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Study on shelf life of fish cake prepared from surimi of silver carp (*Hypophthalmichthys molitrix*) during frozen storage

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Abstract
Surimi was prepared from silver carp with an aim to put this underutilized fish for profitable use. The mince prepared was washed twice with chilled water (5^{0}C) using mince to water ratio (w/v) of 1:2 for 5-6 minutes each. After final dewatering to moisture content to about 80%; half the quantity of washed minced meat was mixed with cryoprotectants (4% sorbitol, 4% sucrose and 0.3% sodium tripolyphosphate) to produce surimi. The prepared surimi and the dewatered minced meat were packed in LDPE bags, frozen using a plate freezer and stored at -20^{0}C. Surimi and dewatered minced meat from frozen storage were used as base material for production of fish cakes. These were fried at 160^{0}C for 3 to 4 minutes before serving for organoleptic test. Changes in salt soluble nitrogen, total volatile base nitrogen, non-protein nitrogen, peroxide value and free fatty acid of surimi and dewatered mince were estimated at every ten days interval during the storage period of 3 months. The study has indicated that frozen storage of surimi could be a potential method for effective utilization of silver carp. This surimi when incorporated in fish cakes yielded products which retained the shelf life even up to 90 days of storage.

Key words: Silver carp, Surimi, Cryoprotectant, Frozen storage

Introduction

Silver carp (*Hypophthalmichys molitrix*), which is widely grown in the composite cultures due to its quick growth and resistance to stress, disease and rough handling are seldom processed or preserved. In India, the consumer acceptance of silver carp is poor as compared to the Indian major carps in spite of its year round availability and cheaper price. An attempt has been made for the production of surimi from silver carp and to incorporate it in fish cakes keeping in view the value addition of this fish. With the discovery of cryoprotectants, mainly sucrose, sorbitol and sodium tripolyphosphate, the surimi industry was able to produce frozen surimi on a commercial scale. Hence, a study was initiated to produce surimi with the addition of these above mentioned cryoprotectants from this fish and study quality changes during frozen storage (-20^{0}C) and correlate the changes with the sensory quality of fish cakes prepared from it.

Materials and methods

Five silver carps caught from a culture pond with an average weight of 1600g were brought to the laboratory for processing within an hour of harvest. The fishes were washed well, dressed and then the meat was separated using a drum type fish meat picking machine. The picked meat was then minced and washed twice with chilled water (5^0C), using a mince to water ratio of 1:2 for 5 minutes. After washing, the meat was gently squeezed in a muslin cloth to remove as much water as possible. Final dewatering was done using screw press and the moisture content of the meat was reduced to about 80% level.

The partially dehydrated meat was divided into two equal batches of 1500g each. The first batch was mixed with 4% sorbitol, 4% sucrose and 0.3% sodium tri-polyphosphate in a bowl chopper for five minutes to produce surimi. Surimi was packed in LDPE bags of 100g each, frozen at -35^{0}C and stored at -20^{0}C temperature. The second batch of dewatered minced meat (DWM) was packed similarly in LDPE bags without any further treatment which was similarly frozen and stored. The effect of freezing and frozen storage on DWM and surimi was assessed.

Moisture content, total protein and ash content were determined according to the methods of AOAC (1995). Total lipid was estimated by solvent extraction method in soxhlet apparatus as described by Nambudiri (1985). Total volatile base nitrogen (TVB-N) was estimated by the method recommended by EIC (1995). For estimation of salt soluble nitrogen (SSN), the method of Dyer *et al.* (1950) was used. Non-protein nitrogen (NPN) and free fatty acid (FFA) were estimated by the method as described by Nambudiri (1985). The peroxide value (PV) was determined iodometrically (Jacobs 1958). To study the gel strength of the washed meat, folding test was performed as described by Lee (1984).

Table 1. Recipe used for fish cake

Paste	Percentage
Surimi	60
Potato	25
Onion	10
Garlic	1.0
Ginger	1.0
Green chili	0.3
Cumin	0.3
White pepper	0.3
Salt	1.5
Chili powder	0.3
Batter	Egg albumin
Breading	Toasted bread crumbles

Sensory quality of surimi stored for three months, was assessed by using it in the production of fish cakes as outlined by Gopakumar (1997). The recipe used for the preparation of fish cake is presented in Table 1. Surimi is mixed with boiled and peeled potato, salt and spice ingredients fried with oil in a bowl chopper till the ingredients are uniformly mixed. The paste is then formed into rectangular shaped cakes each of 20g weight which were battered with egg albumen and breaded with finely ground toasted bread crumbles. The products were fried at 160^0c for 4 minutes and evaluated for sensory attributes such as colour, flavour, texture and overall acceptability on an 8-point hedonic scale (Keeton 1983). The results were analysed statistically (Snedecor and Cochran 1967).

Results and discussion

The raw material characteristics that include the physical and freshness parameters and the proximate composition are presented in Table 2. The dressing yield of silver carp was 68.3% which was fairly good and this may be attributed to the efficient meat picking operation as well as to fairly large size of the fish used in the experiment.

Table 2. Raw material characteristics

Physical Parameters		Values±SD
1	Round weight of fish (g)	1600.0±207.4
2	Weight of dressed fish(g)	1093.0±76.9
3	Yield of dressed fish (%)	68.3±4.4
4	Yield of picked meat(g)	707.0±107.8
5	Yield of picked meat (%)	44.2±1.2
6	Weight of picked meat after washing(g)	580.0±51.9
7	Folding test after first wash*	AA
8	Folding test after second wash*	AA
Proximate composition		
1.	Moisture (%)	74.4±0.30
2.	Protein (%)	16.8±0.10
3.	Ash (%)	1.5±0.09
4.	Fat (%)	2.9±0.05
Freshness parameters		
1.	TVB-N (mg %)	2.6±0.03
2.	SSN (% OF TOTAL NITROGEN)	77.4±0.42
3.	NPN (g/100g)	0.3±0.01
4.	FFA (% of oleic acid)	2.0±0.06
5.	PV (milliequivalent of O_2 /kg)	13.4±0.35
6.	pH	6.9±0.04
Microbiological characteristics		
1.	TPC/g of sample	$2.04x10^5$

* Folding test grading- AA-no breakage on folding twice; A- breaks on second folding; B- breaks on folding once; C- breaks to finger touch.

The proximate composition of DWM and surimi are presented in Table 3. After washing procedure the protein content was found to be 15.4 % in the washed mince. Crawford *et al.* (1989) reported similar observation in whiting washed mince. In the present study, the number of washing cycles was reduced to two, which helped in minimizing unnecessary loss of myofibrilar proteins. Lin and Park (1996) indicated that most sarcoplasmic proteins are removed in the initial washing steps and subsequent washing removed the residual sarcoplasmic proteins along with a small amount of myofibrilar proteins (Lin and Park 1996).

Table 3. Proximate composition and microbiological characteristics of DWM and surimi at 0 day storage

Parameters*	DWM	Surimi
Moisture (%)	80.8±0.16	78.1±0.31
Protein (%)	15.4±0.28	15.9±0.08
Lipids (%)	0.8± 0.03	0.82± 0.02
Ash (%)	0.98±0.008	1.12±0.07
TPC/g	$1.64x10^5$	$1.04x10^5$

*Values are mean of three determinations with S.D.

The fat content of washed mince was 0.8%. Lin and Morrissey (1995) reported a 39% reduction of lipid in freshwater squawfish mince after third washing. The high level of lipid reduction in the present study (72.02%) may be attributed to the characteristic of the meat that contained less fatty muscles. Cryoprotectants in the present study were sucrose (4%), sorbitol (4%) and tripolyphosphate (0.3%) as suggested by Lee (1984). Regenstein and Regenstein (1991) also reported similar formulation. The mixing of the cryoprotectants with washed mince was achieved using a bowl chopper within two and a half minutes as suggested by Park and Morrisey (2000). Care was taken to keep the temperature of the mix within 10°C as at a higher temperature protein functionally could be damaged.

In the present study the TVB-N value for DWM and surimi was found to be 17.03mg% and 12.92mg% respectively, after 90 days of storage (Table 4). As per the EEC directive TVB-N should not be more than 30mg% and thus both the samples were found to be within the acceptable limits. The result is in concurrence with the result obtained by Dora and Chansrasekhar (1998) and Siddaiah *et al.* (1999). SSN was observed to decrease gradually for both the DWM and surimi, the decrease being more in the former and this could be because of the cryoprotective action of sucrose, sorbitol and tri polyphosphate used in the experiment. Dora and Chandrasekhar (1998) observed similar results in pink perch where the decrease in SSP was more in the control samples as compared to the polyphosphate treated one. The NPN content had a decreasing trend in both the samples, which is in confirmation with the result reported by Siddaiah *et al.* (1999).

Table 4. Changes in chemical parameters of DWM and surimi during frozen storage

Days	TVB-N (mg%)		SSN (% of total nitrogen)		NPN (g/100g meat)		FFA (g/100g meat)		PV (milliequivalent of O_2/kg of fat)	
	DWM	Surimi	DWM	Surimi	DWM	Surimi	DWM	Surimi	DWM	Surimi
10	8.05	4.62	80.52	82.65	0.17	0.21	2.49	2.82	14.65	9.10
20	9.06	5.58	78.21	81.15	0.16	0.20	3.41	3.65	15.60	10.23
30	10.23	6.58	76.22	80.22	0.16	0.20	4.43	4.48	16.54	11.66
40	11.31	7.63	74.12	78.98	0.15	0.19	5.26	5.32	17.49	12.62
50	12.40	8.65	73.01	76.32	0.14	0.19	6.18	6.15	18.40	13.83
60	13.48	9.65	70.13	74.95	0.13	0.18	6.64	6.71	19.79	15.78
70	14.19	10.05	76.73	74.02	0.12	0.18	8.03	7.72	21.16	16.14
80	15.76	11.67	63.29	72.87	0.12	0.18	9.85	8.71	22.60	17.31
90	17.03	12.92	61.78	71.33	0.11	0.17	11.76	9.58	23.50	17.76

The increase in PV was observed to be lower in surimi as compared to DWM sample after 90 days of storage. This could be explained due to the application of polyphosphates in surimi, which may indirectly retard lipid oxidation. Higher values of FFA were obtained for DWM as compared to surimi during the storage period which is in confirmation with the result of Verma and Srikar (1994).

The mean panel score for overall acceptability of fried fish cakes prepared from DWM indicates a sudden drop after 60 days (Table 5). The products from surimi were acceptable even after 90 days of storage. The results of ANOVA for flavour showed a significant variation between days ($p<0.05$) as well as between the treatment ($p< 0.05$). As far as texture is concerned there was a significant variation between the days of storage ($p<0.05$) whereas between the treatments variation was insignificant.

Table 5. Mean panel score of sensory attributes of fried fish cakes from frozen stored raw materials

Days	Samples	Colour & Appearance	Flavour	Texture	Overall Acceptability
0	DWM	6.0±1.18	6.6±0.66	6.6±0.66	6.6±0.66
	Surimi	6.6±0.66	7.0±0.45	6.6±0.92	6.8±0.4
30	DWM	5.8±0.4	6.2±0.6	6.2±0.6	6.2±0.4
	Surimi	6.4±0.49	6.4±0.49	6.6±0.91	6.0±1.18
60	DWM	5.6±0.48	5.8±0.6	6.0±0.63	5.4±0.48
	Surimi	6.2±0.6	6.2±0.6	6.4±0.66	6.0±0.77
90	DWM	5.6±0.66	5.8±0.75	5.4±0.66	5.0±0.63
	Surimi	6.0±0.63	6.0±0.89	6.0±0.89	5.8±0.87

*Values are mean scores of 10 panelists with SD

Sensory Evaluation Rating Scale: Like extremely=8; Like=7; Like moderately=6; Like slightly=5; Dislike slightly=4; Dislike moderately=3; Dislike=2; Dislike extremely=1.

Thus, surimi with such a prolonged storage life can be used as a base material to produce diversified products. The silver crap is available locally in good quantity and the products processed out of surimi are found be acceptable after reasonable storage period. Therefore it can be conveniently be concluded that this method, if commercialised shall fetch a good return to the entrepreneurs and silver carp can be put to better and effective use.

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