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Research Note

Nutritional Stability and Sensory Quality of Fish Chips Made from Recovered Thai Pangas (*Pangasianodon hypophthalmus*) Mince During Extended Storage

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This study aimed to develop chips from (Thai pangas (*Pangasianodon hypophthalmus*) fish filleting discards and evaluate their nutritional stability during storage at 28-32°C. The chips were made with 40% recovered mince, 22.5% rice bran, and 20% mashed potatoes. Nutritional parameters, including moisture, protein, lipid, ash, carbohydrates, and calories, were monitored initially at 15-day intervals, then every 30 days. Results showed minimal changes in sensory qualities over a period of 270 days. The findings indicate that fish chips made from recovered Thai pangas mince can be stored at room temperature for up to nine months without significant degradation in nutritional aspects/parameters.

Keywords: Thai pangas (*Pangasianodon hypophthalmus*), Recovered mince, Fish chips

Snacks, which are often energy-dense and nutrient poor, contribute close to one third of daily energy intake in the recent time (Njike et al., 2016). Notably, the production and consumption of snack foods have increased worldwide, becoming popular among all ages and social groups (Hassan-Wassef, 2004). Therefore, the addition of fish mince to various types of food products should be seriously considered for promoting health (Egemen, 1986; Eksi & Karadeniz, 1996; Obatoluve & Cole, 2000). Mahmoud, Khallaf, Nessrien, & Abou-Taleb (2016) produced silver carp fish chips and stored them at -18±2°C for three months. Izci, Gunlu, & Bilgin (2010) produced fish chips using *Carassius gibelio* and investigated the fatty acid profile and sensory quality of the fish crackers. Zzaman, Yusoff, & Yang (2017) processed fish chips from frozen bighead carp (*Hypophthalmichthys nobilis*), Rohu (*Labeo rohita*), and Dory (*Pangasius hypothalamus*). Shaltout (1993) prepared fish chips from wheat flour and minces of cod (*Gadus morhua*) at a flour-to-fish ratio of 90-10, 80-20, and 70-30. Thai pangas *(Pangasianodon hypophthalmus*) is the most popular, and cheapest fish species in Bangladesh. Sarker (2000) reported that among exotic fish species, Thai pangas is the best due to its ease of culture, favorable weather conditions for culture, and high market demand. It is an excellent source of protein and lipids that contain omega-3 fatty acids, especially eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) (Kris-Etherton et al., 2000). The yield of this fish is around 35% for boneless fillets, and the rest of the parts are bones and oils (Patil, 2013). It has been observed that after preparing fillets from the whole fish, a considerable amount of muscle remains unutilized with the head, tail, and other body parts of the fish. This unutilized muscle can be recovered and utilized in the preparation of mince-based fish products. Therefore, preparing mince-based products like fish chips with the recovered mince from Thai pangas fish waste might be a better option for utilizing this unutilized mince. Research on product development has not been done extensively, and literature on these types of products is also scarce. Considering these facts, the present study was carried out to prepare chips by incorporating the recovered mince from Thai pangas fish waste. These fish chips were stored in air-tight polyethylene packets at room temperature (28 to 32°C) and the changes in the nutritional parameters

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during the storage period of 270 days were determined.

Thai pangas (*P. hypophthalmus*) fish frames and other major ingredients (potatoes, rice flour, salt, oil, and different spices) were procured from the nearby KR Market, Bangladesh Agricultural University campus, Mymensingh, Bangladesh. Fish frame samples were washed and simmered at low heat for 15 to 20 minutes. Fish flesh was recovered from the skeleton by manually removing the oil and skin. The recovered flesh was minced, and water was removed. The fish mince was weighed, packed in a plastic container, and stored in the refrigerator for about an hour until the other ingredients were prepared. The formulation of fish chips is presented in Table 1. In the preparation of control chips, rice flour, and potatoes were mixed with other ingredients. For the fish chips, the exact quantity of potatoes by weight were replaced with the recovered fish mince (20%, 30%, and 40% of the total amount). The quantity of other ingredients in the fish chips was the same as in the control chips. The dry ingredients, such as rice flour, salt, and powdered spices, were weighed and kneaded for 15 minutes. Then, oil and boiled (mildly hot) water were added to the mixture to prepare the dough. The dough was prepared by mixing all the ingredients with the fish mince and made into thin breads and then cut into small pieces with a knife to shape the chips. The fish chips were then dried in an oven at 65°C for 4-6 hours. After drying, the fish chips were cooled, packed in air-tight polyethylene packets, and stored at room temperature (28 to 32°C) until further use. Sensory evaluation of the prepared fish chips (control and chips with 20%, 30%, and 40% fish mince) was conducted by a panel of 10 members (in the age group of 24-50 years). The samples were evaluated on a 9-point hedonic scale based on overall acceptability (Table 2) (Peryam & Pilgrim, 1957). The hedonic rating scores were as follows: 9 = like extremely, 8 = like very much, 7 = like moderately, 6 = like slightly, 5 = neither like nor dislike, 4 = dislike slightly, 3 = dislike moderately, 2 = dislike very much, 1 = dislike extremely. Among the four different fish chips, S3 (prepared with 40% recovered fish mince) received the highest score for all characteristics (Table 2). This variant was further prepared and stored at room temperature (28 to 32°C) in air-tight polyethylene packets (12×18 cm zipper polyethylene bags with 0.08 mm thickness). The moisture, ash, protein, and lipid content were determined according to the procedures described in AOAC (2000) and AOAC (2004). The total carbohydrate was calculated by approximation, indirectly, by subtracting the measured moisture, ash, protein, and lipid from 100 (Srivastava & Kumar, 1994). The total calories of the samples were calculated using the following formula (Srivastava & Kumar, 1994):

Calories of the samples (kcal) = [9× (g fat)] + [4 × (g protein)] + [4 × (g carbohydrate)]

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All measurements were performed in triplicate, and values are expressed as the mean±SD.

The proximate composition of whole raw fish mince recovered fish mince, and dough of fish chips is presented in Table 3. In this study, the moisture, ash, protein, and lipid content were found to be 72.37±0.68, 1.64±0.14, 19.60±0.95, and 5.29±0.47 for

Table 1. Basic formulation of 100 g control chips and fish chips with rice flour and recovered mince (20,30 and 40%) from Thai Pangaswaste

Ingredients	Samples with fish mince			
	Control	20% fish mince	30% fish mince	40% fish mince
Fish mince (g)	0	20	30	40
Potatoes	52.5	32.5	22.5	12.5
Rice flour (g)	30	30	30	30
Oil (g)	5	5	5	5
Salt (g)	2	2	2	2
Powdered Spices (g)	0.5	0.5	0.5	0.5
Water (g)	10	10	10	10
Total	100	100	100	100

Table 2. The assessment scoresgiven for fish chips by panel members

Panel Members	Scores			
	CN (Control)	S_1N (20% fish mince)	S_2N (30% fish mince)	S_3N (40% fish mince)
Member 1	5	8	8	9
Member 2	6	7	8	8
Member 3	6	8	8	9
Member 4	7	7	8	9
Member 5	6	7	7	8
Member 6	5	6	7	9
Member 7	6	6	8	8
Member 8	5	7	8	7
Member 9	5	6	6	7
Member 10	7	7	8	9
Total	58	69	76	83
Mean	5.8	6.9	7.6	8.3

Table 3. Proximate composition of raw pangas fish, recovered fish mince and dough of fish chips (% moisture basis)

Components (%)	Raw fish	Recovered fish mince	Dough of fish chips (40% fish chips)
Moisture	72.37±0.68	66.05±1.13	52.11±1.67
Ash	1.64±0.14	1.51±0.08	1.20±0.19
Protein	19.60±0.95	21.22±1.52	11.91±1.85
Lipid	5.29±0.47	5.11±0.37	1.50±0.27

raw fish; 66.05±1.13, 1.51±0.08, 21.22±1.52, and 5.11±0.37 for recovered fish mince; and 52.11±1.67, 1.20±0.19, 21.91±1.85, and 1.50±0.27, respectively, for the dough of fish chips. Among these samples, the highest moisture content (72.37±0.68) was found in whole raw fish mince, and the lowest (52.11±1.67) was found in the dough of fish chips. The highest protein content (21.22±1.52) was obtained in recovered fish mince, and the lowest was observed in the dough of chips incorporating 40% fish mince (11.91±1.85). Orban et al. (2008) found a protein content range of 12.6-15.6% in Thai pangas fillets. Begum, Akter, & Minar (2012) reported a moisture content of 78.29%, ash content of 1.78%, and protein content of 12.78% for aquarium-reared Thai pangas (*P. hypophthalmus*). In another study, Shikha, Hossain, Rahman, Sharma, & Asadujjaman, (2014) found a moisture content of 78.60% and a lipid content of 4.56% in Thai pangas. The values for proximate analyses obtained in the present study differed slightly from the reported values, which may be due to differences in experimental time and conditions. Four different chip samples (Control chips without recovered fish mince and fish chips with 20%, 30%, and 40% recovered fish mince per 100g) were analyzed for moisture, ash, protein, and lipid content. The results are presented in Table 4. In the control chips sample, moisture content was 4.08±0.31, ash content was 2.79±0.32, protein content was 10.96±1.19, and lipid content was 5.6±0.47. In the fish chips sample (with 40% mince), moisture content was 5.11±0.46, ash content was 1.89±0.41, protein content was 23.84±1.46, and lipid content was 7.21±0.84. In their study, Kamari & Shabanpour (2013) found 3.48% moisture and 16.06±0.83% protein in dried fish chip samples. Kim (2005) reported an ash content of 1.10% in noodle samples, which is close to the values obtained in the present study. The increase in protein content in the fish chips sample compared to the control is attributed to the addition of recovered fish mince in the chip dough preparation. The changes in the proximate

Table 4. Proximate composition of prepared fish chips samples (dry matter basis)

Components(%)	CN (Control)	S_1N (20% fish mince)	S_2N (30% fish mince)	S_3N (40% fish mince)
Moisture	4.08±0.31	4.18±0.29	4.96±0.42	5.11±0.46
Ash	2.79±0.32	1.16±0.43	1.43±0.39	1.89±0.41
Protein	10.96±1.19	18.05±1.11	21.12±1.24	23.84±1.46
Lipid	5.6±0.47	6.75±0.51	7.01±0.62	7.21±0.84

Table 5. Changes in nutritional parameters of fish chips during storage of 270 days at room temperature (28 to 32°C)

Storage periods (Days)	Moisture	Ash	Protein	Lipid	Carbohydrate	Calories
0	5.78±0.96	1.93±0.35	23.84±2.04	7.40±0.79	60.86±3.37	406.16
15	5.71±0.84	1.95±0.21	23.92±1.77	7.10±0.30	61.32±3.21	404.86
30	5.87±1.20	1.98±0.14	23.83±1.03	6.80±0.98	61.52±1.96	402.60
45	5.94±0.73	2.01±0.57	23.56±1.44	6.75±0.65	61.74±2.06	401.95
60	5.98±1.21	2.04±0.76	22.98±0.60	5.51±0.21	63.49±1.61	395.47
90	6.02±0.62	2.08±0.93	22.93±1.76	5.09±0.16	63.88±0.53	393.05
120	6.06±0.83	2.02±0.25	22.88±1.48	4.78±0.83	63.26±1.21	387.58
150	6.09±1.32	2.07±0.18	22.83±0.81	4.54±0.48	63.47±1.69	386.06
180	7.03±0.10	2.01±0.34	22.79±0.14	4.31±0.55	61.86±1.66	377.39
210	7.06±0.34	2.05±0.08	22.76±0.16	4.10±0.10	62.03±1.93	376.06
240	8.00±0.57	2.09±1.03	22.73±1.77	3.88±0.89	61.30±2.72	371.04
270	8.05±0.38	2.03±1.51	22.68±0.89	3.71±0.71	60.53±2.24	366.23

composition of stored fish chips (prepared with 40% fish mince and stored at room temperature in polyethylene packets) are presented in Table 5. The samples were examined at 15-day intervals initially and then at 30-day intervals during advanced stages of storage. The moisture content of the chips gradually increased over time, but none were considered unacceptable. The highest moisture value was 8.05±0.38 on the 270th day of storage. The highest protein content was found on day 0 (24.03±2.04) and gradually decreased over time, reaching 22.68±0.89 on the 270th day. Lipid content ranged from 7.40±0.79 to 3.71±0.71 throughout the storage period. The Ash content of the fish chips was 1.93±0.35 on day 0 and increased gradually with time. The highest carbohydrate content was 63.88±0.53 on the 90th day, with the lowest value recorded as 60.53±2.24 on the 270th day of storage. During storage, the calorie content of the fish chips gradually decreased over time. Huda, Aminah, & Babji (2000) reported moisture content ranging from 9.37% to 13.83%, ash content from 3.39% to 5.94%, protein content from 5.53% to 15.80%, and lipid content from 0.85% to 3.38% for fish crackers. Ejembi, Sanni, Emmanuel, & Abbah (2014) found a protein content of 12.69% in their noodle samples. Ikasari & Hastarini (2016) reported moisture content ranging from 3.22% to 5.42%, ash content from 3.33% to 4.94%, protein content from 3.77% to 5.83%, lipid content from 6.59% to 9.04%, and carbohydrate content from 71.06% to 76.34% for chips enriched with shrimp shell powder. The reported values for noodles, chips, or fish crackers are comparable to the values obtained for fish chips in the present study. No major changes were observed in the proximate composition of fish chips during the extended storage period of up to 270 days. The sensory evaluation of the prepared fish chip samples was conducted for color and appearance, flavor, taste, and texture during the 270-day storage period (Table 6) at room temperature in air-tight polyethylene packets. Sensory evaluations

Table 6. Changes in the sensory quality attributes (on the basis of sum of the scores given by the panelists) of fish chips during 270 days of storage at room temperature (28 to 32°C)

Storage Temperature	Days of Storage	Observation			
		Color and appearance	Flavor	Taste	Strength
Room	0	Excellent	Excellent	Excellent	Excellent
temperature	15	Excellent	Excellent	Excellent	Excellent
(28 to 32°C)	30	Excellent	Excellent	Excellent	Excellent
	45	Excellent	Excellent	Excellent	Excellent
	60	Excellent	Excellent	Excellent	Excellent
	90	Very good	Very good	Very good	Very good
	120	Very good	Very good	Very good	Very good
	150	Very good	Very good	Very good	Very good
	180	Very good	Very good	Very good	Very good
	201	Very good	Very good	Very good	Very good
	240	Good	Good	Good	Good
	270	Good	Good	Good	Good

were performed at 15-day and 30-day intervals. The results showed no major changes in the color and appearance, flavor, taste, or texture of the fish chips. No mold growth was observed on the fish chip samples during this storage period. Neiva, Machado, Tomita, Furlan, Lemos Neto, & Bastos (2011) evaluated the chemical stability and microbiological safety of non-expanded dried fish crackers during a 180-day storage period at room temperature using appropriate packaging materials. Netto, Oliveira Filho, D., Lapa-Guimarães, & Viegas (2014) assessed the sensory acceptance of fish snacks prepared from Nile tilapia waste mince and found no significant changes in color, taste, flavor, texture, or crispiness, which is consistent with the findings of this study.

This study demonstrates that chips made from recovered mince of Thai pangas (*P. hypophthalmus*) are nutritionally stable and sensory acceptable over a long-term storage period. The incorporation of 40% fish mince in the chip formulation significantly influenced the proximate composition, resulting in higher protein content compared to control chips without fish mince. The chips exhibited minimal changes in moisture, ash, protein, and lipid content over the 270-day storage period at room temperature (28-32°C). The sensory qualities, including color, appearance, flavor, taste, and texture, remained largely unaffected, indicating the potential of these fish chips to maintain quality over extended storage. These findings suggest that the utilization of recovered fish mince in snack products can enhance nutritional value while addressing waste management issues in fish processing. The development of such value-added products could promote better utilization of fish by-products, contributing to economic and environmental sustainability. Further research could explore optimization of the formulation and packaging techniques to extend shelf life and improve the sensory attributes of fish chips.

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