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Quality evaluation of mince-based fish burger from tilapia (*Oreochromis mossambicus*) during frozen storage

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ABSTRACT

Biochemical, microbial and sensory qualities of burger patty and fish mince prepared from Mozambique tilapia were determined during frozen storage condition (-18 ºC) up to 75 days. Significant decrease (P>0.05) in moisture and lipid contents of mince and burger were observed during the storage period although moisture and lipid contents of burger was higher than the mince. Protein content of mince and burger reduced at the end of storage period however, reduction rate was not significant (p>0.05) and protein content of burger was slightly higher than that of mince. Ash content of both mince and burger increased significantly (p<0.05) throughout the storage period and ash content in burger was higher than that of mince. TVB-N content in fish mince and burger increased significantly (p<0.05).The pH value increased in both groups but the rate of increment was not significant (p>0.05). Microbial load of burger was found higher than mince but microbial load of both groups remained under maximum allowable count until the end of the storage period. Sensory parameters (color, texture, taste and overall acceptability) of burger decreased significantly (p<0.05), whereas, all parameters other than texture remained in good condition until the end of the storage period.

Introduction

Fish is a great source of ω3 fatty acids (Horrocks *et al.,* 1999, Sidhu, 2003) therefore, consumption of fish and fishery products are increasing significantly in recent years. Tilapia is one of the most significant fish species and widely cultured in Bangladesh to meet up the increased protein demand. Tilapia *(Oreochromis mossambicus*) is regarded as a "weed fish" in aquaculture because of its fast growth rate (Ninan *et al.,* 2008). However, quality of Tilapia flesh is very appropriate for fish mince-based products (Gopakumar, 1997). Tilapia as whole fish is found to have a storage life of 10–14 days in chilled condition (Surendran *et al.,* 1989). However, various fish species have been investigated for the suitability of mince-based products (Onibala *et al.,* 1997), among them flesh of tilapia has considered suitable for preparation of surimi-based products (Gopakumar, 1997). Surimi prepared from tilapia was very high in quality to that from Indian major carps (Ninan *et al.,* 2004). After 180 days in frozen storage, the mince from tilapia was found to be physically stable with acceptable condition (Gryschek *et al.,* 2003). The mince is white in color, has low fat content and no pronounced odor, which makes it an ideal raw material for the preparation of value-added products like fish burger (Ninan *et al.,* 2010).

In recent years, people are very concerned about their food intake and due to life style, consumer's preference led to ready-to-eat foods because of their convenience (Yerlikaya *et al.,* 2005). Value added products from fish are acceptable fast food products in the world (Chomnawang *et al.,* 2007). Converting tilapia flesh into value added products like burger is a simple and a cost-effective means which will increase the consumer acceptability of the fish (Vanitha, 2013). This type of technology will increase the utilization through the development of diversified fishery products, at the same time the farmer can increase income by supplying fish to the fish burger processing industries. Considering the facts, the present study was conducted to develop fish burger from tilapia (*O. mossambicus)* and subsequently quality changes in tilapia fish burger was investigated at frozen storage (-18 ^{0}C) condition.

Materials and methods

Study area and period

Experiment was conducted in the Laboratory of the Department of Fisheries Technology, Hajee Mohammad

Danesh Science and Technology University, Dinajpur, during the period of July 2017 to August 2018.

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Sample collection

Fresh Tilapia was purchased from Bahadur Bazar Fish market, Dinajpur, Bangladesh. Total 15kg fishes were collected, average weight of each fish was 750g and average length was 25 cm. The fishes were immediately transported to the Fisheries Technology Laboratory.

Preparation of fish mince and fish burger

The collected fish were beheaded, eviscerated and washed with clean water. After that fishes were filleted and skinned with sharp knife, deboned and minced with a meat mixer in cold condition. A considerable amount of prepared mince was packed in zip lock PVC bag for quality analysis during frozen storage period. The mince obtained from tilapia fish was mixed with onion (8.40%), ginger (3.45%), garlic (3.85%), green chili (4.80%), salt (3.00%), sugar (1%), black pepper (0.90%), tasting salt (0.45%), corn flour (4.40 %) and egg (6.0%) (Ninan et al., 2010). The amount of spice was determined by adding small amount of each ingredient, until desirable taste was achieved. After that, the prepared dough was spread in aluminum tray at thickness about 0.5 inch. It was then kept at -18°C for 1 hour in a freezer for partial setting and then cut into round shaped burger patty. Diameter of produced fish burgers were about 1 inch and weight of each fish burger was around 100g. The battering solution was prepared by mixing with egg white, black pepper and salt. Then fish burger patties were dipped into the battering solution and rolled in the bread crumbs until uniform coating on the surface. Produced fish burger patties were put in zip lock PVC bags manually. Each zip lock bag contained3 pieces of burgers; in total 30 packets were prepared and stored at -18°C for 75 days.

Frying of tilapia fish burger

Battered and breaded fish burger patties were dip fried in soybean oil until the surface of the burger became golden brown color. Finally, prepared fish burger patties were kept on the paper towels in order to soak the extra oil from the surface of the fried tilapia fish burger.

Quality analysis of tilapia fish burger patty

Fresh fish mince and fish burger patties were analyzed for microbiological, chemical and sensory attributes periodically at 1st, 15th, 30th, 45th, 60th and 75th day of storage period. Samples were drawn randomly for chemical, microbiological and sensory quality analyses and all the analyses were performed at least in triplicate.

Biochemical analysis

Proximate composition (moisture, protein, lipid and ash), Total Volatile Base Nitrogen (TVB-N) and pH of fish mince and burger were tested according to the methods described by Association of Official Analytical Chemists (AOAC, 2005).

Determination of microbial load

Standard plate count (SPC) was determined by using consecutive decimal dilution technique in spread plate method. Approximately 10g of burger samples were put in a pre-sterilized blender containing 200 ml of peptone water (0.2% peptone) and homogenate was properly mixed with peptone water. Aliquots of 0.1 ml of the serial dilutions were pipetted out and transferred aseptically to the agar plates. The samples were spread by L- shaped glass rods throughout the surface of the media until the samples dried out. The plates were then put in incubator at 30°C for 24-48 hours and then plates were counted.

Sensory evaluation of tilapia fish burger

A panel of seven trained personnel was formed for sensory evaluation of tilapia fish burger. Panelists scored the burger for color, taste, texture and overall acceptability following 4-point hedonic scale as 1 for "excellent", 2 for "good", 3 for "average", 4 for "Bad" (Tokur *et al.,* 2004). For each sensory analysis fish burger patties were taken out randomly from frozen storage and stored at 4ºC for thawing. After that, burger patty was fried in sunflower oil and presented to each panellist to recognize every attribute

Statistical analysis

For statistical analysis, SPSS 11.5 (SPSS Inc, Chicago, IL, USA) was used to determine the difference between group of biochemical and sensory data. Analysis of variance (ANOVA) was used to find the significance of difference between the storage periods.

Results

Changes in moisture, protein, lipid and ash content of tilapia fish mince and burger over 75 days are shown in Table 1. The moisture content of both fish mince and burger decreased significantly ($p<0.05$) over the storage period but fish burger contained higher amount of moisture than fish mince throughout the storage period.

Table 1. Changes in proximate composition (%) of tilapia fish mince and burger during frozen storage period (-18°C)

Analysis	Group	1st day	15th days	30th days	45th days	60th days	75th days
Moisture	Mince	72.68±.28	70.81±.65	70.52±.56	69.65±.19	69.35±.12	68.15±.16
	Burger	77.88±.71	77.06±.62	73.78±.29	72.66±.35	72.13±.39	70.53±.16
Protein	Mince	15.14±.22	15.05±.31	14.84±.14	14.50±.12	14.31±.08	13.42±.31
	Burger	15.51±.10	15.30±.18	15.12±.12	14.91±.19	14.78±.25	14.16±.33
Lipid	Mince	0.96±.03	0.83±.00	0.68±.03	0.62±.02	0.53±.01	0.41±.01
	Burger	1.93±.04	1.76±.04	1.54±.02	1.41±.01	1.11±.01	0.99±.01
Ash	Mince	1.79±.05	1.79±.04	1.91±.04	1.95±.03	2.30±.07	3.80±.11
	Burger	3.53±.15	3.77±.08	3.93±.05	4.03±.10	4.36±.18	4.92±.18

Data are expressed as means± standard deviation

Decrease in protein content of fish mince and burger throughout the storage period which was not significant ($p>0.05$). The protein content of fish burger was marginally higher than fish mince. Lipid content of fish mince and fish burger reduced over the storage condition significantly ($p<0.05$), however the lipid content of fish burger was significantly higher than fish mince. Therefore, proportion of lipid in fish burger and fish mince differs over the time. On the other hand ash content of both fish mince and fish burger increased significantly ($p<0.05$) throughout the storage period. Amount of ash content in fish burger was higher than that of fish mince. During frozen storage temperature, pH content in fish burger and mince increased slowly with the increase of storage period, which were not significant ($p>0.05$). However, no significant differences were observed between fish mince and burger over the period. In frozen storage condition, pH content of mince from 1st day to 75th day intervals were 6.07±0.02, 6.22±0.17, 6.56±0.06, 6.75±0.065, 7.11±0.18 and 7.30±0.18, respectively and in burger, pH contents from 1st day to 75th days were 6.60±0.16, 6.82±0.12, 6.91±0.12, 7.04±0.07, 7.59±0.03 and 7.92±0.08, respectively.

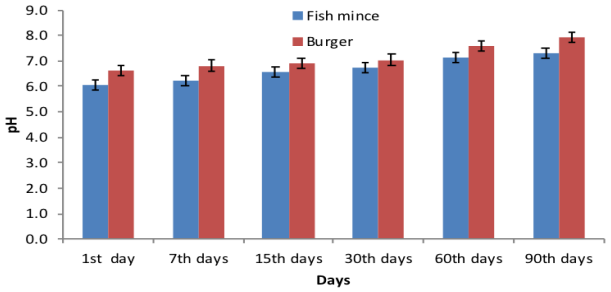

Fig. 1. Changes in pH of fish mince and burger during frozen storage

During frozen storage, TVB-N content in fish burger and mince increased slowly with the increase of storage period (Fig. 2).TVB-N content of mince from 1st day to 75th days were 10.23±0.26, 11.64±0.15, 11.85±0.07, 12.17±0.16, 12.29±0.16, and 12.29±0.52, respectively and TVB-N contents of burger from 1st day to 75th days were 9.97±0.56, 11.14±0.09, 11.72±0.09, 11.88±0.09, 12.13±0.10, and 13.10±0.47, respectively.

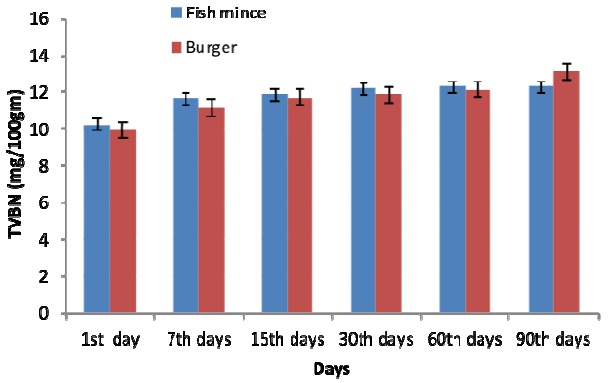

Fig. 2. Changes in TVB-N content (%) of tilapia fish mince and burger during frozen storage

The microbial load of fish burger was found higher than fish mince due to use of some additive. Decreasing rate of microbial load was related to freezing time, therefore gradual decrease of microbial load was found throughout the frozen storage period. The SPC count of fish mince and fish burger during the storage period are shown in (Table 2)

Table 2. Change in microbial load in fish mince and burger during frozen storage

Day	SPC of Fish Burger (CFU/g)	
	Fish Mince	Burger
1st	3.60×10^5	4.39×10^5
15th	2.69×10^5	3.27×10^5
30th	2.53×10^5	3.02×10^5
45th	2.46×10^5	3.16×10^5
60th	2.51×10^5	3.12×10^5
75th	2.05×10^5	2.48×10^5

To determine the sensory parameters, namely, color, taste, texture and over all acceptability of tilapia fish burger were evaluated and the result has been presented in Table 3. All parameters except taste decreased significantly ($p>0.05$) during storage. However, overall acceptability and taste obtained "good" score until the end of storage whereas texture and color obtained "average" score.

Table 3. Change in sensory attributes in fish burger during frozen storage

Day	Color	Taste	Texture	Overall acceptability
1st	1.14±0.38	1.14±0.38	1.14±0.38	1.00±0.00
15th	1.29±0.49	1.57±0.79	1.57±0.79	1.29±0.49
30th	1.71±0.76	1.57±0.79	1.71±0.76	1.43±0.53
45th	2.00±0.58	1.86±0.69	1.71±0.76	1.71±0.76
60th	2.29±0.76	2.14±0.69	2.57±0.79	2.00±0.82
75th	2.86±0.69	2.43±0.98	2.86±0.69	2.43±0.53

Means within the same column having different superscript are significantly different at $p<0.05$
Score: 1-"excellent", 2- "good", 3- "average", 4- "Bad"

Discussion

Produced fish burgers had higher moisture, protein, lipid and ash content than fish mince but all parameters except ash content decreased gradually as frozen storage period progressed. Reduction of total moisture content both in fish mince and burger was due to dehydration during frozen storage (Ninan *et al.,* 2008). However, moisture content of fish burger was higher than the mince, this was happened due to the addition of onion, ginger and garlic paste in burger patty. Likewise, present study, Tokur *et al.* (2004) evaluated chemical and sensory qualities of tilapia fish burger during frozen storage (−18°C) and found similar type of result. Reduction of protein in fish burger was slightly lower than mince may be due to the spices such as ginger, garlic paste, onion paste, green chili and eggs etc. added during preparation of fish burger. Mahmoudzadeh *et al.* (2010) reported similar findings when fish burger was prepared by adding various ingredients such as spice. However, denaturation of fish protein and leaching out of water soluble protein is associated with the decrease

in protein in fishery products (Arannilewa *et al*., 2005). Changes in the pH of fish muscle have been considered one of the causative factors in the denaturation of fish protein during frozen storage (Shimizu and Fujita, 1985). Reduction of protein was observed due to denaturation fish muscle during chilled and frozen storage (Gopakumar, 2002) and leaching out of some extractable soluble protein fraction during storage (Daramola *et al.*, 2007).

In the present study, percentage of lipid content was higher in fish burger than fish mince. Lipid content both in burger and mince decreased gradually due to lipid oxidation during frozen storage condition. Al-Bulushi *et al.* (2005) found decreasing pattern of lipid at the end of the frozen storage period for fish burger. Ninan *et al.* (2008) found that lipid content increased generally due to deep frying as well as dehydration during frozen storage period. Marimuthu *et al.* (2012) also reported that the lipid content in fried fish fillet increased due to absorption of oil during frying. During preparation of burger, spices like onion paste, ginger paste, garlic paste, green chili paste etc. were incorporated that was may be the main cause of increased ash percentage in burger than fish mince. Increase in ash content during the frozen storage of fish fingers made from croakers during the frozen storage was reported by Lakshminatha *et al.,* (1992). Hassaballa *et al.* (2009) analyzed that the initial ash content of catfish burger was higher than the ash content at the end of frozen storage period. The change in pH of fish muscle is usually a good index for quality assessment which might indicate the enzymatic degradation of fish muscle (Love, 1992 and Vareltzis *et al*., 1997). In the present study, burger showed slightly increased pH from 6.60±0.16 to 7.92±0.08 (Figure, 1) when stored at freezing temperature. The pH also increased significantly due to release of CO_2 by the microbial flora present in the product (Adams & Moss, 2000). Similar observation during the refrigeration storage of fish patties produced from anchovy was reported by the (Kilinc, 2003). Bao *et al.* (2007) also reported the increasing trend of pH in Arctic charr (*Salvelinus alpines*) fillets at super chilling (-2°C) and chilling (3°C) storage temperature. These results are more or less similar to the present study. TVB-N is a commonly used chemical method to determine spoilage of fish. The TVB-N in freshwater fish and their products comes from ammonia (Tokur *et al*., 2004). In the study, TVB-N of tilapia fish burger during frozen storage increased from 9.97 to 13.10 mg/100g till 75thdays. Ninan *et al.,* (2008) reported that TVB-N value was in the range of 12.4 to 20.2 mg/100g in tilapia fish cutlet. Mohmaudzadeh *et al*., (2010) reported TVB-N in deep flounder (*Pseudorhombus elvatus*) and brush tooth lizardfish (*Saurida undosquamis*) during storage at -18°C for 5 months. The increasing TVB-N value was related with bacterial spoilage and activity of endogenous enzymes (Chomnawang *et al*., 2007). TVB-N of Catla cutlet during frozen storage increased from 4.15 to 15.06 mg/100g till 105th days and then onward decreased to 10.53 mg/100g on 180th days (Pawar *et al.,* 2013).

Total viable count is an important criterion for quality evaluation. Microbiological count of fish mince and burger decreased with freezing time and maximum decrease was found during the first month of storage period (Mahmoudzadeh *et al.,* 2010).The maximum acceptable microbial load for fresh and frozen fish is 10^7 CFU/g recommended by International Commission of Microbiological Standards for Foods (ICMSF, 1978). There was no standard for fish burgers but according to hamburger standard maximum total viable count was given as 10^6 CFU/g (Anonymous, 1992) and maximum level for the same product was 10^7 CFU/g (Wehr, 1982). ICMSF (1978) suggested that maximum level of total viable count for some fish products (i.e., fish sticks, fish portions, fish cakes) was 10^7 CFU/g. According to the above data, prepared tilapia burger was safe for consumption up to75 days of frozen storage. Overall acceptability of produced fish burger remained in good condition until the end of storage periods. Tokur *et al*. (2004) reported similar changes in the sensory qualities of fish burger developed from tilapia at -18°C for 8 months of storage. Mohmaudzadeh *et al*. (2010) reported that sensory parameters of fish burgers from deep flounder and brush tooth lizardfish decreased significantly during storage at -18°C for 5 months. Reddy *et al*. (1992) reported organoleptic score of frozen fish fingers from croaker and perch during storage and both types of fish fingers were acceptable up to 22 weeks at -20°C.

Conclusion

Keeping quality of tilapia fish mince and fish burger was determined on the 1st, 15th, 30th, 45th, 60th and 75th days of storage period and result showed that sensory, biochemical and microbial properties of fish burger remained in good condition compared to the fish mince throughout the storage period. The present study revealed that the preparation of burger from low cost fish would pave a way for proper utilization of this resource particularly during the peak season of harvesting. Scientific knowledge on quality changes in fish burger during frozen storage will provide a basis for supplying premium quality products. This study has immense importance to satisfy consumer's query relating to and how long fish burger can be stored without any deterioration in domestic freezer for the betterment of the public health.

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