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DEVELOPMENT OF FISH FINGER FROM ROHU (*Labeo rohita*) AND ITS QUALITY EVALUATION DURING REFRIGERATED STORAGE CONDITION

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Abstract: Study was conducted to study the shelf life, proximate composition, biochemical, microbiological and organoleptic changes in fish finger prepared from minced meat of fish rohu (*Labeo rohita)* with suitable recipe. Prepared fish finger was stored in refrigerated condition at $4^0C \pm 1^0C$ for 11 days. The yield rate of minced meat from the whole fish was 39.31 %. The moisture and protein content of fish finger during refrigerated storage was decreased significantly from 64.90 % to 57.36 % and 18.5 % to 16.29 % ($P < 0.01$) respectively while fat and ash content were increased significantly from 8.68 % to 15.33 % and 2.5 % to 3.43 % ($P<0.01$) respectively. The pH of fish finger decreased significantly ($P<0.01$) from 6.95 to 6.44. PV of fish finger increased from 10.73 to 17.8 meqO_2/kg of fat till the end of 5th day of storage and subsequently decreased to 10.4 meqO_2/kg of fat at the end of 15 days of storage period. The pattern of change in free fatty acid content and TBA of fish finger was gradual increment from 0.0014 to 0.0046 % of oleic acid and 0.095 to 1.030 mg MA/kg of sample respectively ($P<0.01$). The TVBN content steadily increased significantly ($P<0.01$) from an initial value of 2.65 to 4.43 mg/100g sample during 15 days refrigerated storage. TPC and psychrophilic bacterial count increased steadily ($P<0.01$) from the initial count of 5.68×10^2 cfu/g of sample to 1.72×10^5cfu/g of sample and from 2.54×10^2 cfu/g of sample to 1.24×10^5 cfu/g of sample respectively. The overall mean acceptability scores declined significantly ($P<0.01$) with increase storage period. The ideal shelf life for storing the fish finger in refrigerated condition was found as 9 days.

Keywords: Minced product, Rohu, Organoleptic, Shelf life, Storage.

Introduction

Over exploitation through unplanned and unmanaged marine fishery is lead to depletion of commercially valuable fishes and increase of bycatch and discards. Considering huge quantity of landing of bycatch which are low in commercial value, there is a need for the total utilization of the catch to meet the increased global requirement of the protein. During the last few years, there has been considerable structural change in the development of fishery products and export industry. There is a growing demand for “ready to cook” or

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"ready to serve" fishery products, hygienically prepared and attractively packed convenience foods to match the changing needs of urban population. In India, poor attention is paid to process and do the value addition to the fresh water fishes mainly Indian Major Carps which are produced in huge quantity and fetch low price in the market as raw material.

Among the freshwater fish produced in India, the major carps of India *(Labeo rohita, Catla catla and Cirrhinus mrigala)* and Chineese carps *(Cyprinus carpio, Ctenopharyngodon idella and Hypophthalmicthys molitrix)* form a major component of Indian aquaculture, with a market share of over 90%. These carps have nowadays poor consumer preference due to their intramuscular bones which leads to limited market. Processing and value addition to these carps would certainly sustain the carp culture and make the products more profitable. These fish are usually consumed fresh locally and excess are transported to internal markets and neighbor states. However, other than marine fishing season, these fishes fetch very low return to the producers. Owing to these, it has been suggested to use these carps for the production of surimi (Shankar *et al.,* 2005) and other value added products like Fish patties and fingers (*Sehgal* and *Sehgal,* 2002). The demand for ready to eat and or ready to cook products are gradually growing because of their convenience (Yerlikaya *et al.,* 2005). Battered and breaded or coated systems have the benefits of versatility and familiarity because they enhance the flavor and texture of processed food products (Biswas *et al.,* 2004). Fish is a preferable substitute for livestock meat because of its low cholesterol level and high omega-3 fatty acid content which help in reducing cardiovascular and various other diseases (Kolanowski *et al.,* 2006). Freezing and frozen storage of fish cutlet, fish finger and fish burger are commonly used because of the consistency, reliable quality, ease of transportation and the fact that they are very close to fresh equivalents (Tokur *et al.,* 2004 and Sharma *et al*., 2000). Efforts have also been made to improve the quality and stability of ready to eat foods (Cakli *et al.,* 2005). Owing to these, the value addition to rohu fish meat and its storage methods are studied.

Materials and Methods

The fish Rohu (*Labeo rohita*) with the mean length of 36.75± 2.98 cm and weight of 884.40 ± 114.77 kg respectively were collected from the nearby commercial fish ponds and brought to the laboratory in iced condition. The fish brought were washed with chilled water and dressed to remove head and viscera. Meat was separated from dressed fish using rotary type deboner (Safe World, Malaysia). The deboned fish meat was later minced using a mincer (Sirman, Italy) to obtain uniform size meat particles. The fresh minced meat obtained from rohu fish was used for the preparation of fish finger. Preliminary experiments were conducted to standardize the various levels of ingredients required for the development of value added fish products from rohu meat and to optimize processing conditions. Different recipe with different taste were prepared and analyzed organoleptically to find out a right formula of recipe for the preparation of fish finger. Based on the highest average organoleptic scores for all attributes, the best recipe was selected with the ingredients of 93.5 % Minced meat, 2% wheat flour, 1.5 % salt, 1 % sugar, 1 % Chilli powder, 0.26 % onion, 0.24 % cumin seed, 0.24 % pepper, 0.24 % garlic and 0.02 % Sodium tripolyphosphate. After mixing of all the ingredients, the pasty mass was made into slabs and frozen at – 40^0C in a freezer unit. The frozen piece was cut into fingers of uniform size having weight of 15 g each and battered followed by rolled over the bread crumbs. After battering, it was pre-fried at 180^0C for 30 seconds. They were packed in HDPE pouches after cooling and stored at 4^0C ± 1^0C for quality evaluation with clear markings.

Two samples were drawn randomly on every alternate day up to 15 days of refrigerated storage to analyze proximate, sensory, microbiological and biochemical parameters. Microbial analysis was first carried out aseptically and afterwards, the product was brought to room temperature for carrying out the proximate, biochemical and sensory analysis. The first analyses were carried out on the 0^{th} day of preparation of the product and all the parameters were analysed in triplicate. Mean sensory numerical scores were obtained based on the assessment carried out by seven panelists.

Proximate composition like moisture, fat, protein and ash were analyzed in fresh minced meat and the fish finger by the method described in AOAC (2000). Total Volatile Base Nitrogen (TVBN) was determined by the micro diffusion method (Conway, 1962) while Thiobarbituric Acid value was quantified using the method of Tarladgis et al (1960). Peroxide Value (PV) and Free Fatty Acid (FFA) were determined following the method developed by Jacobs (1958) and Olley and Lovern (1960) respectively. The microbiological enumeration was carried out as per the APHA (1992). The microbial count for various species like *Staphylococcus aureus, Escherichia coli*, *Faecal streptococci, Vibrio* spp., *Salmonella* spp.*,* Psychrophilic bacteria and Moulds were estimated by spread plate technique.

Sensory characteristics of the deep fried fish finger from rohu minced meat were evaluated by experienced panel members of the institute on a nine-point scale (Reddy, 1992) and assigned scores were 9,8,7,6,5,4,3,2,1 for extremely, like very much, like moderately, like slightly, neither like nor dislike, dislike slightly, dislike moderately, dislike very much and dislike extremely respectively for each of the sensory characteristics of the product. . The characteristics covered under the taste panel were appearance, colour, odour, flavor, taste, texture and overall acceptability for fish fingers.

The SPSS (Statistical Package for Social Sciences) 19 (SPSS, 2010) statistical package was used for analysis of the experimental results. Sufficient numbers of samples were carried out for each analysis. The results were expressed as mean ± standard deviation (SD). The correlation coefficients between the parameters were carried out using the same software.

Results and Discussion

Proximate composition

The proximate composition of fresh rohu (*Labeo rohita*) mince like moisture, protein, fat, ash content was 78.55 ± 0.24, 18.78 ± 0.02, 3.29 ± 0.01, 1.23 ± 0.14 respectively. The proximate composition of rohu is comparable to the other fresh water fishes (Arekere, 1993; Siddaiah *et al.,* 2001; Panchavarnam *et al.,* 2003; Vanitha et al., 2015 and Manjunatha Reddy *et al.,* 2012). The estimated biochemical values like pH, Total volatile base nitrogen (TVBN), Thiobarbutric acid (TBA) content, Peroxide value (PV), Free fatty acid (FFA) and Total plate count (TPC) of fresh minced meat were 6.51 , 0.98 mg/100g of meat, 0.40 mg of MA/100g of sample, 5.8 meqO_2/kg of fat, 0.0008 %, and 6.36x10^2 cfu/g of meat respectively. The lower pH value observed in the present study indicates the freshness of fish meat used for further processing. The TVBN, TBA, PV, FFA and TPC levels in fresh rohu meat used in the study are below the threshold values.

The yield rate of minced meat from the whole fish was 39.31 %. However, the yield of raw mince from fresh water fishes like common carp, silver carp and Catla varies from 40-47% (Arekere,1993; Siddaiah *et al.,* 2001; Vanitha et al., 2015). Quality of the final product depends mainly on the raw material characteristics and treatments, if any, given during processing (Dhanapal, 1992). Ideal recipe selected for fish finger preparation contained the ingredients in various percentage are Wheat (93.5%) flour (2.0), Salt (1.5), Sugar (1.0), Chilli powder (1.0), Cumin seed (0.24), Onion (0.26), Garlic (0.24), Pepper (0.24), Sodium tripolyphosphate (0.02) respectively. Various attributes for the selected recipe were Appearance (8.90±0.24), Colour (8.64±0.35), Flavour (8.50±0.19), Odour (8.72±0.27), Taste (9.00±0.47) Texture (8.57±0.58) and Overall acceptability (8.72±0.17). Elyasi *et al.* (2010) developed fish fingers with 93.5% fish mince and 6.5% additive substances in common carp (*Cyprinus carpio*). Cakli *et al.* (2005) developed the fish fingers by adding 80% minced meat and 20 % additive substances in three fish species (sardine, whiting and pink perch). Tokur *et al.* (2006) prepared fish fingers with 93.5% of carp mince.

The moisture and protein content of fish finger during refrigerated storage was decreased significantly from 64.90 % to 57.36 % and 18.5 % to 16.29 % ($P < 0.01$) respectively while fat and ash content were increased significantly from 8.68 % to 15.33 % and 2.5 % to 3.43 % ($P<0.01$) respectively (Table 1.) The decrease in moisture content during the refrigerated storage of finger was significant at 0.01% level ($P < 0.01$). Similar observation was observed by various researchers (Elyasi *et al,* 2010; Alamelu *et al*, 2007; Vanitha et al., 2015). The reduction in protein content can be attributed to the leaching out of the water soluble nitrogenous components, during storage along with moisture. Sehgal *et al.* (2010) suggested that cooking can be a possible reason for reduction in the protein content. Alamelu *et al.* (2007) reported that there was no significant change in the protein content of fish fingers during 21 days of refrigerated storage. The increase in fat can be attributed to the decrease in moisture content as they are inversely proportional. Increase in fat content may also be attributed to cooking of the product in oil (Sehgal *et al.*, 2008; Tokur *et al.* 2006). The ash content in the product was higher than the fresh fish mince, due to the addition of the ingredients during the preparation of fish finger. Vanitha et al. (2015) also concluded that the ash content in fish burger prepared from Catla increased during the refrigerated storage. In the present study, the sum of moisture, crude protein, lipid and ash content has been determined as 94% for fish finger and rest of the composition is considered as carbohydrates (Tokur *et al.,* 2006). The higher amount of carbohydrate in the products might be derived from coating materials which contain carbohydrate rich ingredients such as bread crumbs. Similar results have been confirmed by Sayar (2001) who found 15.2% carbohydrates in fish fingers due to the coating materials such as flour, starch, bread crumbs, potatoes, etc.

Biochemical Changes

The biochemical values of fish fingers are given in Table 2. The pH of fish finger decreased significantly ($P<0.01$) from 6.95 to 6.44. Decrease of pH in the product might be due to the decrease in oxygen content by the oxygen consumption by the aerobic microflora growth which released CO_2 content. At lower temperatures increased solubility of CO_2 in unbuffered solution can produce a drop in pH (Metin *et al,* 2002; Alamelu *et al.*, 2007).

The primary product of lipid oxidation is fatty acid hydroperoxide, measured as PV (Uchak *et al.,* 2011). During the initial stage of storage period, PV of fish finger increased from 10.73 to 17.8 meqO_2/kg of fat till the end of 5th day of storage and subsequently decreased to 10.4

meqO_2/kg of fat at the end of 15 days of storage period. The decrease of the PV at the end of the storage may occur owing to decomposition of hydro peroxides into secondary oxidation products and similar trend was also observed by the Yerlikaya *et al.* (2005) during the refrigerated studies of fish patties from anchovy. The peroxides being unstable undergo decomposition; consequently many of the decomposed products might have interacted with proteins which might have resulted in a reduction of PV. It is opined that the oxidation is a surface effect and the coating with egg white and addition of spices with antioxidant properties may function as an oxygen barrier, thus preventing the fat from oxidation.

Table 1. Changes in the Proximate Composition of Fish Finger during Refrigerated storage

Storage(Days)	Moisture* (%)	Crude Protein (%)	Crude Fat (%)	Ash (%)
0	$64.9±0.37^{a}$	$18.5±0.07^{i}$	$8.68±0.15^{a}$	$2.50±0.08^{bc}$
1	$63.73±0.67^{b}$	$18.21±0.01^{h}$	$9.01±1.40^{ab}$	$2.76±0.12^{ab}$
3	$63.06±0.98^{b}$	$18.06±0.03^{g}$	$10.83±0.04^{abc}$	$2.70±0.21^{a}$
5	$62.31±0.08^{bc}$	$17.86±0.04^{f}$	$11.39±0.36^{bcd}$	$2.86±0.04^{abc}$
7	$62.24±1.20^{bc}$	$17.60±0.02^{e}$	$11.93±0.82^{cd}$	$2.98±0.06^{bc}$
9	$59.86±0.98^{bc}$	$17.19±0.00^{d}$	$12.06±0.24^{cd}$	$3.01±0.13^{bc}$
11	$58.65±1.09^{bc}$	$16.83±0.04^{c}$	$13.15±2.83^{cd}$	$3.02±0.00^{bc}$
13	$58.5±1.08^{bc}$	$16.47±0.07^{b}$	$13.56±0.38^{d}$	$3.07±0.05^{c}$
15	$57.36±1.29^{c}$	$16.29±0.06^{a}$	$15.33±0.47^{e}$	$3.43±0.16^{d}$

*Each value is represented as the mean ± SD of n=3.
^{abcdefgh}Means followed by the same superscript with in a column are not significantly different ($P > 0.01$).

Table 2. Bio-chemical changes during refrigerated storage of fish finger

Storage (Days)	pH	PV* (meqO_2/kg of fat)	FFA* (% of oleic acid)	TBA* (mg MA / kg of sample)	TVBN* (mg /100g of sample)
0	$6.95±0.04^{e}$	$10.73±0.09^{b}$	$0.0014±0.00^{a}$	$0.095±0.01^{a}$	$2.65±0.68^{a}$
1	$6.71±0.06^{d}$	$11.26±0.09^{c}$	$0.0019±0.00^{ab}$	$0.100±0.00^{a}$	$2.80±0.00^{ab}$
3	$6.64±0.02^{c}$	$14.4±0.19^{f}$	$0.0022±0.00^{b}$	$0.560±0.01^{b}$	$3.07±0.01^{ab}$
5	$6.62±0.00^{c}$	$17.8±0.09^{i}$	$0.0022±0.00^{b}$	$0.580±0.06^{b}$	$3.09±0.13^{ab}$
7	$6.61±0.00^{bc}$	$16.2±0.04^{h}$	$0.0024±0.00^{b}$	$0.590±0.06^{b}$	$3.11±0.03^{ab}$
9	$6.61±0.00^{bc}$	$15.21±0.00^{g}$	$0.0032±0.00^{c}$	$0.600±0.01^{b}$	$3.33±0.04^{b}$
11	$6.59±0.03^{bc}$	$13.3±0.08^{e}$	$0.0042±0.00^{d}$	$0.640±0.01^{b}$	$3.38±0.02^{b}$
13	$6.55±0.00^{b}$	$12.4±0.16^{d}$	$0.0044±0.00^{d}$	$0.730±0.03^{c}$	$4.00±0.16^{c}$
15	$6.44±0.01^{a}$	$10.4±0.16^{a}$	$0.0046±0.00^{d}$	$1.030±0.01^{d}$	$4.43±0.12^{c}$

*Each value is represented as the mean ± SD of n=3.
^{abcde}Means followed by the same superscript with in a column are not significantly different ($P > 0.01$).

The pattern of change in free fatty acid content and TBA of fish finger was gradual increment from 0.0014 to 0.0046 % of oleic acid and 0.095 to 1.030 mg MA/kg of sample respectively ($P<0.01$). Similar observation was made by Vanitha et al. (2015) in
fish burger during refrigerated storage. The increase of FFA during storage might be due to enzymatic hydrolysis of esterified lipids (Hwang and Regenstein, 1993). The initial content of FFA was low in the products since cooking of mince prior to preparation of product might have deactivated the lipolytic enzymes and flash frying after preparation of the product (Ninan *et al.,* 2011). TBA is a secondary breakdown product of lipid oxidation and widely used as an indicator of degree of lipid oxidation (Aubourg, 1999). The increase in TBA content might be due to the development of oxidative rancidity in the product. Similar studies were conducted by Izci (2010) in fish fingers from prussian carp during refrigerated storage.

The TVBN content steadily increased significantly ($P<0.01$) from an initial value of 2.65 to 4.43 mg/100g sample during 15 days refrigerated storage. Total volatile base nitrogen is known as a product of bacterial spoilage and endogenous enzymes action and its content is often used as an index to assess the keeping quality and shelf life of products (EEC, 1995). Chomnawang *et al.* (2007) stated that the increasing of TVBN value during storage is related to bacterial spoilage, activity of endogenous enzymes and degradation of tissue proteins. According to Adebona (1978) increase in TVBN with length of storage is mainly attributed to the production of ammonia. A similar observation was made by Boran *et al.* (2007) and Akkus *et al.* (2004) in the refrigerated storage of fish balls.

Microbiological Changes

The changes in the total plate count and psychrophilic bacteria count during storage were enumerated and the results are presented in Table 3. TPC and psychrophilic bacterial count increased steadily ($P<0.01$) from the initial count of 5.68×10^2 cfu/g of sample to 1.72×10^5cfu/g of sample and from 2.54×10^2 cfu/g of sample to 1.24×10^5 cfu/g of sample respectively. The same increase of bacterial count was observed by various researchers in different fish products stored in refrigerated condition (Taskaya *et al,* 2003; Kilinc, 2007; Baygar *et al,* 2008). It may be attributed to the fluctuation in the storage temperature due to power failure. However, TPC and *Psychrophilic* bacteria level did not exceed the maximum level of 7 Log. cfu/g of meat as described by the ICMSF (1978).

Pathogenic bacteria like *Salmonella* spp, *Vibrio* spp, *Staphylococcus aureus, Faecal streptococci, Escherichia coli,* and molds were not detected in fish finger during the entire period of refrigerated temperature. Absence of other pathogenic bacteria like *Salmonella spp,* *Vibrio spp, Staphylococcus aureus, Faecal streptococci, Escherichia coli*, and mold might be due to flash frying of the product.

Organoleptic Evaluation

The mean scores for the overall acceptability of the fish finger obtained during organoleptic evaluation of the product are given in Table 4. The overall mean acceptability scores declined significantly (P<0.01) with increase storage period (Fig.1). The ideal shelf life for storing the fish finger in refrigerated condition was found as 9 days. Many researchers observed that shelf life various fish products stored in refrigerated condition are 9 to 11 days (Boran *et al,* 2007; Tasakaya *et al,* 2003).

Table 3. Changes in the microbial quantity in fish finger during refrigerated storage.

Storage period (Days)	Total plate count* (cfu/gram of meat)	Psychrophilic count* (cfu/gram of meat)
0	$5.68x10^2$ (2.75)	$2.54x10^2$ (2.50)
1	$1.02x10^3$ (3.00)	$6.24x10^2$ (2.79)
3	$3.28x10^3$ (3.51)	$1.34x10^3$ (3.12)
5	$7.68x10^3$ (3.89)	$4.54x10^3$ (3.65)
7	$9.68x10^3$ (3.98)	$7.56x10^3$ (3.87)
9	$2.54x10^4$ (4.40)	$1.54x10^4$ (4.18)
11	$7.54x10^4$ (4.87)	$5.42x10^4$ (4.73)
13	$9.78x10^4$ (4.99)	$8.52x10^4$ (4.93)
15	$1.72x10^5$ (5.23)	$1.24x10^5$ (5.09)

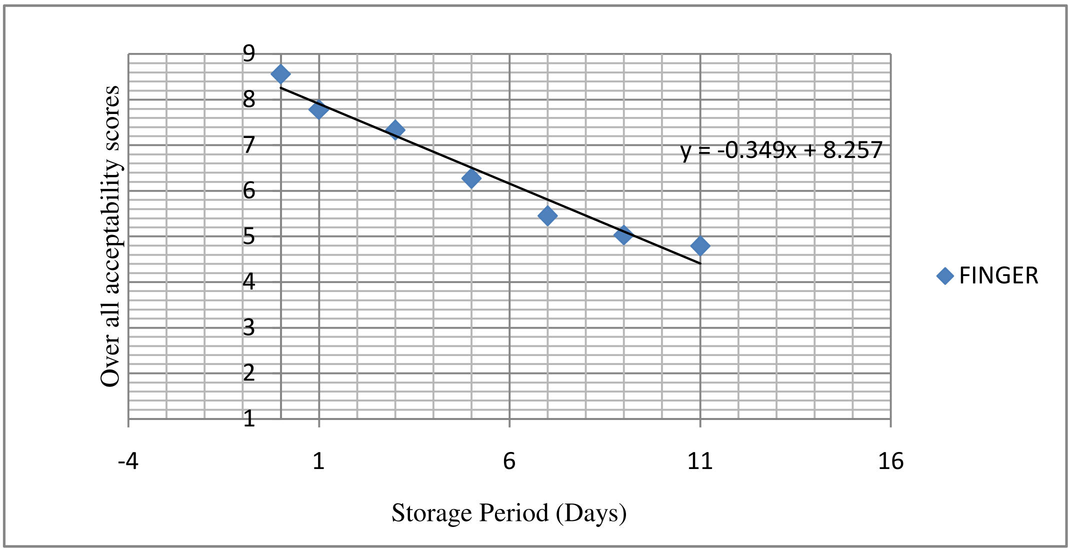
*Each value is represented as the mean of two estimates
Figures in the parenthesis indicates Log. Bacterial count cfu = colony forming units

Table 4. Overall Acceptability of fish finger during refrigerated storage

Storage period (Days)	Overall acceptability scores *
0	$8.56±0.02^i$
1	$7.78±0.00^h$
3	$7.33±0.02^g$
5	$6.27±0.04^f$
7	$5.45±0.12^e$
9	$5.03±0.04^d$
11	$4.79±0.03^c$
13	$4.36±0.01^b$
15	$4.01±0.04^a$

*Each value is represented as mean ± SD of n=7
^{abcdefghi}Means followed by the same superscript with in a column are not significantly different (P > 0.01).

Fig. 1. Relationship of storage period with overall acceptability of fish fingers during refrigerated storage



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