International Journal of Science, Environment and Technology, Vol. 3, No 3, 2014, 1251 – 1259
ISSN 2278-3687 (O)

DEVELOPMENT OF FISH LOAVES FROM FARM CULTURED *Catla* FISH (*Catla catla*) PREPARED AFTER INCORPORATION OF TOFU

[1]Amandeep Kaur, [2]S.S. Thind*, [3]Amarjeet Kaur and [4]Ritika Walia
[1]Student, [2]Professor, [3]Senior Milling Technologist cum Head, [4]Teaching Assistant
Department of Food Science and Technology, College of Agriculture,
Punjab Agricultural University, Ludhiana, Punjab, India

Abstract: Fish loaf, a minced meat product was prepared from *Catla* (*Catla catla*) fish meat, tofu, spices and other additives. In the minced *Catla* fish meat tofu was incorporated at 0, 5, 10, 15 and 20 percent levels. The loaves were cooked by two methods i.e. simmering (90-92°C for two and a half hours) and baking (150°C for 2 hours). The proximate composition, cooking characteristics, organoleptic quality and microbiological quality of fresh loaves and frozen stored loaves were evaluated. The results revealed that tofu can be successfully incorporated into fish loaves with best acceptability at 10 per cent level of incorporation as per sensory evaluation The loaves produced had better texture, juiciness and overall acceptability scores as compared to control. The loaves were acceptable up to 30 days of frozen storage (-18±2°C).
Keywords: Catla fish, frozen storage, loaves, simmered and tofu.

Introduction

Fish is a good source of animal protein and it has been used from antiquity as a valuable source of food. Around 50 per cent of the world's population derived at least 20 per cent of its animal protein requirements from fish. Fish is also a good source of minerals (Copper, phosphorous, sulphur, iodine and selenium) and rich in calcium, particularly small fish that is eaten with bones. Polyunsaturated fatty acids (especially ω-3 fatty acids) in fish lipids have anti-atherosclerotic and anti-thrombotic properties. In India, annual fish production in 2011-12 was 8.7 million tons (MT) consisting 3.4 MT from marine and 5.3 MT from inland fishery sources (Economic Survey 2012-13). India is the 3rd largest producer of fish in the world and ranks second in Aquaculture. Inland fish production which is growing at a rate of 6 % per annum contributes 55% in the total fish production. The potential for growth is immense and the country is on the threshold of massive development in fisheries and aquaculture (MarEvent 2011).

*Received May 15, 2014 * Published June 2, 2014 * www.ijset.net*

In Punjab, aquaculture is gaining popularity among the farmers as it is becoming more profitable than the cultivation of other regular crops. It has now established itself as a profit making venture and as a means of diversification from agriculture (wheat-paddy rotation). Five major rivers, several rivulets, reservoirs and lakes support a vast irrigation system, and water is also extracted from a rich ground water resource (Dhawan 2006). The commercial success of carp culture in some of the other states like Andhra Pradesh has also encouraged some of the farmers to venture in to carp farming in Punjab. Although fish production has increased significantly, but the carps raised are not very popular among the local population due to the presence of numerous intramuscular bones (Sehgal and Sehgal 2002). Therefore for maintaining growth in this sector, value added convenience fish products as per the local requirements to enhance consumer acceptability need to be developed and popularized.

Kassama *et al* (2003) prepared pan-fried beef patties and studied the effects of soy protein type such as soy protein flour (SPF) or texturized soy protein (TSP) and soy protein extender concentration on pan fried beef patties. Bhadra (2005) developed fish patties from pond cultures *Catla* fish (*Catla Catla*) incorporating texturized soy protein (TSP), deboned minced chicken (DMC) and soy-chicken (SC) at 0, 10, 20, 30 and 40 per cent levels. As per the study 20 per cent TSP, 30 per cent DMC and 20 per cent SC levels were most acceptable organoleptically. Jafarpour *et al* (2012) made a comparative study on effect of egg white, soy protein isolate and potato starch on functional properties of common carp (*Cyprinus carpio*) Surimi gel. Rao and Reddy (2000) studied the influence of binders and refrigerated storage on the quality of chicken meat loaves. They also studied the effect of binders and pre-cooking meat on quality of chicken loaves. Devatkal *et al* (2004) investigated the quality characteristics of loaves from buffalo meat, liver and vegetables. Dunajski (2007) reviewed the morphological and chemical aspects of fish muscle texture and pointed out the differences from red meat. Presland (2003) discussed the source of microbial contamination in fish and fish products.

With this in view, the present investigation was undertaken to improve the binding and textural properties, to enhance the nutritional and functional quality of the fish loaves besides reducing the cost of the final product by blending *Catla* fish mince with non-meat ingredient such as tofu.

Materials and Methods

Catla fish was procured from the local market. The fish were cleaned and dressed in the Department of Food Science and Technology, PAU, Ludhiana as per standard hygienic proce-

dures. They were deboned manually; the deboned meat was packed in double layer polythene bags and frozen at -18±2°C in the commercial freezer. The deboned meat was thawed at 5-10°C by placing it in a refrigerator 10-12 hrs before use and was minced in a food processor (Inalsa, Maxi Plus) before its use in the preparation of loaves. A standard commercial brand of tofu was procured from the local market. The tofu slab was shredded, mixed with 5 per cent water and was ground in food processor for 5 min to form paste, before its incorporation into the batter for fish loaves.

Standardization of product formulation

The recipe of fish loaves was standardized according to local taste requirements through preliminary trials. The opinion of taste panel members was analyzed in optimizing the recipe of the product. The standard recipe is given in Table 1. The trials were conducted using different levels of salt, spices and different ratios of green curry stuff for optimizing the recipe. The trial preparation also helped in training the taste panel members. After standardizing the recipe, the trials were conducted incorporating tofu at 0, 5, 10, 15 and 20% levels.

Preparation of Loaves

The deboned and ground *Catla* fish mince and salt were mixed and chopped for 15 min. in food processor (Inalsa, Maxi Plus) to form a paste. Ground tofu and other ingredients as per formulation were added to the batter and chopped for 15 min in the food processor to form a uniform emulsion. The emulsified batter was filled compactly into metallic moulds (2" x 2") to form loaves approximately 110±5 g in weight. The filled moulds were covered tightly with lids, and then partially cooked for half an hour. Cooking of the fish loaves was done by two methods:-

i) Simmering (90-92°C) in water for two and half hours (till the core temperature of loaves was 71°C).

ii) Baking in hot air oven at 150°C for 2 hours. A container of water was placed inside the oven to maintain high humidity throughout the baking process.

Table 1: Standardized Recipe for the Preparation of Fish Loaves

Ingredients	**Quantity (g)**
Minced Fish	1000.0
Refined Groundnut oil	100.0
Salt	18.0

Dry spices (White pepper – 7 g, cardamom – 2.5 g)	9.5
Green curry stuff (GCS) (25 g onion + 12.5 g ginger + 12.5 g garlic)	50.0
Maida	35.0
Chilled water	40 ml*
Sodium tripolyphosphate	4.0
Sodium alginate	10.0
Sodium nitrate	0.30
Sodium nitrite	0.15
Calcium Carbonate	3.0

*Additional 2 per cent water was added in the formulation for baked loaves.

Tofu was incorporated at 0-20 per cent level.

The loaves were then removed from the moulds after chilling and packed in double layer polythene bags. The loaves were frozen stored at -18±2°C and kept at this temperature till the end of frozen storage period.

Physico-chemical Analysis

The proximate composition (percent moisture, protein, fat, ash) and pH of raw and cooked loaves were determined by AOAC (2000) methods. The cooking yield and per cent shrinkage were calculated by following methods.

Cooking yield: Per cent cooking yield were determined by calculating weight differences of the loaves before and after cooking.

$$\% \text{ Cooking yield} = \frac{\text{Cooked loaf weight}}{\text{Raw loaf weight}} \times 100$$

Shrinkage: Per cent shrinkage was determined by calculating the volume differences of the loaves before and after cooking.

$$\% \text{ Shrinkage} = \frac{\text{Vol of raw loaf} - \text{Vol of cooked loaf}}{\text{Vol of raw loaf}} \times 100$$

Sensory evaluation: Sensory evaluation was conducted by semi-trained panel comprising ten members of the faculty and post-graduate students of Punjab Agricultural University, using a nine point Hedonic scale for evaluation of loaves for appearance, colour, flavor, texture, juiciness and overall acceptability (Keeton 1983).

Microbiological analysis: Microbiological analysis of raw and cooked loaves was conducted by standard pour plate method (APHA 1995) and total plate count (TPC/g) was determined by:

TPC/g = Mean colony count x dilution factor

Statistical analysis: The data on the proximate composition, cooking characteristics, microbial quality and organoleptic scores of fresh and stored frozen fish loaves were statistically analyzed and subjected to analysis of variance using completely randomized design (CRD) (Snedecor and Cochran 1989).

Product economics: It was calculated on relative cost given by Koutsoyiannis (1979).

Results and discussion

The data presented in Table 2, 3 and 4 indicated that moisture content of cooked loaves (simmered and baked) decreased significantly ($P<0.05$) with increase in levels of tofu as compared to raw loaves. It could be due to loss of moisture during cooking. Among the cooked loaves, the reduction of moisture was higher in baked loaves as compared to simmered loaves which could be due to higher temperature (150°C) and higher evaporation during baking as compared to simmering (90-92°C). The protein and fat contents of cooked loaves decreased significantly ($P<0.05$) with increase in levels of tofu.

Table 2: Effect of Replacement of Fish with Tofu (Soy Paneer) Levels on Proximate Composition of Raw Fish Loaves (n=3)

Levels of replacement (%)	Moisture %	Protein %	Fat %	Ash %	pH
0	69.48	15.05	12.59	1.19	6.7
5	68.83	14.91	12.26	1.25	6.8
10	68.54	14.76	12.15	1.33	6.9
15	67.95	14.59	11.89	1.45	7.0
20	67.70	14.50	11.67	1.56	7.0
CD (0.05)	**0.18**	**0.12**	**0.08**	**0.06**	**0.05**

The protein and fat contents of baked loaves was higher as compared to simmered loaves. This could be due to higher moisture loss during baking as compared to simmering. Ash content increased significantly ($P<0.05$) with increase in levels of tofu in cooked loaves as compared to raw loaves. Ash content of baked loaves was higher as compared to simmered loaves which could be due to higher moisture loss during baking as compared to simmering. The pH of loaves increased significantly after baking. The average pH of baked loaves increased with increase in levels of tofu.

Table 3: Effect of Replacement of Fish with Tofu (Soy Paneer) Levels on Proximate Composition of Simmered Fish Loaves (n=3)

Levels of replacement (%)	**Moisture (%)**	**Protein %**	**Fat %**	**Ash %**	**pH**
0	62.25	17.56	12.61	1.42	6.9
5	61.93	17.51	12.29	1.48	7.0
10	61.34	17.36	12.18	1.54	7.0
15	60.73	17.32	11.92	1.67	7.1
20	59.55	17.25	11.70	1.78	7.1
CD (0.05)	**0.25**	**0.11**	**0.08**	**0.06**	**0.05**

Table 4: Effect of Replacement of Fish with Tofu (Soy Paneer) Levels on Proximate Composition of Baked Loaves (n=3)

Levels of replacement (%)	Moisture %	Protein %	Fat %	Ash %	pH
0	58.61	17.72	12.66	1.47	6.98
5	56.61	17.59	12.34	1.53	7.05
10	56.35	17.41	12.23	1.61	7.08
15	55.68	17.37	11.97	1.70	7.15
20	55.52	17.32	11.76	1.84	7.20
CD (0.05)	**0.28**	**0.12**	**0.08**	**0.06**	**0.05**

The cooking yield increased significantly ($P<0.05$) with increase in levels of tofu as detailed in Table 5. The cooking yield was higher in simmered loaves (89.01%) as compared to baked loaves (83.08%). These differences in cooking yield can be due to higher moisture loss during baking as compared to simmering.

Table 5: Effect of Replacement of Fish with Tofu (Soy Paneer) Levels on the Cooking Characteristics of Simmered and Baked Fish Loaves (n=3)

Levels of Replacement (%)	**Cooking Yield (%)**		**Shrinkage (%)**	
	Simmered	**Baked**	**Simmered**	**Baked**
0	88.13	81.80	2.15	4.84
5	88.48	82.34	2.07	4.73
10	89.01	83.08	2.01	4.65
15	89.42	83.43	1.96	4.51
20	90.24	83.77	1.91	4.47
CD (0.05)	0.26	0.23	0.03	0.05

Similar findings were reported by Nath *et al* (1996) on chicken patties. Per cent shrinkage was significantly (P<0.05) higher in baked loaves (4.65%) as compared to simmered loaves (2.01%). The total plate count (TPC) of fresh raw fish-tofu loaves was $3.29x10^5$/g which decreased significantly (P<0.05) to $1.63x10^2$/g in cooked loaves after 30 days of frozen storage (-18±2°C). A microbial reduction of two log cycles was observed in all frozen loaves as can be seen in Table 7. Simmering resulted in decrease of TPCs from 2.51 x 10^3/g to 4.83 x 10^1/g in fish tofu loaves whereas by baking TPCs decreased from 2.33 x 10^3/g to 4.73 x 10^1/g. It was observed that baking resulted in lower TPC values in loaves than simmering.

It was inferred that only spore forming microorganisms might have survived higher baking temperatures (150°C) than simmering (90-92°C). The data presented in Table 6 indicated that the simmered loaves scored higher ratings for appearance, color, flavor, texture, juiciness and overall acceptability as compared to baked loaves.

Table 6: Effect of Replacement of Fish with Tofu (Soy Paneer) Levels on the Organoleptic Scores of Simmered and Baked Fish Loaves (n=10)

Levels of Replacement %	**Appearance**		**Colour**		**Flavour**		**Texture**		**Juiciness**		**Overall acceptability**	
	B	**S**	**B**	**S**	**B**	**S**	**B**	**S**	**B**	**S**	**B**	**S**
0	8.30	8.50	8.00	8.00	8.00	8.05	7.59	8.00	7.20	7.75	7.81	8.06
5	8.50	8.55	8.50	8.55	8.50	8.50	7.90	8.50	7.51	8.00	8.18	8.42
10	8.70	8.94	8.60	8.95	8.55	9.00	8.15	8.85	7.80	8.95	8.36	8.93

15	7.50	8.00	7.50	8.80	7.50	8.50	8.12	8.35	7.43	8.35	7.61	8.40
20	7.00	7.50	7.00	7.50	7.00	7.67	7.00	7.75	7.35	7.50	7.07	7.58
CD (0.05)	0.32	0.26	0.36	0.25	0.30	0.27	0.38	0.45	0.40	0.50	0.40	0.19

Results showed that tofu can be successfully incorporated in the *Catla* fish loaves at 10 per cent level and its substitution improved their texture, binding properties and nutritional quality. It was found that the relative cost of fish loaves using tofu was 0.35 as compared to control (1.00) *Catla* fish loaves.

Table 7: Effect of Frozen Storage and Cooking (simmered and baked) on Total Plate Count (TPC/g) of Fish Loaves incorporated with Tofu (n=3)

Loaves	**Frozen Storage period (days) (-18±2°C)**	**Total Plate Count – Raw**	**Total Plate Count – simmered**	**Total Plate Count – Baked**
Control	0	3.92×10^5	2.86×10^3	2.57×10^3
	15	2.99×10^3	4.27×10^2	4.07×10^2
	30	1.98×10^2	5.94×10^1	5.67×10^1
CD (0.05)		**1.82**	**1.71**	**1.54**
Fish Tofu	0	3.29×10^5	2.51×10^3	2.33×10^3
	15	2.71×10^3	3.98×10^2	3.87×10^2
	30	1.63×10^2	4.83×10^1	4.73×10^1
CD (0.05)		**1.78**	**1.58**	**1.48**

References

[1] AOAC 2000. Official Methods of Analysis. 16th Edn. Association of Official Analytical Chemists, Washington, U.S.A.

[2] APHA. 1995. Standard methods. 19th Edition. American Public Health Association, Washington, DC.

[3] Ali Jafarpour, Habib-Allah Hajiduon and Masoud Rez aie (2012). A Comparative Study on Effect of Egg White, Soy Protein Isolate and Potato Starch on Functional Properties of Common Carp (Cyprinus carpio) Surimi Gel. , *J Food Process Technol* 2012, 3:11.

[4] Bhadra P, (2005) Development of fish patties from low value *Catla* fish (*Catla Catla*). M.Sc. Thesis, Punjab Agricultural University, Ludhiana, India.

[5] Dhawan, A. (2006) Diversification from major carp farming-promising options in Punjab. *Fishing chimes*, **25**(10): 136–140.

[6] Economic Survey 2012-13. Govt. of India, Ministry of Finance, Economic Division, p 186.

[7] E. Dunajski (2007) Texture of Fish Muscle. *J. Tex. Stu.*, **10**(4): 301-318.

[8] Indian Fisheries Aquaculture – MarEvent (2011) - Fisheries And Aquaculture Booming In India, http://www.marevent.com/apa11india/INDIAN%20FISHERIS%20&%20AQUACULTURE[1].pdf, 20th dec 2013.

[9] Kassama L S, Ngadi M O and Raghavan G S V (2003) Structural and instrumental textural properties of meat patties containing soy protein. *International J Food Properties* **6**: 519-29.

[10] Keeton J T (1983) Effect of fat and NaCl/phosphate levels on the chemical and sensory properties of pork patties. *J Food Sci* **48** : 878-81.

[11] Koutsoyiannis A (1979) Modern Microeconomics. 2nd edition. The Macmillan Press Ltd., New York. P 107.

[12] Nath R L, Mahapatra N, Kondaiah N and Anand D (1996) Effect of levels of chicken fat on quality and storage life of chicken patties. *Indian J Poultry Sci* **30** : 52-57.

[13] Presland F (2003) Microbial threats in fish and fish products. *International Food Hygiene* **14**: 11-13.

[14] Rao, B.J. and K.P. Reddy (2000) Influence of binders and refrigerated storage on the quality of chicken meat loaves. *Indian J. Poult. Sci*., **35**: 302-305.

[15] Sehgal H S and Sehgal G K (2002) Aquacultural and socio-economic aspects of processing carps into some value-added products. *Bioresource Technol* **82** : 291-93.

[16] Snedecor G W and Cochran W G (1989) Statistical Methods. 8th Edn. IOWA State University Press, Ames, IOWA.

[17] Suresh Devatkal, S.K Mendiratta and N Kondaiah (2004) Quality characteristics of loaves from buffalo meat, liver and vegetables. *J. Meat Sci.,* **67**: 377-383.