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Effects of freezing periods and polythene packaging with or without turmeric powder paste on proximate composition of *Labeo bata* fish

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ABSTRACT

The study was designed to investigate the effects of freezing periods and the combination of packaging with or without turmeric on the proximate composition of whole and sliced *Labeo bata*. The samples were subjected to 28 days of frozen (-20 °C) storage periods and analyzed for proximate composition such as moisture, protein, lipid and ash at intervals of 0, 14 and 28 days. Data obtained was subjected to analysis of variance (ANOVA) at 95% significant level. Different preservation periods and methods significantly affected the nutritional composition of fresh fish. Moisture, protein, lipid and ash content decreased with increasing storage periods when compared to the fresh fish as control. The highest percentage of protein was found in turmeric-treated whole fish preserved in polythene, C_4, after the 14^{th} (15.70±0.14) and 28^{th} (15.27±0.21) day. On the other hand, the lowest percentage (14.01±0.10 and 13.22±0.18 for the 14^{th} and 28^{th} day, respectively) was found in sliced fish preserved without polythene, C_5. In conclusion, the turmeric-treated whole fish preserved in polythene retained fish nutrients and ensured its good quality and composition longer than other treatments, thereby extending the shelf life during frozen storage.

Introduction

Fish is consumed in many parts of the world, due to its abundance of high-quality proteins and fats, and other essential nutrients, such as vitamins, trace elements, and minerals (Edea et al., 2018). Fish is rich in n-3 polyunsaturated fatty acids, n-3 PUFAs (Kocatepe et al., 2011), such as docosahexaenoic acid (DHA; C22:6n-3), and eicosapentaenoic acid (EPA; C20:5n-3). These fatty acids have been reported to be beneficial in controlling diseases such as cancer, coronary heart diseases and inflammatory diseases (Belluzzi, 2001; Gerber, 2005). In fact, fish muscle contains the entire essential nutrient component that is required most for human body maintenance.

However, fish is highly perishable food due to its high-water activity, protein content, activities of autolytic enzymes and losses in quantity before consumption (Makawa et al., 2014; Farid et al., 2017). Therefore, good techniques of fish preservation prevent spoilage without influencing its superiority and nutritive value (El-Lahamy et al., 2018). Preservation of food is necessary to raise its shelf life, protect its nutritional value, flavour and texture (Ghaly et al., 2010). There are some preservation methods, freezing, chilling, drying, salting and smoking, for prolonging the shelf life of fish and retard the losses.

Freezing is a common practice to preserve fish by lowering temperature which inactivates micro-organisms and slows enzymatic and biochemical activities down (Gandotra et al., 2012). The quality of frozen fish is controlled by many factors such as protective packaging and maintenance of proper storage temperature (Beroumand and Jooyandeh, 2010). Protective packaging, along with turmeric, can increase the freezing method to maintain a high quality, because turmeric has been recognized as antioxidant or antibacterial agent for many fish

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species including bonito, mackerel and shrimp (Lin and Lin, 2005; Banerjee, 2006; Cadun et al., 2008). Curcuminoids are the main component of turmeric and have a range of pharmacological activities (Pandit et al., 2011). Turmeric is used as a food additive, preservative and colouring agent in many countries (Chattopadhyay et al., 2004). In Bangladesh, rural people usually use turmeric for short time preservation of small sized fish as it is easily available and cheap (Farid et al., 2017). Therefore, the present study was conducted to determine the effects of freezing periods and combination of packaging with or without natural preservative, turmeric, on the proximate composition of whole and sliced *Labeo bata* during storage at -20 °C.

Materials and methods

Collection of fish sample

Bata (*Labeo bata*) were randomly selected and purchased from Sonapur fish market in Noakhali, Bangladesh (Figure 1). Then the samples were brought to the laboratory of Fisheries and Marine Science Department at Noakhali Science and Technology University within 15 mins in isolated ice box. After that, the samples were washed with tap water for several times to remove adhere materials.

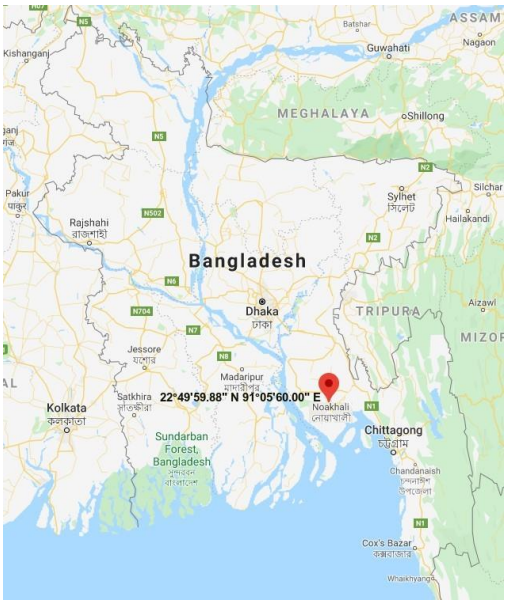

Fig. 1. Sampling sites

Preparation of Fish Sample

Fish were divided into six different groups and prepared for storage according to categories (Table 1). A total of 18 replications (three for each category) were prepared and considered to the proximate analysis. Commercially available food grade turmeric powder was mixed with sterile distilled water and made into turmeric paste. This paste was applied over the whole and sliced fish (coating the fish) for turmeric treated categories (C_2, C_4, C_6). All the categories of fish were stored in refrigerator at -20 ºC for the duration of 28 days.

Table 1. Experimental setup

Category	Details
C_1	Whole fish preserved without polythene
C_2	Turmeric treated whole fish preserved without polythene
C_3	Whole fish preserved with polythene
C_4	Turmeric treated whole fish preserved with polythene
C_5	Sliced fish preserved without polythene
C_6	Turmeric treated sliced fish preserved without polythene

Proximate composition analysis

A representative and standardized sample was taken from the front, rear and the middle of the fish from both the fresh and refrigerated samples at intervals of 14 and 28 days, respectively, for the analysis of proximate composition. Ash, fat and moisture content of the fish samples were evaluated using the standard AOAC procedure (AOAC, 2000). Moisture contents were determined via loss on drying at 105°C for 24 h. Fat content was assessed using the Soxhlet method. The ash was determined by heating in furnace at 550 °C for 6 h. Micro-Kjedal method was used to determine protein (N x 6.25) content of fish. Glass distilled water and analytical grade chemicals were used for the analysis.

Statistical analysis

Data was subjected to one-way analysis of variance (ANOVA), level of significance was set at 0.05 for all tests and analysis performed using SPSS version 20.

Results and discussion

The proximate composition of *Labeo bata* of fresh and frozen fish with different freezing periods (14 and 28 days) on different packaging categories is presented in Table 2. For C_1 category, freezing whole fish without polythene, the protein content was the highest in fresh fish, while the lowest was found after 28 days. The lipid content was also higher in fresh fish than after 14- and 28-days of storage. However, the protein and lipid contents of C_1 category decreased significantly

($p<0.05$) through the 28 days of storage. Oxidative alterations can cause various functional changes in texture, digestibility and succulence in fish (Baron et al., 2007). Lipid and protein oxidation also decline the quality of fish fillets (Secci and Parisi, 2016). The reduction in protein and lipid content during storage also attributed to leaching out of some extractable soluble protein fraction and hydrolysis of some of the lipid fraction (Daramola et al., 2007). The oxidation of the fat leads to objectionable flavours and odours. The rate of oxidation can be abridged by reducing the contact to oxygen. This can be achieved by introducing a barrier at the outward of the fish. Packaging materials impermeable to moisture and oxygen can be effective (Aberoumand, 2013).

The category of turmeric treated whole fish without polythene, C_2, showed that moisture, protein, lipid and ash content was higher in fresh fish. The lowest value was found after 28 days storage period. This decrease in moisture content was attributed to the sublimation of ice in frozen storage and drip loss during thawing process (Benjakul et al., 2005; Gandotra et al., 2012). The ash content was decreased for the drip loss during thawing process (Sharaf, 2013). Protein content was found to be significantly ($p<0.05$) higher in fresh fish than what obtained in other storage periods, while the lipid and moisture contents significantly ($p<0.05$) decreased in 14 and 28 days of storage, respectively, in C_3 category. In the category of turmeric treated whole fish with polythene (C_4), the highest protein content (16.04±0.06%) was observed in the fresh samples that were not subjected to frozen storage, while the least (15.27±0.21%) was recorded for fish samples that were stored for 28 days. The protein content decreased significantly ($p<0.05$), while there was no significant difference in lipid content through 28 days. The highest percentage of protein, lipid, moisture and ash content was found in fresh fish and the lowest value was recorded for those stored for 28 days. The protein, lipid and ash content significantly ($p<0.05$) decreased through the 28 days storage periods for C_5 category. The moisture content decreased through 28 days storage periods, though Arannilewa et al. (2005) observed that moisture content remained almost the same throughout the 60 days of frozen storage for Tilapia slices. The highest protein content (16.04±0.06%) was obtained for fresh samples whose values significantly ($p<0.05$) reduced (13.3±0.34%) after 28 days of freezing for C_6 category. Siddique et al. (2011) on *Puntius sp.* stated significant decrease in protein content during frozen storage and Gandotra et al. (2012) also reported the same trend for frozen fish muscle of *Labeo rohita* stored for 21 days.

Among the categories, C_4 (turmeric treated whole fish preserved with polythene) had the highest percentage of protein, while the least was found in C_5 category (sliced fish preserved without polythene) in the 14th and 28th day of storage (Figure 2 and Figure 3). Dipping the whole gutted fish in turmeric solutions also delays the chemical changes, maintains sensory attributes and extends the shelf life (Pezeshk et al., 2011). On day 28, the moisture content was found to be higher in the C_6 (68.35±0.41), while the lowest value was found in C_5 (63.73±0.42). The moisture content was found to be higher in C_6 than the fresh fish. Siddique et al. (2011) similarly found an increasing trend in moisture content in *Puntius sp.*

Table 2. Proximate composition (%) of C_1, C_2, C_3, C_4, C_5 and C_6 categories of *Labeo bata* during freezing periods

Category	Freezing periods (days)	Moisture (%)	Protein (%)	Lipid (%)	Ash (%)
C_1	0	68.15±1.19^a	16.04±0.06^a	1.85±0.02^a	4.74±0.05^a
	14	64.93±0.80^b	15.28±0.45^b	1.66±0.07^b	2.95±.10^b
	28	64.06±0.31^b	13.72±0.35^c	1.41±0.13^c	2.65±0.54^b
C_2	0	68.15±1.19^a	16.04±0.06^a	1.85±0.02^a	4.74±0.05^a
	14	67.53±1.22^a	15.44±0.47^a	1.72±0.13^{ab}	3.09±0.20^b
	28	65.20±0.32^b	14.04±0.33^b	1.55±0.09^b	2.86±0.20^b
C_3	0	68.15±1.19^a	16.04±0.06^a	1.85±0.02^a	4.74±0.05^a
	14	64.45±0.61^b	15.49±0.19^b	1.76±0.09^a	3.92±0.08^b
	28	64.33±0.35^b	14.97±0.15^c	1.71±0.14^b	3.68±0.31^b
C_4	0	68.15±1.19^a	16.04±0.06^a	1.85±0.02^a	4.74±0.05^a
	14	65.20±0.66^b	15.70±0.14^b	1.80±0.11^a	4.13±0.61^{ab}
	28	66.42±0.32^b	15.27±0.21^c	1.76±0.13^a	3.79±0.12^b
C_5	0	68.15±1.19^a	16.04±0.06^a	1.85±0.02^a	4.74±0.05^a
	14	64.19±0.19^b	14.01±0.10^b	1.28±0.11^b	2.93±0.10^b
	28	63.73±0.42^b	13.22±0.18^c	1.03±0.08^c	2.27±0.17^c
C_6	0	68.15±1.19^a	16.04±0.06^a	1.85±0.02^a	4.74±0.05^a
	14	66.42±0.32^a	14.27±0.22^b	1.64±0.13^b	2.85±1.04^b
	28	68.35±0.41^b	13.30±0.34^c	1.27±0.15^c	2.97±0.34^b

Mean values in the same column with different superscript are significantly ($p<0.05$) different for each category

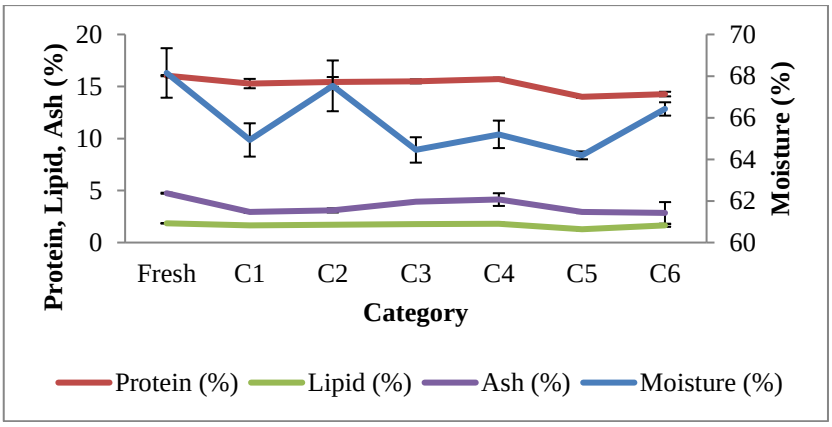

Fig. 2. Different proximate composition (%) among categories and fresh fish on day 14

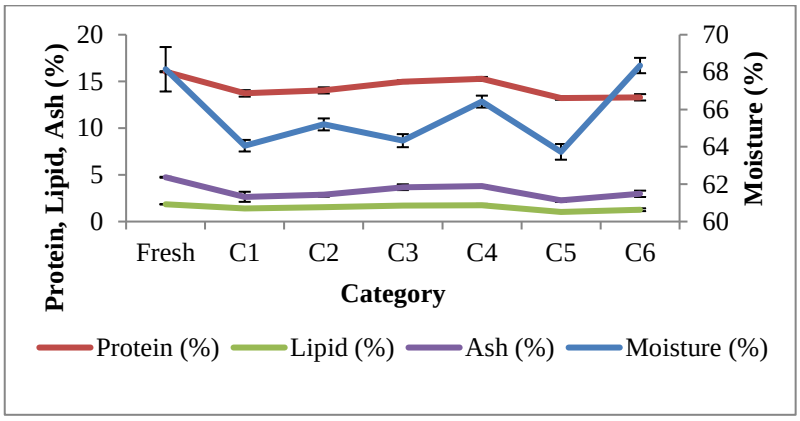

Fig. 3. Different proximate composition (%) among categories and fresh fish on day 28

Freezing is a common practice for the storage of fish, because it preserves the quality for an extended time and offers minimum deterioration in products' colour, flavour and texture. However, freezer burn, dehydration, rancidity, drip loss and product bleaching affect the quality of frozen storage (Kropf and Bowers, 1992). The vital nutrients of fish have been known to depend largely on the methods of storage. Different processing methods alter the percentages of moisture, ash, protein, fat, carbohydrate and energy (Bassey et al., 2014). Processing methods and storage may have accounted for the alterations observed in composition. In this study frozen storage reduced both the percentage of moisture, protein, lipid and ash content in all categories. Several studies have similarly revealed that protein, ash, moisture and fat reduced with frozen storage (Omotosho, 1995; Arannilewa et al., 2005).

Conclusion

Fresh fish would be healthier choice than frozen fish. Frozen fish could also be a healthy choice, if fresh fish was prepared properly and stored shortly. However, the freshness of fish along with how long it was frozen can impact its proximate composition. The reduction in the proximate composition of fresh fish was observed to be significant after 14 days of storage. The study revealed that the percentage of moisture, protein, lipid and ash content decreased with the increase of time. The study also concluded that different preservation periods and methods affected the nutritional composition of fresh fish. Fresh whole fish treated with turmeric and preserved in polythene delayed the chemical changes and kept the nutritional quality unbroken better than others preserving categories through the 28 days of frozen storage.

Authors contributions: The study was designed by Shuva Bhowmik. The experiments were performed and data were analyzed and interpreted by Nustrat Jahan Shoshi and Md. Harun or Rashid. The analysis was done by Shuvagato Mondal and the manuscript was written by MUM Abu Zakaria, corrected by Shuva Bhowmik.

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