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Development of pickle from Thai pangus (*Pangasianodon hypophthalamus*) muscle and changes in it's nutritional composition during storage

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Abstract

Fish pickle was developed from Thai pangus (*Pangasianodon hypophthalamus*) fish muscle by using different types of food additives. Mustard oil and soybean oil were used for preparing fish pickle. Dorsal muscle and whole fish muscle without bone were used as raw material for preparing fish pickle. Changes in nutritional composition, pH, bacteriological and sensory attributes were determined at room temperature (30–35°C) according to standard procedures. At room temperature (30-35°C) fish pickle prepared from dorsal muscle and whole fish muscle using both mustard oil and soybean oil remained in acceptable condition until 12/13 days. Bad smell produced in the pickle after 15th day of storage. Moisture, protein, lipid and pH value decreased but ash content increased with the progress of storage period. In case of soybean oil used pickle deterioration was faster than the pickles prepared using mustard oil. Bacterial load was higher in soybean oil pickle and the pickle prepared from whole fish muscle.

Introduction

It is well known that fish flesh has some unique characteristics as having high protein content with balanced profile of amino acids, polyunsaturated and essential fatty acids with ω-3 series of fatty acids and low level of harmful cholesterol and saturated fat (Edwards and Kaewpaitoon, 1981).

Fish can act not only as a source of protein to human being, but also provide foreign exchange earning to many people when the harvesting, handling and processing methods done in the right way and time (Mazrouh MM. 2015). In addition, preservation and processing can assure availability of fish in all year round (Smida MAB, 2014 and Oparaku *et. al.*, 2013) The bio-chemical composition of fish is the vital aspect in fish processing, because which influences both the quality and technological characteristics of it (Farid FB *et. al.*, 2014) Different processing methods of fish have different effect on their chemical, physical and nutritional compositions (Akinneye JO *et. al.*, 2010) The effect could be either chemical or physical changes, which affects digestibility due to protein denaturation and reduction in the content of mobile compounds and polyunsaturated fatty acids. The quality and shelf life of fish differs using different methods and has different acceptability by consumers (Mojisola O., 2014). During fish processing several changes is occurred. Depending on the extent of heating and temperature protein denaturation may resulted. Heating also brings deconformation of natural features of the protein molecules or complexes, resulting in exposure of the reactive groups. Most proteins are compounds liable to quality and quantity changes during heat processing. The loss of solubility of temperature sensitive proteins can be utilized as an indicator of the time and temperature that had been applied in heat processing of varieties of fish and fish products (Akinneye JO *et. al.*, 2010; Alipour HJ *et. al.* 2010; Sarker ZI *et. al.*, 2012 and Sriket P *et. al.*, 2007). Sriket P. *et al.*, 2007 and El & Kavas 91996) reported that protein digestibility is reduced as a result of complex chemical (cross-linking) reactions, such as protein interactions or protein-fat interactions when fish is boiled at high temperatures. Pourshamsian K. *et al.* (2012) noted that frying has an effect on proximate composition and fatty acids of fish and fish products. Nevertheless, no basic information regarding the effect of processing methods on nutritional and physicochemical composition of fish processed in Eritrea fish processing plants (Eri-fish processing plant and Eritrea Marine Product Company) has been reported (https://medcraveonline.com/MOJFPT/MOJFPT-06-00191.pdf).

Pickling is a safe and easy method of putting up fish for short term storage when carefully prepared under most hygienic conditions with addition of required quantity of salt, preservatives and spices (Sharma and Sarma, 2012). Most of the sea fish like prawn, tuna, pomfret, mackerel,

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etc. are ideally suitable for making fish pickles (http://cift.res.in/fish-pickle). Preserving fish through pickling is a universal method and in South Africa what sets this apart is the addition of flavorful spices (http://eprints.cmfri.org.in/1842/1/Article_10.pdf). For effective capacity utilization and potential production of diversified products, processing of the underutilized fish species into value added products will bring immediate benefit to the existing fish processing industries in Bangladesh (Nowsad *et al.*, 1994). Therefore it is very important to develop new processing techniques of underutilized protein resources to make them useful and palatable food for human consumption. In Bangladesh almost no publication is available on the development of fish pickle and it's shelf life. So, it is important to explore researches on developing fish pickles from available low cost fishes and also on their storage life under various conditions.

Pangus catfish, commonly called Thai pangus (*Pangasianodon hypophthalamus*) a low priced fish in fish markets. On the other hand the smell and pinkish color of pungas muscle are not much suitable to produce fillet of high grade. But this pungas muscle would serve as an adequate source of raw material for preparing fish pickle. As picking undergoes with the addition of different ingredients and cooking operation so it may provide a product of sub continental familiar taste and also fish protein to young and outgoing people in "ready to eat" form. A sustainable aquaculture of pangus catfish can be achieved by increasing its utilization in the development of diversified fishery products like fish pickle. At the same time the farmer can earn handsome money by supplying fish to the pickle producing companies Considering these facts, current study was designed to develop fish pickle from the dorsal muscle and whole Thai pangus fish muscle using mustard oil and soybean oil and observing the changes in nutritional composition, pH, bacteriological and sensory attributes stored at room temperature (30-35°C).

Materials and Methods

Duration of the Study

The present study was conducted in April-May, 2013 (From January to March, 2013 was trial period), in the laboratories of Fisheries Technology Department of Bangladesh Agricultural University, Mymensingh.

Sources of Samples

The samples (Thai pangus; *Pangasianodon hypophthalamus*) were collected from Kamal- Ranjit (KR) market of Bangladesh Agricultural University, Mymensingh in fresh condition. These were immediately transported to the Fish Processing laboratory of Fisheries Technology Department.

Preparation of Fish Pickle

Ingredients for Fish Pickle

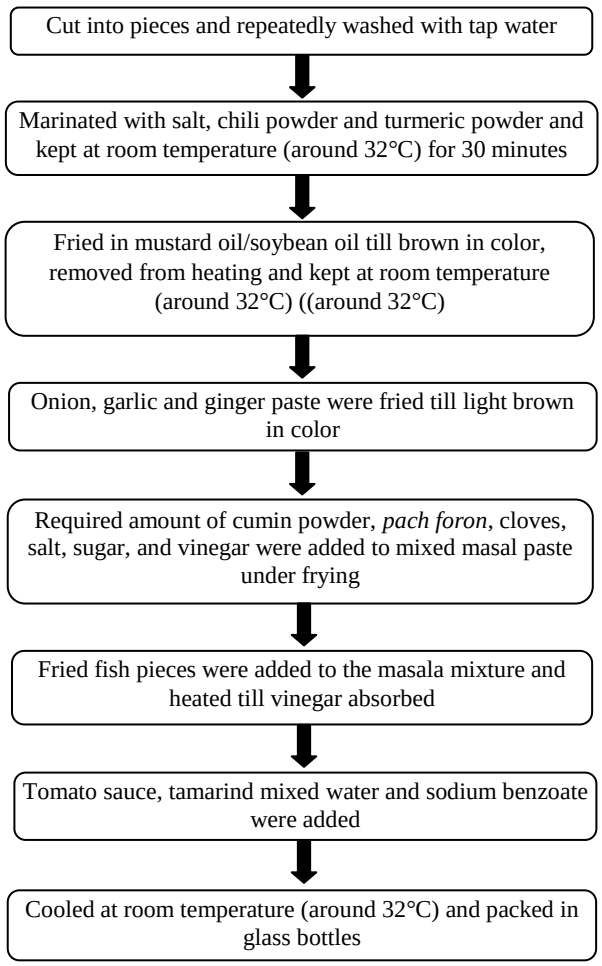
Fish pickle was prepared from the collected fish according to the method described below. Standard recipe for the preparation of pickle and condiment are given in the following Table 1.

Table 1. Standard Recipe for Fish Pickle Preparation

Ingredient name	Amount	Ingredient name	Amount
Fish muscle	500g	Vinegar	50ml
Chili powder	20g	Black pepper	2g
Turmeric powder	2g	*Pach foron*	5g
Cumin	10g	Sugar	50g
Onion	20g	Salt	30g
Garlic	80g	Tomato sauce	30g
Ginger	10g	Tamarind	20g
Cloves	2g	Sodium benzoate	1g
Mustard oil	150ml		

Fish Pickle Preparation Procedure

The fishes were thoroughly washed with tap water to remove contaminants on the skin. Then the fishes were cut into small pieces (approx. 1 cm^3) using sharp knife and washed with tap water in the laboratory to remove bloods and other contaminants. The pieces were marinated, fried in mustard oil, added other ingredients and finally heated till vinegar absorbed. During packing care was taken to see that there was layer of oil over the contents in the bottles. The detail procedure is as follows-



Flow Diagram of Fish Pickle Preparation

Sample Storage:
Prepared pickle samples were stored at room temperature (30–35°C) in 12 glass bottles for around 20 days. Each of the bottles contained 300g pickle. Among these 12 bottles- pickle prepared from dorsal muscle with mustard oil were stored in 3 bottles, pickle prepared from dorsal muscle with soybean oil were stored in another 3 bottles. Pickle prepared from whole fish muscle also stored in 3 + 3 separate bottles for mustard oil and soybean oil.

Quality Analysis
Weekly analysis of the samples were done for 15 days at room temperature (30–35°C). Triplicate samples were taken to carry out the experiment. Proximate composition (moisture, protein, lipid and ash) of fish pickle were tested according to the standard methods described by Association of Official Analytical Chemists (AOAC, 2005).

Determination of pH value
pH was measured at room temperature following the method described by AOAC (2005). At first accurately 5g sample was taken and homogenously mixed in 50 ml distilled water. pH was measured using an electronic pH meter (HANNA pH 211 Microprocessor pH Meter) with a glass electrode using expandable scale.

Determination of APC
The colonies units (CFU) were counted under a Quebec dark field colony counter (Leica, Buffalo. NY. USA) equipped with a guide plate ruled in square centimeters. Plates containing 30-300 colonies were used to calculate bacterial load using following formula:

$$\mathrm{APC}\left(\frac{\mathrm{CFU}}{\mathrm{g}}\right) = \frac{\text{No of colonies on petridish} \times \text{Dilution factor} \times \text{Vol. of stock solution} \times 10}{\text{Wt. of pickle or condiment sample}}$$

Sensory evaluation
A panel of nine persons of teachers and students of the Department of Fisheries Technology provided the sensory assessments of the products (Nowsad *et al.*, 2000). Sensory evaluation of the fish pickle was conducted according to the grade 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. Chewiness / Rubberiness were defined as the amount of effort the panelist had to exert in chewing to prepare the sample for swallowing. Color and flavor were evaluated organoleptically.

Statistical Analysis
One-way analysis of variance and the general linear model using Windows for SPSS 9.0 were used to analyze the data. The Duncan‟s New Multiple Range Test (DMRT) was used to find the significant differences between storage periods.

Results

Biochemical Composition of Fresh Fish
The fish collected from the Kamal-Ranjit market of Bangladesh Agricultural University were fresh and many of them were in live condition. The initial chemical composition of fresh fish samples obtained as protein content 13.92%, lipid content 4.93%, moisture content 78.61% and ash content 2.25% (Table 2).

Table 2. Proximate Composition (average value) of the Fresh Thai pangus (*Pangasianodon hypophthalamus*) Muscle

Parameters	**Results (%)**
Moisture	78.61 ± 0.76
Protein	13.92 ± 0.62
Lipid	4.93 ± 0.12
Ash	2.25 ± 0.06

Changes in the Protein Content of Fish Pickle
The initial protein content was 13.92% in fish body. After preparing fish pickle with mustard oil and soybean oil the protein content reached to19.47% and 16.15% (pickle prepared with dorsal muscle) and 19.07% and 16.62% (pickled prepared with whole fish muscle), respectively. As the time passed, protein content mostly decreased. In case of pickle prepared with dorsal muscle (using mustard oil), after 7days of storage protein content reached to 17.67%, then after 15 days of storage more deterioration occurred and the value reached to 15.99%. While soybean oil was used to prepare pickle these values were 15.85% (after 7 days) and 15.45% (after 15 days), respectively (Table 3). On the other hand fish pickle prepared with whole fish muscle using both mustard oil and soybean oil slight differences in the protein content were observed. Fish pickle prepared with whole fish muscle (using mustard oil), protein content reached to 17.81% after 7days of storage and after 15 days of storage 16.38 %. While pickle was prepared using soybean oil (with whole fish) the obtained values were 16.30% (after 7 days) and 15.97% (after 15 days), respectively (Table 3).

Changes in the Lipid Content of Fish Pickle
The changes in the lipid content (%) of fish pickle prepared with dorsal muscle during storage period of 15 days at room temperature (30-35°C) are shown in Table 4. The initial lipid content of fresh fish was 4.93%. After preparing pickle using mustard oil and different spices it reached to 17.57%. As the time passed the lipid content gradually decreased and reached to 16.78% after 7 days of storage and after 15 days of storage to 15.38%. In the pickle prepared using soybean oil the lipid content reached to 18.28% which is greater than the sample prepared using mustard oil. As the time passed lipid content gradually decreased to 17.38% after 7 days of storage then after 15 days of storage it declined to 16.68%. On the other hand, the lipid content of fish pickle prepared with whole fish muscle using mustard oil during the storage period of 15 days reached to

22.59%. As the time passed lipid content gradually declined to 20.42% after 7 days of storage and after 15 days of storage it decreased to 17.18%. In fish pickle prepared using soybean oil from whole fish the lipid content reached to 25.58% initially which is greater than the sample prepared using mustard oil. As the time passed lipid content gradually decreased to 22.78% after 7 days then after 15 days of storage it declined to 19.58% (Table 4).

Changes in the Moisture Content of Fish Pickle

Changes in the moisture content (%) of fish pickle prepared with dorsal muscle during storage period of 15 days at room temperature (30–35°C) are shown in Table 5. The initial moisture content of fresh fish was 78.87%. Moisture content of fish pickle was 57.25% on '0'day for mustard oil pickle which decreased gradually after 7 days of storage it declined to 42.06% and on 15 days of storage the value was obtained 36.92%. In case of fish pickle prepared using soybean oil the moisture content reduced from 51.41% to 45.85% after 7 days of storage and on 15 days of storage it declined to 39.28%. In case of soybean oil, moisture reduction was lower than mustard oil. Changes in the moisture content of fish pickle prepared with whole fish muscle during storage period of 15 days at room temperature (30-35°C) are shown in Table 4. In this case, the moisture content was 56.69% on '0'day for mustard oil pickle which decreased gradually after 7 days of storage, it declined to 55.25% and on 15 days of storage the value was obtained 53.56%. On the other hand, fish pickle made with soybean oil, the moisture content reduced from 51.81% to 49.71% after 7 days of storage and on15 days of storage it declined to 47.31%. In case mustard oil pickle, the fungal growth was lower than the soybean oil pickle.

Changes in the Ash Content of Fish Pickle

The changes in the ash content (%) of fish pickle prepared with dorsal muscle during storage period of 15 days at room temperature (30-35°C) are shown in Table 6. The ash content of pickle prepared using mustard oil was 4.31% on '0' day. The ash content started to increase gradually as the fish muscle liquefied. After 7 days of storage it reached to 4.92% and it reached to 5.22% on 15 days of storage. In case of soybean oil used pickle the value was 5.21% on '0' day which reached to 5.32% after 7 days of storage and to 5.52% on 15 days of storage. The changes in the ash content of fish pickle prepared with whole fish muscle during storage period of 15 days are also shown in Table 6. Here, the value for pickle prepared using mustard oil was 4.25% on '0' day. After 7 days of storage it reached to 4.61% and to 5.11% on 15 days of storage. The ash content of fish pickle prepared with whole fish muscle by using soybean oil was 4.36% on '0' day which reached to 4.81% after 7 days of storage and to 5.66% on 15 days of storage.

Table 3. Changes in the Protein Content (%) of Fish Pickle (Dorsal and Whole Fish Muscle) during Storage Period of 15 days at Room Temperature (30-35°C)

Days	Protein Content (%)			
	Dorsal Muscle		Whole Fish Muscle	
	Mustard Oil	Soybean Oil	Mustard Oil	Soybean Oil
0	19.47 ± 0.43	16.15 ± 0.41	19.07 ±0.35	16.62 ±0.28
7	17.67 ± 0.35	15.85 ± 0.29	17.81 ± 0.29	16.30 ± 0.23
15	15.99 ± 0.30	15.45 ± 0.25	16.38 ± 0.19	15.97 ± 0.15

*mean value ± standard deviation of 3 individual measurement

Table 4. Changes in the Lipid Content (%) of Fish Pickle (Dorsal and Whole Fish Muscle) during Storage Period of 15 days at Room Temperature (30-35°C)

Days	Lipid Content (%)			
	Dorsal Muscle		Whole Fish Muscle	
	Mustard Oil	Soybean Oil	Mustard Oil	Soybean Oil
0	17.57 ± 0.14	18.28 ± 0.11	22.59 ± 0.41	25.58 ± 0.29
7	16.78 ± 0.28	17.38 ± 0.19	20.42 ± 0.32	22.78 ±0.17
15	15.38 ± 0.12	16.68 ± 0.10	17.18 ± 0.25	19.58 ± 0.91

*mean value ± standard deviation of 3 individual measurement

Table 5. Changes in the Moisture Content (%) of Fish Pickle (Dorsal and Whole Fish Muscle) during Storage Period of 15 days at Room Temperature (30-35°C)

Days	Moisture Content (%)			
	Dorsal muscle		Whole Fish Muscle	
	Mustard Oil	Soybean Oil	Mustard Oil	Soybean Oil
0	57.25 ± 0.75	51.41 ± 0.65	56.69 ± 0.72	51.81 ± 0.69
7	42.06 ± 0.76	45.85 ± 0.61	55.25 ± 0.82	49.71 ± 0.78
15	36.92 ± 0.68	39.28 ± 0.52	53.56 ± 0.56	47.31 ± 0.71

*mean value ± standard deviation of 3 individual measurement

Table 6. Changes in the Ash Content (%) of Fish Pickle (Dorsal and Whole Fish Muscle) during Storage Period of 15 days at Room Temperature (30-35°C)

Days	Ash Content (%)			
	Dorsal Muscle		Whole Fish Muscle	
	Mustard oil	Soybean oil	Mustard oil	Soybean oil
0	4.31 ± 0.05	5.21 ± 0.10	4.25 ± 0.08	4.36 ± 0.05
7	4.92 ± 0.08	5.32 ± 0.11	4.61 ± 0.11	4.81 ± 0.03
15	5.22 ± 0.12	5.52 ± 0.18	5.11 ± 0.15	5.66 ± 0.09

*mean value ± standard deviation of 3 individual measurement

Changes in the pH Value of Fish Pickle

The changes in the pH value of fish pickle prepared from dorsal muscle during storage period of 15 days at room temperature (30–35°C) are shown in Table 7. The pH value of fish pickle prepared with dorsal muscle using mustard oil at room temperature was 4.54 on '0'day, as the time passed, it increased. After 7 days of storage it reached to 4.45 and after 15 days of storage it reached to 4.36. The pH value of pickle prepared using soybean oil was 4.91which reached to 4.82 after 7 days and to 4.75 after 15 days of storage. On the other hand, the pH value of fish pickle prepared with whole fish muscle using mustard oil at room temperature was 4.60 on '0' which decreased to 4.34 after 7 days of storage. But after 15 days of storage increased and reached to 4.04. The pH value of fish pickle prepared with whole fish muscle using soybean oil at room temperature was 4.43. After 7 days of storage the value declined to 4.38 and after 15 days it reached to 4.31.

Changes in the Bacterial Load of Fish Pickle

Changes in the bacterial load in fish pickle prepared with dorsal muscle during storage period of 15 days at room temperature (30-35°C) are shown in Table 8. In case of sample prepared using mustard oil the bacterial load increased throughout the storage period. Here, the initial bacterial load of fish pickle was 2.5×10^3 CFU/g. With the progress of storage time on 7 days of storage it increased to 3.3×10^5 CFU/g and after 15 days of storage the value found 5.2×10^7 CFU/g. On the other hand sample prepared using soybean oil the initial bacterial load of fish pickle was 3.0×10^3 CFU/g, which increased to 3.7×10^6 CFU/g after 7 days and to 7.2×10^8 CFU/g after 15 days of storage. These results showed that bacterial load is higher in pickle prepared using soybean oil than mustard oil. Changes in the bacterial load in fish pickle prepared with whole fish muscle during storage period of 15 days at room temperature (30-35°C) are also shown in Table 8. In this case the pickle prepared using mustard oil bacterial load increased throughout the storage period. The initial bacterial load was 3.7×10^5 CFU/g which increased with the progress of storage time. On 7^{th} days of storage bacterial load increased to 5.2×10^7 CFU/g and after 15 days of storage this value reached to 8.9×10^8 CFU/g. On the other hand the pickle prepared using soybean oil the initial bacterial load was 4.2×10^5 CFU/g. After 7 days of storage the value increased to 6.5×10^7 CFU/g and then after 15 days of storage the value reached to 9.2×10^8 CFU/g. Pickle prepared with whole fish muscle also showed the similar trend as was for pickle prepared with dorsal muscle.

Sensory Evaluation

The results of changes in sensory quality attributes of fish pickles during storage at room temperature (30-35°C) are shown in Table 9. The sensory attributes changed with the progress of storage period. The prepared pickles mostly deteriorated after 15 days of storage. Fish pickle prepared by using mustard oil was more accepted than soybean oil by panelists. They almost equally accepted the fish pickles prepared from both dorsal muscle and whole fish muscle.

Table 7. Changes in pH value of Fish Pickle (Dorsal and Whole Fish Muscle) during Storage Period of 15 days at Room Temperature (30-35°C)

Days	pH Value			
	Dorsal Muscle		Whole Fish Muscle	
	Mustard Oil	Soybean Oil	Mustard Oil	Soybean Oil
0	4.54 ± 0.02	4.91 ± 0.32	4.60 ± 0.10	4.43 ± 0.11
7	4.45 ± 0.27	4.82 ± 0.04	4.34 ± 0.05	4.38 ±0.09
15	4.36 ± 0.06	4.75 ± 0.08	4.04 ± 0.07	4.31 ± 0.16

*mean value ± standard deviation of 3 individual measurement

Table 8. Changes in Bacterial load (CFU/g) of Fish Pickle (Dorsal and Whole Fish Muscle) during Storage Period of 15 days at Room Temperature (30-35°C)

Days	Bacterial load (CFU/g)			
	Dorsal Muscle		Whole Fish Muscle	
	Mustard Oil	Soybean Oil	Mustard Oil	Soybean Oil
0	2.5×10^3	3.0×10^3	3.7×10^5	4.2×10^5
7	3.3×10^5	3.7×10^6	5.2×10^7	6.5×10^7
15	5.2×10^7	7.2×10^8	8.9×10^8	9.2×10^8

Table 9. Changes in Sensory Quality Attributes of Fish Pickle (Dorsal and Whole Fish Muscle) during Storage Period of 15 days at Room Temperature (30-35°C)

Pickle Type	Storage period (Day)	Color	Flavor	Texture	General acceptability
Dorsal Muscle+ Mustard Oil	0	9	9	9	9
	7	9	8	9	0
	15	Rejected	Rejected	Rejected	Rejected
Dorsal Muscle+ Soybean Oil	0	8	8	9	8
	7	8	7	7	7
	15	Rejected	Rejected	Rejected	Rejected
Whole Fish Muscle+ Mustard Oil	0	9	9	9	9
	7	9	8	8	9
	15	Rejected	Rejected	Rejected	Rejected
Whole Fish Muscle+ Soybean Oil	0	8	7	8	7
	7	8	7	7	7
	15	Rejected	Rejected	Rejected	Rejected

N.B 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.

Discussion

The proximate composition and its variation in edible and inedible parts of freshwater fish species of Bangladesh was reported by Chakraborty *et al.* (2003). The highest protein content found 20.14% in *Labeo boga*, the lipid content was 17.80% in *Hilsa ilisha* and the ash content was 4.38 *Setipinna phasa*. On the other hand the lowest values of these parameters were 13.50, 1.30 and 1.00% respectively in *Chanda nama*, *Glossogobius giuris* and *Chanda reticulata*. This finding establishes the fact that freshwater fishes of Bangladesh are in the category of high protein food. The proximate composition of fish reported by Stansby (1962) was in the ranges of moisture 28 to 90%, protein 6 to 28.9%, crude fat 0.2 to 64% and ash 0.4 to 1.5%. Ejaz *et al.* (2009) found protein content 23.01%, lipid content 4.89%, moisture content 70.15%, ash content 2.01% and pH 6.8 in the mince of pangus fish. All these findings more or less support the findings of the present study.

Data on chemical composition of fish products like fish pickle are scare. Parvin *et al* (2010) prepared fish pickles (with olive and tamarind) from mola fish (*Amblypharyngodon mola*) and studied their nutritional and food quality. The quality of the pickle prepared with olive was excellent and the pickle prepared with tamarind was found good. Moisture content of the two pickle products were 43.85% (with tamarind) and 50.89% (with olive). The protein and lipid contents of tamarind added pickle were 19.13 and 35.64% respectively; pickle with olive contained less protein (13.16%) compared to tamarind added mola pickle. Lipid contents were almost same in both cases. Ash content of two pickles was also found similar (1.00%). Arannilewa *et al.* (2005) reported that protein content in fish and fishery products decrease during storage due to the denaturation of fish protein and leaching out of water soluble protein. McGill *et al.* (1974) reported that lipid content in fishery products started to decrease when oxidation occurs. The decline in moisture content is due to deep frying and dehydration during storage of the test samples (Ninan *et al.*, 2008). Ash content increased due to moisture loss in the processed fish pickle during frying and cooking (Kocatepe *et al.*, 2011) and another reason might be addition of different ingredients during pickle preparation Tanuja and Hameed (1998) recorded the pH of squilla pickle 4.46 which dropped gradually during storage. S S Patil *et al*. (2014) reported protein content 14.38%, lipid content 17.16%, moisture content 60.25%, ash content 5.45% and pH 4.26 in pickle prepared with pangus muscle on the 1st day of preparation. These findings for fish pickle are nearer to the obtained results for fish pickles in most parameters of the present study. With the extension of storage period the sensory attributes changed and showed lower score for the prepared product in the present experiment coincides with findings of Kumar and Basu (2001). They reported, for shrimp pickle the overall acceptability rating showed a downward trend due to increase in peroxide and TVN value with the laps of storage period.

Conclusion

The study could be concludes that- pangus fish muscle could be used for the preparation of fish pickle. In both cases pickles either prepared from dorsal muscle or whole fish muscle with mustard oil and stored at room temperature (30-35°C) the moisture reduction was higher. In case of pickle prepared with soybean oil though the moisture content was lower but the smell was not accepted by the panelists. These findings indicated that-mustard oil is better than soybean oil for preparing fish pickle because its flavor is well known for any kind of pickle at this region. On the other hand the shelf life of prepared pickle from pangus fish mince is shorter, not more than 15 days at room temperature (30–35°C).

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References

Akinneye JO, Amoo IA, Bakare OO. 2010. Effect of drying methods on the chemical composition of three species of fish (Bonga spp., Sardinella spp. and Heterotis niloticus). African Journal of Biotechnology, 9(28):4369–4373.

Alipour HJ, Shabanpoor B, Ali Shabani, *et al*. 2010. Effects of cooking methods on physico-chemical and nutritional properties of Persian sturgeon Acipenser persicus fillet. Internaional Aquatic Resource, 2:15–23.

AOAC, 2005. Official Methods of Analysis. Association of Official Analytical Chemists International, 18th edition, Washington (D. C.).

Arannilewa, S.T., Salawu, S.O., Sorungbe, A.A. and Ola-Salawu, B.B. 2005. Effect of frozen period on the chemical, microbiological and sensory quality of frozen tilapia fish (Sarotherodun galiaenus). African Journal of Biotechnology, 4(8): 852–855.

Chakraborty, S.C. 2003. A study on proximate composition of common fresh water fishes of Bangladesh. Bangladesh Journal of Fisheries. 26 (1-2): 23–36.

Edwards and Kaewpaitoon. 1981. "Fish Farming with Livestock Manure". Paper presented at a seminar on Maximum Livestock Production from Minimum Land, jointly organized by the Department of Animal Science, BAU, NYRDP-DANIDA, Bangladesh Agricultural University, Mymensingh 2-5 February, 1981.

Ejaz, M. A., Shikha, F. H. and Hossain, M. I. 2009. Preparation of fish burgar from pangus catfish (Pangasius sutchi) and evaluation of quality and shelf life during different storage conditions. Progress. Agric. 20(1 & 2): 153–162.

EL SN, Kavas A. 1996. Determination of protein quality of rainbow trout (Salmo irideus) by in vitro protein digestibility-corrected amino acid score (PDCAAS). Food Chemistry, 55(3):221–223. https://doi.org/ 10.1016/0308-8146(95)00111-5

Farid FB, Latifa GA, Nahid MN, et al. 2014. Effect of Sun-drying on proximate composition and pH of Shoal fish (C. striatus; Bloch, 1801) treated with Salt and Salt-turmeric storage at Room Temperature (27°C–30°C). IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS). 7(9): 1–8. https://doi.org/10.9790/2380-07930108

Kocatepe, D., Turan, H., Taskaya, G., Kaya, Y., Erden, R. and Erdogdu, F. 2011. Effects of cooking methods on the proximate composition of Black Sea anchovy (Engraulis encrasicolus). Academic Food Journal (GIDA), 36(2): 71-75.

Kumar, S. and Basu, S. 2001. Preparation of Prawn pickle and it's storage characteristics. Journal of the Indian Fisheries Association 28: 105–111.

MacGill, A.S., Hard, R. and Burt, J.R. 1974. Hept-cis-4-enal and its contribution to the off flavour in cold stored cod. Journal of the Science of Food and Agriculture, 25: 1477–1489. https://doi.org/10.1002/jsfa.2740251208

Mazrouh MM. 2015. Effects of freezing storage on the biochemical composition in muscles of Saurida undosquamis (Richardson, 1848) comparing withimported frozen. International Journal of Fisheries and aquactic Science, 3(2):295–299.

Mojisola O. 2014. The Effect of Different Processing Methods on the Nutritional Quality and Microbiological Status of Cat Fish (Clarias lezera). Journal of Food Processing & Technology, 5(6). https://doi.org/10.4172/ 2157-7110.1000333

Ninan, G., Bindu, J. and Joseph, J. 2008. Frozen storage studies of minced based products developed from tilapia (Oreochromis mossambicus, Peter 1852). Fishery Technology, 45(1): 35–42.

Nowsad, A. A., Kanoh, S., Chanda, S. C. and Niwa, E. 2000. The effects of heating and washing on the gelling properties of tropical major carp muscle. Journal of Aquatic Food Product Technology 8(2):5–23. https://doi.org/ 10.1300/J030v08n02_02

Nowsad, A.K.M.A. 1994. Raw material for the manufacture of surimi – II. The Bangladesh Observer, March 8 and 9, 1994, Dhaka, Bangladesh.

Oparaku, Nkiruka Francisca, Nwaka FC. 2013. Effect of processing on the nutritional qualities of three fish species (Synodontis clarias, Trachurus trecae and Clarias gariepinus). International Journal Of Biology and Biological Sciences, 2:143–149.

Patil, S. S, Pagarkar1, A.U, Chaudhary, K. J, Desai A. S and S. M. Shaikh. 2014. Organoleptic and Biochemical Quality Changes in Fish Pickle Prepared from Freshwater Catfsh Pangasius (Pangasianodon hypothalamus). The Indian veterinary journal 91(7):12–14.

Pervin, K, Nayeem, M.A., Newaz, A.W., Kamal, M., Yeasmine, S. and Nurullah, M. 2010. Production and quality assessment of fish pickles from mola (Amblypharyngodon mola) fish. Bangladesh Journal of Fisheries Research, 14 (l-2): 87–96.

Pourshamsian K, Ghomi MR, Nikoo M. 2012. Fatty Acid and Proximate Composition of Farmed Great Sturgeon (Huso huso) Affected by Thawing Methods, Frying Oils and Chill Storage. Advanced Studies in Biology, 4(2):67–76.

Product Technology, 9(3): 71-75.

properties of eleven underutilized tropical marine fish species. Journal of Aquatic Food

Sarker ZI, Elgadir MA, Ferdosh S, et al. 2012. Effect of some biopolymers on the rheological behavior of surimi gel. Molecules, 17(5):5733-5744. https://doi.org/10.3390/molecules17055733 PMid:22628045

Sharma, P.J. and Sarma, J. 2012. Preparation of Pickles from Fresh Water Fish and Their Changes during Storage. Environment and Ecology, 30(3): 478–480.

Smida MAB, Bolje A, Ouerhani A, et al. 2014. Effects of Drying on the Biochemical Composition of Atherina boyeri from the Tunisian Coast. Food and Nutrition Sciences. 5(14):1399–1407. https://doi.org/10.4236/fns.2014. 514152

Sriket P, Benjakul S, Visessanguan W, et al. 2007. Comparative studies on the effect of the freeze–thawing process on the physicochemical properties and microstructures of

black tiger shrimp (Penaeus monodon) and white shrimp (Penaeus vannamei) muscle. Food Chemistry, 104(1):113–121. https://doi.org/10.1016/j.foodchem. 2006.11.004

Stansby, M.B. 1962. Proximate composition of fish. Fish in Nutrition. In: E Heen, R Ercnzer (Editors) Fishing News (Books). Ltd. Ludgate, 110 Fleet Street London, E.G. 4, England.

Tanuja, D. and Hameed, M.S. 1998. Preparation and storage studies of squilla pickle. School of Industrial Fisheries, Cochin University of Science and Technology Fine Arts Avenue, Cochin, India. 3: 24–28.