and Chinabhark *et al.* (2007).

Table 3. Chemical composition of raw materials (catfish and shrimp), surimi and shrimp-analogues. (*% on dry weight basis).

Constituent		Moisture %	Protein %*	Fat %*	Ash %*	Carbohydrate %*
Raw materials	Catfish	79.85 ± 0.2^{b}	82.63 ± 0.1^{a}	9.23 ± 0.01^{a}	4.52 ± 0.03^{d}	3.62 ± 0.2^{c}
	Shrimp	73.64 ± 0.3^{b}	85.17 ± 0.2^{a}	9.66 ± 0.03^{a}	4.90 ± 0.01^{d}	0.27 ± 0.1^{d}
Surimi		82.10 ± 0.1^{a}	75.53 ± 0.1^{b}	5.64 ± 0.02^{c}	6.81 ± 0.02^{c}	12.02 ± 0.1^{b}
Shrimp-analogues (Shrimp%)	5	72.31 ± 0.2^{bc}	54.36 ± 0.2^{d}	8.59± 0.01^{b}	8.52 ± 0.02^{a}	28.53 ± 0.2^{a}
	10	70.21 ± 0.2^{bc}	56.27 ± 0.3^{c}	8.73 ± 0.02^{b}	7.91 ± 0.03^{b}	27.09 ± 0.3^{a}
	15	68.18 ± 0.1^{c}	57.96 ± 0.3^{c}	9.20 ± 0.01^{a}	7.59 ± 0.01^{b}	25.25 ± 0.1^{a}

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

Data in Table (4) shows the fatty acids composition of raw materials (catfish and shrimp), surimi and surimi-based products. Results indicated a slightly decrease in the Saturated fatty acids composition (SFA) and Polyunsaturated fatty acids (PUFA) of surimi compared to the raw catfish flesh, while the Polyunsaturated fatty acids (PUFA) and Unsaturated/Saturated (U/S) ratio increased in surimi during the processing from catfish flesh.

Table 4. Fatty acids composition (% w/w of total fatty acids) of raw materials (catfish and shrimp), surimi and shrimp-analogues.

Constituent	Raw materials		Surimi	Shrimp-analogues (Shrimp%)		
	Catfish	Shrimp		5	10	15
C8:0	---	---	0.1	---	---	---
C10:0	---	0.2	0.6	0.6	0.5	0.5
C12:0	---	0.1	0.1	0.1	0.1	0.1
C14:0	0.1	3.1	0.3	0.4	0.4	0.4
C15:0	1.5	1.7	1.6	1.6	1.6	1.6
C16:0	27.0	11.4	24.9	24.4	23.2	22.9
C18:0	7.6	5.9	7.2	6.8	6.3	6.0
C20:0	---	1.4	1.1	1.2	1.2	1.3
C22:0	0.8	---	0.5	0.5	0.4	0.4
C23:0	1.4	3.0	0.8	0.8	0.9	0.9
C24:0	0.8	---	0.5	0.4	0.4	0.4
ΣSFA	39.2	26.8	37.7	36.8	35.9	34.5
C16:1	8.1	17.1	7.4	7.8	8.3	9.0
C18:1	26.7	21.2	26.2	26.1	26.0	25.8
C20:1	2.2	1.4	5.3	5.0	4.8	4.5
C22:1	4.0	4.5	4.6	4.6	4.5	4.5
ΣMUFA	41.0	44.2	43.5	43.5	43.6	43.8
C18:2	17.1	22.2	15.6	16.4	17.0	18.1
C18:3	2.7	6.8	3.2	3.3	3.5	3.6
ΣPUFA	19.8	29.0	18.8	19.7	20.5	21.7
U/S Ratio	1.55	2.73	1.65	1.72	1.79	1.90

Surimi-based products mixed with 5, 10 and 15% shrimp had an increase, respectively, in the fatty acids (Monounsaturated fatty acids (MUFA), Polyunsaturated fatty acids (PUFA) and Unsaturated/Saturated (U/S) ratio compared with surimi, while data showed a gradually decrease in SFA for the same samples of surimi-based products compared to surimi. On the other side, the predominant fatty acids were C16:0, C18:1 and C18:2 in the raw materials (catfish and shrimp), surimi and surimi-based products. These results agree with these achieved by Wetterskog and Undeland (2004) and Singh and Balange (2005).

Results presented in Table (5), shows total volatile bases nitrogen (TVBN), trimethyl amine nitrogen (TMAN), peroxide value (PV) and thiobarbituric acid (TBA) contents of raw materials (catfish and shrimp), surimi and surimi-based products. Data indicated significant differences ($P<0.05$) between all types of fish products. The lowest values of TVBN, TMAN, PV and TBA for surimi were 9.76 mg/100g, 2.82 mg/100g, 5.92 mg. Peroxide/kg and 0.87mg/kg, respectively, compared with the raw materials. Also, there are an increase in TVBN, TMAN, PV and TBA values after mixing surimi with 5, 10 and 15% of shrimp, respectively, compared with surimi. Connel (1995) reported that, the content of TVBN is useful for estimating the freshness of lean fish and suggested TVBN in freshly caught fish is generally between 5 and 20 mg/100g muscle. However, the levels of 30-35 mg/100g muscle are considered the limit of acceptability for stored fish. Moreover, Bonnell (1994) revealed that, fish and fish products of good quality will have TBA-value less than 2, while poorer quality fish will have a TBA-value within 3 and 27. Fish with TBA number greater than 2 will probably smell and taste rancid.

Table 5. 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 raw materials (catfish and shrimp), surimi and shrimp-analogues.

Constituent		TVBN	TMAN	PV	TBA
Raw materials	Catfish	18.85 ± 0.5^{a}	5.72 ± 0.06^{b}	11.32 ± 0.3^{a}	1.37 ± 0.02^{a}
	Shrimp	21.15 ± 0.6^{a}	7.32 ± 0.07^{a}	10.78 ± 0.4^{a}	1.14 ± 0.03^{b}
Surimi		9.76 ± 0.5^{c}	2.81 ± 0.07^{d}	5.92 ± 0.3^{c}	0.87 ± 0.01^{c}
Shrimp-analogues (Shrimp %)	5	10.27 ± 0.3^{b}	3.15 ± 0.05^{c}	6.25 ± 0.2^{c}	0.95 ± 0.01^{bc}
	10	10.89 ± 0.4^{b}	3.27 ± 0.07^{c}	7.76 ± 0.3^{b}	1.01 ± 0.02^{b}
	15	12.11 ± 0.6^{b}	3.84 ± 0.08^{c}	8.47 ± 0.4^{b}	1.13 ± 0.03^{b}

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

Table 6. PH-value, water holding capacity (WHC) %, total soluble nitrogen (TSN) and soluble protein nitrogen (SPN) contents of raw materials (catfish and shrimp), surimi and shrimp-analogues.

Constituent		pH	WHC	TSN	SPN
Raw materials	Catfish	6.42 ± 0.01^{a}	69.96 ± 0.5^{a}	4.85 ± 0.02^{a}	1.72 ± 0.02^{a}
	Shrimp	6.38 ± 0.02^{a}	67.53 ± 0.4^{a}	4.26 ± 0.05^{a}	1.53 ± 0.01^{a}
Surimi		6.79 ± 0.01^{a}	65.28 ± 0.3^{b}	4.43 ±0.03^{a}	1.57 ± 0.03^{a}
Shrimp-analogues (Shrimp %)	5	6.75 ± 0.03^{a}	65.12 ± 0.6^{b}	3.19 ± 0.04^{b}	1.13 ± 0.01^{c}
	10	6.67 ± 0.01^{a}	63.44 ± 0.5^{c}	3.30 ± 0.02^{b}	1.17 ± 0.02^{b}
	15	6.61 ± 0.02^{a}	62.10 ± 0.7^{c}	3.40 ± 0.05^{b}	1.21 ± 0.01^{b}

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

On the other hand, data in Table (6), indicates an increase in pH-value, Water holding capacity (WHC %), while a decrease in total soluble nitrogen (TSN %) and soluble protein nitrogen (SPN %) content of compared with the raw materials were obtained, while after mixing surimi with 5, 10 and 15% of shrimp a decrease in pH, WHC, TSN and SPN were observed compared with the surimi. These results agree with those reported by Chaijan *et al.* (2004), Dutta *et al.* (2004) and Singh and Balange (2005).

Microbiological evaluation

If 6.0 (log_{10} CFU/g) microorganisms are considered, the TBC limit of acceptability (Özogul *et al.,* 2005). Results presented in Table 7 indicated that the highest significant (P<0.05) levels were observed in raw catfish followed by raw shrimp, surimi-based products and surimi, respectively. Also, the coliform groups (CG) was not detected in all samples, lowest significant levels (P<0.05) of total bacterial count (TBC) and psicrophilic bacterial count (PsBC) were 2.20 and 1.68 (log_{10} CFU/g), respectively, for surimi. These results are in line with those obtained by Suvanich *et al.* (2000) and Singh and Balange (2005).

Table 7. Total bacterial count (TBC), psychrophylic bacterial count (PsBC) and coliform groups (CG) (Log_{10} CFU / g.) contents of raw materials (catfish and shrimp), surimi and shrimp-analogues.

Constituent		TBC	PsBC	CG
Raw materials	Catfish	3.21 ± 0.01^{a}	2.45 ± 0.01^{a}	<1
	Shrimp	2.76 ± 0.02^{b}	2.10 ± 0.03^{a}	<1
Surimi		2.20 ± 0.01^{c}	1.68 ± 0.02^{c}	<1
Shrimp-analogues (Shrimp %)	5	2.36 ± 0.02^{bc}	1.80 ± 0.02^{bc}	<1
	10	2.40 ± 0.02^{b}	1.83 ± 0.01^{b}	<1
	15	2.53 ± 0.01^{b}	1.93 ± 0.03^{b}	<1

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

Organoleptic evaluation

From Table 8 data indicated color, flavor, texture and overall acceptability scores of raw materials, surimi and surimi-based products. The statistical analysis of the grades, showed that the scores were significantly differences (p<0.05) between raw materials compared the other treatments. The highest significant (P<0.05) scores were 9.5, 9.1, 9.3 and 93.0 for color, flavor, texture and overall acceptability, respectively, of raw shrimp, followed by surimi-based products mixed by 15, 10 and 5% shrimp. While, the lowest significant scores for raw catfish followed by the surimi scores. These results are in agreement with those obtained by Gokoglu *et al.* (2000); Wetterskog and Undeland (2004) and Chinabhark *et al.* (2007).

Table 8. Color, flavor, texture and overall acceptability scores of raw materials (catfish and shrimp), surimi and shrimp-analogues.

Constituent		Colour	Flavor	Texture	Overall acceptability
Raw materials	Catfish	6.3 ± 0.02^{d} (F.G.)	8.4 ± 0.03^{b} (V.G.)	6.5 ± 0.01^{d} (F.G.)	70.7 ± 0.3^{d} (G.)
	Shrimp	9.5 ± 0.04^{a} (E.)	9.1 ± 0.02^{a} (E.)	9.3 ± 0.01^{a} (E.)	93.0 ± 0.5^{a} (E.)
Surimi		7.1 ± 0.01^{c} (V.)	8.5 ± 0.01^{b} (V.G.)	7.3 ± 0.02^{c} (G.)	76.3 ± 0.3^{c} (G.)
Shrimp-analogues (Shrimp %)	5	7.5 ± 0.03^{c} (G.)	8.5 ± 0.01^{b} (V.G.)	7.5 ± 0.02^{c} (G.)	78.3 ± 0.4^{c} (G.)
	10	8.2 ± 0.03^{b} (V.G.)	9.0 ± 0.03^{a} (E.)	8.5 ± 0.01^{b} (V.G.)	85.7 ± 0.6^{b} (V.G.)
	15	9.1 ± 0.01^{a} (E.)	9.0 ± 0.02^{a} (E.)	9.0 ± 0.01^{a} (E.)	90.3 ± 0.5^{a} (E.)

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

A. = Acceptable F.G. = Fairly Good G. = Good V.G. = Very good E. = Excellent

From the abomination results, it could be recommended that, catfish mince was feasible to produce surimi and surimi-based products. As well as, shrimp analog (10 and 15%) are the best treatments and it recommended for the production of seafood imitation.

REFERENCES

1. AMC. 1979. Recommended method for the examination of fish and fish products. Analyst. 104, 433.
2. AOAC. 2000. Official methods of analysis of the Association of Analytical Chemist's 15th Ed., Washington, D.C., USA.
3. Bonnell, A. D. 1994. Quality assurance in seafood processing. Chapter 5. Quality assessment, P. 72. Academic press, New York, USA.
4. Chaijan, M., S. Benjakul, W. Visessanguan and C. Faustman. 2004. Characteristics and gel properties of muscles from sardine and mackerel caught in Thailand. Food Research International, 37 (10), 1021-103.
5. Chinabhark K, S. Benjakul, T. Prodpran. 2007. Effect of pH on the properties of protein-based film from bigeye snapper (*Priacanthus tayenus*) surimi. Bioresour Technol., 98 (1), 221-5.
6. Connel, J. J. 1995. Control of fish quality (4th ed.). London: Published by Fishing News Books Limited.
7. Duncan, D. B. 1955. Multiple range and F test. Biometrics 11, 1-42.
8. Dutta, C., K. Dora, S. Sarkar and B. Chand. 2004. Storage Characteristics of fish ball prepared surimi of Rohu, *Labio rohita*. Journal of Applied Zoological Researches. 15 (1), 78-80.
9. Egan, H, R. S. Kirk and R. Sayer. 1981. Pearson's chemical analysis of foods 8th end, Churchill Livingstone. Edinburgh.

10. Gokoglu, N., N. Erkan and O. Ozden. 2000. The effect of frozen storage on the proximate composition and quality of mussels (*Mytilus galloprovincialis*). J. Aquatic Food Product Technology, 9 (2), 83-88.

11. Hitchins, A. D., P. Feng, W. D. Watkins, S. R. Rippey and L. A. Chandler. 1995. Escherichia coli and the coliform bacteria, p. 4.01-4.49. In Food Drug Administration bacteriological analytical manual, 8th ed. Association of Official Analytical Chemists, Arlington, VA.

12. Özogul, Y, G. Özyurt, F. Özogul, E. Kuley and A. Polat. 2005. Freshness assessment of European eel (*Anguilla anguilla*) by sensory, chemical and microbiological methods. Food Chemistry, 92, 745-751.

13. Park, J. W. 1994. Unpublished data (industry survey). OSU Seafood Laboratory, Astoria, OR.

14. Park, J. W. and T. C. Lanier. 2000. Processing of surimi and surimi seafood. Marine and freshwater products handbook, Technomic Publishing Company, Inc., 417-443.

15. SAS. (2000). SAS User's Guide: Statistics, SAS Institute Inc., Cary, NC.

16. Singh, R., and A. Balange. 2005. Characteristics of pink perch *Nemipterus jaaponicus* surimi at frozen temperature. Journal of Food Processing and Preservation, 29 (1), 75-83.

17. Suvanich, V., D. L. Marshall and M. L. Jahncke. 2000. Microbiological and color quality changes of channel catfish frame mince during chilled and frozen storage. J. Food Sci., 65 (1), 151-154.

18. Swanson, K. M., F. F. Busta, E. H. Peterson and M. G. Johnson. 1992. Colony count methods, p. 75-95. In C. Vanderzant and D. F. Splittoesser (ed.). Compendium of methods for the microbiological examination of foods, 3rd ed. American Public Health Association, Washington, D.C.

19. Tarladgis, B. G., B. M. Watts, M. I. Younathan and I. Dugan. 1960. Distillation method for the quantitative determination of malonaldhyde in rancid foods. J. American Oil Chemists Soc., 37, 44.

20. Teeny, F. M. and D. Miyauchi. 1972. Preparation and utilization of frozen block of minced block fish muscle. J. Milk & Food Technology, 35 (7), 414.

21. 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).

22. Wetterskog, D. and I. Undeland. 2004. Loss of redness (a*) as a tool follow hemoglobin-mediated lipid oxidation in washed cod mince. J. Agric. Food Chem., 52 (24), 7214-7221.

تقييم الخواص التغذوية للسوريمى ومقلدات الجمبرى المجهزة من لحوم سمك القراميط

عاطف عز الرجال إبراهيم ، ساميه إبراهيم على حسنين ، محمد إبراهيم سلامة

المعمل المركزى لبحوث الثروة السمكية ، مركز البحوث الزراعية ، وزارة الزراعة ، مصر.

نظرا لانخفاض القيمة التسويقية لسمك القراميط وكذلك انخفاض خواص جودتها، لم تكن مقبولة لدى المستهلك المصرى. فى هذا البحث تم دراسة إمكانية استخدام لحوم سمك القراميط فى إنتاج السوريمى ومقلدات الجمبرى. حيث تم دراسة الخواص الكيميائية والطبيعية والحسية وكذلك الخواص الميكروبيولوجية لكل من المواد الخام المستخدمة (لحوم سمك القراميط والجمبرى) ، السوريمى ومقلدات الجمبرى.

أظهرت النتائج أن السوريمى اعطى أعلى درجات الجودة مقارنة بالمواد الخام المستخدمة فى عملية التجهيز. كما تشابهت مقلدات الجمبرى مع مثيلاتها من المنتجات البحرية الطبيعية فى كل من الخواص الكيميائية والطبيعية والميكروبيولوجية والحسية. أوضحت النتائج أيضا، أن مقلدات الجمبرى المستخدم فيها نسب اكبر من ١٠% من لحوم الجمبرى الطبيعية كانت الأفضل مقارنة بالمستخدم فيها نسب اقل من ١٠% من لحوم الجمبرى الطبيعية. من هذه الدراسة نجد أن إنتاج السوريمى ومقلدات الأغذية البحرية (مقلدات الجمبرى) تعتبر طريقة مناسبة لتحسين خواص الجودة للحوم سمك القراميط للانتفاع من الكميات الكبيرة المنتجة منها والمنخفضة فى القيمة التسويقية فى مصر.