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Quality Evaluation of Fish Powder Developed from *Labeo bata*, a Minor Carp of Assam

Mansi Tiwari[1], Premila L. Bordoloi[1], Mridula Saikia Barooah[1]

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ABSTRACT

Background: Assam being a riverine state is home to n4umerous fish species that has been relished on for generations. However, fish being a perishable item, they need to be preserved for their availability throughout the year and to minimise wastage. The fish *Labeo bata* is a freshwater medium sized Indian minor carp which is very popular among the locals because of its characteristic taste and their high health ameliorating effects. Therefore, considering these facts, the present study focused on preparation and quality evaluation of fish powder from a minor carp, *Labeo bata*.

Methods: Fresh fish collected from local fish market of Raha, Nagaon, Assam were dressed, washed and dehydrated to prepare fish powder. The prepared fish powder was evaluated for their nutritional composition, functional properties, sensory properties and shelf life as per standard protocols.

Result: The results indicated that the moisture, protein, fat and ash content of prepared fish powder was 4.52, 63.87, 13.04 and 2.96 g/100 g respectively. The prepared flour had superior functional characteristics with bulk density, water absorption capacity, fat absorption capacity and foaming capacity of 0.53 g/ml, 145.00 ml/00 g, 99.00 ml/100 g and 32.20 per cent respectively. The product also displayed good shelf life when evaluated in terms of changed in moisture, free fatty acid (FFA), peroxide value (PV), total plate count (TPC) and pH across storage for a period of 90 days. The change in moisture, FFA, PV, TPC and pH content varied from 4.52-5.40 g/100 g; 0.08-0.22 per cent; 1.00-4.11 mEq O_2/Kg; 3.12-4.23 log cfu/g and 6.22-6.80 respectively.

Key words: Assam, Fish powder, *Labeo bata*, Minor carp, Quality evaluation.

INTRODUCTION

The global fish production is increasing at an average rate of 3.00 per cent annually and has peaked to 178.50 million tons with 156.40 million tons of fish being used for human consumption. With increased production there has also been a persistent elevation in the demands of fish and fisheries products owing to the fact that they represent a valuable source of nutrients for diversified and healthy diets (Fawole *et al.*, 2007). Fish contributes to a major portion of protein in human diet. In 2017, more than 3.3 billion people worldwide derived 17.00 per cent of their animal protein out of which 7.00 per cent protein source was from fish (FAO, 2020).

Fish as food is a valuable protein source containing around 15-20 per cent protein (Mohanty *et al.*, 2011). The functionality of fish protein is attributed to its essential amino acid content and their high biological value due to presence of low quantity of connective tissue. Additionally, they are also an excellent source of omega-3 fatty acids especially eicosapentanoic acid and docosahexaenoic acid (Kris-Etherton *et al.*, 2000). Studies have shown a significant inverse association of omega-3 fatty acid with cardiovascular risk (Mori *et al.*, 2000; Hooper *et al.*, 2006 and Lee *et al.*, 2008) and other health problems as metabolic syndrome, obesity, diabetes, arteriosclerosis *etc.* (Storlien *et al.*, 1997; Connor *et al.*, 2000; William, 2000; Calder and Grimble, 2002; Richardson, 2006). Besides its acceptance as a quality protein and omega-3 fatty acid sources, they have a lower caloric density compared to other terrestrial animals (Tacon and Metian, 2013) and also have high proportion of several micronutrients such as vitamin A, vitamin D, calcium, phosphorus, iron, iodine *etc* (Lund, 2013). Among fish *Labeo bata*, a freshwater medium sized Indian minor carp forms an attractive pond fishery in West Bengal, Assam and Orrisha of India and Bangladesh. Owing to its high nutritional value and good taste, they have great demand in market. However, the major challenge associated with fisheries products are their highly perishable nature due to which they tend to spoil faster. A possible approach to tackle this problem could be dehydration of fish to produce a stable fish product that could also serve the purpose of a protein and mineral rich ingredient for application in food industries. With increased awareness on importance of fish several studies were conducted which included on various value-added fish products and their acceptability. Fish powder,

[1]Department of Food Science and Nutrition, College of Community Science, Assam Agricultural University, Jorhat- 785 013, Assam, India.

Corresponding Author: Mansi Tiwari, Department of Food Science and Nutrition, College of Community Science, Assam Agricultural University, Jorhat- 785 013, Assam, India.
Email: mansi4148@gmail.com

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among the value-added products is one which is a concentrated source of nutrient intended for human consumption were also developed by different researchers from varied fish sources (Kasozi *et al.*, 2018; Shaviklo *et al.*, 2010; Sathivel *et al.*, 2004; Chavan *et al.*, 2008). However, knowledge on evidences of development of fish powder from *Labeo bata* is not so far documented. Since the quality and characteristics of fish protein ingredients are highly dependent on the raw material used, therefore the present investigation was undertaken to develop and evaluate fish powder from a minor carp (*Labeo bata*) of central Brahmaputra Valley. Furthermore, the present investigation involved utilization of fish bone as well as head to reduce the amount of fish wastage and to ameliorate the nutritional value of developed powder in terms of their mineral content.

MATERIALS AND METHODS

Fresh fish samples employed in the preparation of fish powder was procured hygienically from local fish market of Raha, Assam (26°13′41″N 92°31′10″E). The collected fish sample was transported within 30 minutes to the Fish Processing Laboratory housed in the Department of Fish Processing and Technology, College of Fisheries, Assam Agricultural University. During transportation, care was taken to prevent or delay the spoilage by keeping them in an insulated box with the internal temperature maintained at 0 to 4°C. Low internal temperature was maintained through use of gel ice in a ratio of 1:1 (fish : gel ice). Later, the transported fish was kept at a temperature of -18°C in a deep freezer until further use. The research investigation was conducted in the year 2019 in the Department of Food Science and Nutrition, College of Community Science, Assam Agricultural University, Jorhat, Assam.

Fish powder preparation

Fish powder preparation was done according to the method of Abbey *et al.* (2016) with certain modifications. The process involved thorough washing of fresh fish samples thrice using chilled potable water (4±1°C) for removal of dust, impurities and foreign matters. The fish and water ratio of 1:1 was kept for washing. Washed samples were descaled, degutted and de-gilled on a clean stainless steel working table using pre-sterilized tools. All the processing operation were performed using stainless steel equipment. The dressed samples were washed again to remove any blood stains or impurities, if left. Washed-dressed fish was then subjected to blanching operation for 5 minutes keeping fish and water ratio at 1:1. This was followed by mincing of fish in a meat mincer. Minced fish was spread onto a stainless-steel tray and dehydrated in a cabined drier at temperature 55°C and air velocity 70-75 m/min for 8 hours. Later, the dried fish cakes were grounded to powder in a domestic grinder at the rate of 100g/ 2 minute followed by storage in High Density Polyethylene (HDPE) container at refrigerated temperature (0-4°C) until further application.

Nutritional composition

Moisture, protein, fat and ash contents of sample was determined as per AOAC 2000 method 925.10, 950.36, 963.15 and 942.05 respectively. Difference method was used for determination of total carbohydrate content and the total energy was calculated as per the formula given by James (1990). The mineral contents of fish samples were estimated using Atomic Absorption Spectrophotometer (AAS). The solution for mineral estimation was prepared by wet ashing technique of AOAC (2005) method 975.03 in which sample was digested using nitric acid (HNO_3) and perchloric acid ($HCLO_4$). The prepared ash solution was than analysed for calcium (Ca), potassium (K), magnesium (mg), phosphorus (P) and Iron (Fe) using AAS equipped with deuterium lamp, a hollow cathode and a background corrector.

Functional properties of fish flour

Bulk density of developed fish powder was prepared following the method of Jagnam and Thorat (2010). Foaming capacity of samples was analysed as per the procedure given by Narayana and Rao (1982). Water absorption capacity (WAC) and fat absorption capacity (FAC) was determined by the method of Sosulski *et al.* (1976).

Storage study

The storage stability of fish powder stored at refrigerated condition (0-4°C) in a HDPE container was determined by examining the change in sensory scores, colour, moisture, pH, peroxide value (PV), free fatty acid (FFA) and total plate count (TPC) across 90 days.

Sensory evaluation was performed for the developed fish powder for a period of 90 days at an interval of 30 days *i.e.*, 0th day, 30th day, 60th day and 90th day. Fish powder was evaluated by 20 semi-trained panellists in terms of its appearance, odour, texture and overall acceptability using nine-point hedonic scale (9-liked extremely, 8-liked very much, 7-liked moderately, 6- liked slightly, 5-neither liked nor disliked, 4-disliked slightly, 3-disliked moderately, 2-disliked very much and 1-disliked extremely) (Kaushik Shandilya *et al.*, 2017).

Color intensity of fish powder was determined using Hunter Lab Colorimeter (Mini Scan XE Plus Colour Meter, Hunter Associate Laboratory, Inc., Reston, VA) which was fitted with a large area port of 2.5 cm diameter aperture. Calibration of instrument was done using black and white tile ahead of taking sample reading. Measurement of CIE L* a* b* value was done which was further used for measurement of chroma [(a2 + b2)1/2] and hue angle [tan”1(b*/a*)]. The L* a* b* of fish powder was recorded by placing the cuvette filled two-third with sample in front of smallest aperture (Kumar and Kumar, 2011).

The change in moisture content across storage was measured as per the AOAC (2000) method 925.10 and the TPC was determined as per the protocol mentioned in AOAC (1995) method 990.12. The peroxide value of fish powder

was determined by titration method given by AOAC (2000) method 965.33 with some modifications. FFA content of fish powder was determined as per the titration method described in the AOAC (2003) method 940.28 with some modifications.

Statistical analysis

The data obtained in the study were analysed statistically to test significant difference among samples at $P<0.05$. The statistical analysis was performed using Package for Social Scientists (SPSS) version 20.

RESULTS AND DISCUSSION

Nutritional composition

Fish powder prepared from a minor carp *Labeo bata* in the present investigation was nutritionally potential to serve as a rich source of protein, minerals and other nutrients. The superior quality of *Labeo bata* fish powder is attributed to the high nutritional quality of fresh fish used in preparation of fish powder. The nutritional composition of fresh fish (*Labeo bata*) presented in Table 1 shows that the values obtained in the present investigation is in conformation with the study conducted by Paul *et al.* (2018) on nutritional values of minor carps. The study reported a moisture, protein, fat and mineral content of 73.45, 15.64, 3.74 and 2.55 g/100 g in as is basis. However, the study of Jafri (1968) observed a lower protein, fat and ash content of 14.06, 0.23 and 1.60 g/100 g of fresh fish respectively and a higher moisture content of 78.56 g/100 of fresh fish.

The nutritional composition of fish powder developed from *Labeo bata* is presented in Table 2. It shows that the developed fish powder was nutritionally rich which could be dueinitial nutritional quality of fish in fresh form. The developed flour had low moisture content of 4.52±0.65 per cent which is below the acceptable limit of 10 per cent level for microbial safety of the fisheries products (Olayinka *et al.*, 2008). The study carried out by Kasozi *et al.* (2018) on nutrient composition of fish powder developed from *Brycinus nurse* species showed a lower protein and ash contents of 50.4±0.56 and 12.3±0.14 g/100 g respectively and a higher moisture, fat and energy contents of 7.30±0.14 g/100 g, 30.1±0.07 g/100 g and 470.90±0.49 Kcal/100 g respectively. These discrepancies in the nutritional composition might be due to difference in the fish species used and method employed for preparation of fish powder. The developed fish powder was also rich in mineral contents with calcium, phosphorus, iron, magnesium and potassium content of 1692.90±2.97, 1135.03±1.65, 14.49±0.22, 281.00±1.86 and 523.00±0.96 mg/100 g. The high mineral content was mainly due to utilization of fish bones during fish powder preparation which are otherwise discarded.

Table 1: Nutritional composition of fresh fish (*Labeo bata*).

Nutritional attributes	Nutrient per 100 g (As is basis)
Moisture (g)	75.78±0.43
Protein (g)	16.56±0.32
Fat (g)	3.78±0.21
Carbohydrate (g)	0.42±0.53
Ash (g)	3.46±0.31
Energy (Kcal)	101.94±3.06
Calcium (mg)	430.40±2.26
Phosphorus (mg)	333.67±10.40
Iron (mg)	3.29±0.24
Magnesium (mg)	76.00±0.71
Potassium (mg)	121.00±0.96

* Values are mean ± Standard deviation of triplicates

Table 2: Nutritional composition of a minor carp fish powder (*Labeo bata*).

Nutritional attributes	Nutrient per 100 g (As is basis)
Moisture (g)	4.52±0.65
Protein (g)	63.87±0.31
Fat (g)	13.04±0.97
Carbohydrate (g)	5.43±0.79
Ash (g)	12.96±0.15
Energy (Kcal)	394.61±13.13
Calcium (mg)	1692.90± 2.97
Phosphorus (mg)	1135.03± 1.65
Iron (mg)	14.49± 0.22
Magnesium (mg)	281.00±1.86
Potassium (mg)	523.00±0.96

* Values are mean ± Standard deviation of triplicates.

Table 3: Functional characteristics of fish powder (*Labeo bata*).

Functional attributes	Values
Bulk density (r_B) (gm/ml)	0.53±0.01
Water Absorption Capacity (ml/100g)	145.00±5.00
Fat Absorption Capacity (ml/100g)	99.00±3.60
Foaming capacity (%)	32.20±1.81

* Values are mean ± Standard deviation of triplicates.

Functional characteristics

Functional property of any flour is an important criterion that determines the behaviour of any ingredient when exposed to varied environmental conditions (Kaur and Singh, 2006). The results of functional attributes determined for prepared fish powder is presented in Table 3. The bulk density of the developed fish powder was 0.53±0.01 g/ml. The bulk densities are greatly affected by the moisture content, particle size and protein content of flour (Amandikwa *et al.*, 2015 and Chandra *et al.*, 2015). Higher bulk densities are an indication that the developed flour could serve as a suitable ingredient in various food preparations (Chandra and Samsher, 2013). The WAC of developed fish powder in the present investigation was 145.00±5.00 ml/100 g. A lower WAC in the range of 9.00 to 11.00 per cent was

reported in the study of Abdollahi and Undeland (2018) whereas a higher WAC ranging from 220 - 247 ml/100 g was reported in the research findings of Foh *et al.* (2010). FAC of fish powder developed from *Labeo bata* was 99.00±3.60 ml per 100 g which was similar to the observations made by Rathnakumar and Pancharaja (2018) where a FAC of 100 ml/100 g of fish powders was reported. Foaming capacity of the developed flour was 32.20±1.81 per cent which was in conformity with the study of Akhade *et al.* (2016) in which the foaming capacity of developed fish powder ranged from 28.93 to 42.50 per cent.

Sensory evaluation across storage

The results of sensory evaluation of fish powder developed from *Labeo bata* across storage is presented in Table 4. The developed product had good sensory characteristics in terms of its appearance, odour, texture, flavour and overall acceptability on the day of preparation which reduced with increased in storage days. Although sensory scores reduced significantly but the product was acceptable in terms of overall sensory attributes across storage of 90 days. Senapati *et al.* (2016) also revealed a reduction in sensory attributes of fish flour developed from Indian Oil Sardines across storage.

Color analysis

The values of colour measurements using Hunter Colour lab across storage is presented in Table 5. In the table it could be seen that there is significant ($p<0.05$) decrease in L* (lightness) value and increase in a* (redness) and b* (yellowness) value of the developed fish powder indicating a deterioration in the colour characteristics of the product on prolonged storage. This increment was attributed to the lipid oxidation during storage period. This finding is similar to the observations made by Bragadottir *et al.* (2007) and Senapati *et al.* (2016) in which an increase in the redness

Table 4: Mean sensory scores of fish powder (*Labeo bata*) across storage.

Sensory parameters	Storage days			
	0 days	30 days	60 days	90 days
Appearance	7.73±0.59^{a}	7.53±0.51 ^{a}	7.33±0.62 ^{a}	7.33±0.62 ^{a}
Odour	7.40±0.50^{a}	7.20±0.56^{a}	7.07±0.46^{a,b}	6.73±0.46^{b}
Texture	8.47±0.64^{a}	8.20±0.56^{a,b}	7.93±0.46^{b}	7.80±0.41^{b}
Overall acceptability	7.60±0.51 ^{a}	7.47±0.52 ^{a}	7.33±0.49 ^{a}	6.93±0.45 ^{b}

* Values are mean ± Standard deviation of triplicates; Values with different superscript in a row are significantly different ($p<0.05$).

Table 5: Colour measurements of fish powder (*Labeo bata*) across storage.

Sensory parameters	Storage days			
	0 days	30 days	60 days	90 days
L*	51.34±0.43^{a}	50.52±0.35^{b}	49.02±0.55^{c}	47.49±0.37^{d}
a*	1.32±0.08^{a}	2.12±0.06^{b}	2.89±0.12^{c}	3.85±0.08^{d}
b*	11.78±0.15^{a}	12.21±0.21^{a}	12.77±0.17^{b}	13.48±0.43^{c}
Hue	83.60±0.30^{a}	80.15±0.11^{b}	77.25±0.35^{c}	74.06±0.16^{d}
Chroma	11.85±0.16^{a}	12.39±0.21 ^{b}	13.09±0.19 ^{c}	14.02±0.43 ^{d}

* Values are mean ± Standard deviation of triplicates; Values with different superscript in a row are significantly different ($p<0.05$).

In Hunter Colour Lab L* indicates lightness or darkness (0= black, 100 = white).

a* indicates the hue on the green-to-red axis (negative value = greenness, positive value = redness).

b* indicates the hue on the blue –to-yellow axis (negative value = blueness, positive value = yellowness).

C* is the intensity of the hue [c*= (a*2 = b*2)1/2]; and hue angle (H°) is the angle in the colour wheel of 360° (H° = tan $^{-1}$ b*/a*).

Table 6: Storage analyses of fish powder (*Labeo bata*) across storage.

Parameters	Storage days			
	0 days	30 days	60 days	90 days
Moisture (g/100 g)	4.52±0.65^{a}	4.84±0.07^{a}	5.05±0.55 ^{a}	5.4±0.39 ^{a}
FFA (%)	0.08±0.02^{a}	0.16±0.04^{b}	0.27±0.01^{c}	0.33±0.03^{d}
PV (mEq O_2/kg)	1.00±0.00^{a}	1.90±0.14^{b}	3.20±0.28^{c}	4.11±0.17^{d}
TPC (log cfu/g)	3.12±0.17^{a}	3.73±0.19^{a}	4.02±1.83^{a}	4.23±0.43^{a}
pH	6.22±0.12^{a}	6.11±0.10^{a}	6.16±0.06^{a}	6.80±0.05^{b}

* Values are mean ± Standard deviation of triplicates; Values with different superscript in a row are significantly different ($p<0.05$).

and yellowness value of fish powder developed from Saithe powder and Indian Oil Sardine respectively increased across the storage.

Shelf-life analyses

The shelf-life analyses of fish powder prepared from *Labeo bata* across storage of 90 days is presented in Table 6. It is evident from the table that with increased storage period there was no significant increment in the moisture content and total plate count of the developed fish powder. However, the FFA content and PV increased significantly across storage of 90 days in high density polyethylene container at ambient temperature. Although the shelf-life parameters estimated in the study increased with increased in storage days, the increment was within the permissible limit.

CONCLUSION

It is apparent from the study that the fish powder prepared from a minor carp, *Labeo bata* has high nutritional quality along with acceptable sensory attributes. The powder also had fair shelf life of three months, thereby ensuring its availability around the year. These characteristics indicate its high marketable potentialities. Thus, it can provide a window of opportunity in livelihood generation for a large populace, besides serving both the purposes of nutritional and food security.

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Conflict of interest: None.

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