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QUALITY AND STORAGE STABILITY OF FISH CAKE FROM COMMON CARP (CYPRINUS CARPIO) DURING REFRIGERATED STORAGE

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Abstract: Fish cakes prepared from Common carp (*Cyprinus carpio*) were assessed for proximate, chemical, microbiological and sensory quality changes for a period of 15 days at refrigerated temperature of 4 (±1) °C. The changes in proximate analysis of fish cakes were found to be significant at P <0.01. The values of peroxide value, free fatty acid, Thiobarbutric acid and total volatile base nitrogen at the end of storage increased significantly at P <0.01 were determined as 7.86 (±0.04) meqO_2/kg of fat, 0.75 (±0.03)% of oleic acid, 1.42 (±0.02) mg MA/kg of sample and 6.19 (±0.02) mg/ 100 g of sample respectively. Total plate count and psychrophilic bacterial counts increased significantly (P <0.01) during refrigerated storage. *Staphylococcus aureus*, *Faecal streptococci*, *Escherichia coli*, *Salmonella*, *Vibrio*, yeast and moulds were found absent. The color changes in fish cake were observed during the entire storage period. According to sensory scores, the fish cakes have a shelf life of 12 days. A negative correlation was observed between storage period and overall acceptability scores.
Keywords: Common carp, Fish cake, Chemical quality, Sensory quality, Shelf life.

Introduction

Global fish production has grown steadily in the last five decades with food fish supply increasing at an average annual rate of 3.2 percent, outpacing world population growth at 1.6 percent. India is the 2nd largest producer of fish in the world with a share of 5.68% of the global fish production (FAO, 2014). In India, carps are the most important species that supports Indian freshwater fisheries. Among the freshwater fish produced in India, the major carps of India *(Catla catla, Labeo rohita and Cirrhinus mrigala)* and Chinese carps *(Cyprinus carpio, Ctenopharyngodon idella and Hypophthalmicthys molitrix)* form a major component of Indian aquaculture, with a market share of over 90%.

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Common Carp has low acceptability and low economic value due to its strong smell and softening of its flesh (Abdel- Aal *et al.*, 2014). Common carp is unacceptable to the consumer in the fresh form due to numerous bones penetrating the flesh. This fish has a high feed efficiency ratio (Tokur *et al*., 2006), but due to its feeding behaviour has a bad smell (Shabanpour *et al*., 2007) that cause to sell with a lower price. However, ready to eat products (processed fish) were developed in an attempt to increase the acceptability and utilization of carp fish (Ganesh *et al*., 2006).

Hence, the aim of present study is to develop ready to eat fish products (fish cake) from common carp (*Cyprinus carpio*) and to determine the rate and the type of a deterioration process that occurs during the refrigerated storage using proximate, chemical, microbiological and sensory methods.

Materials and Methods

Common carp (*Cyprinus carpio*) harvested from freshwater culture ponds was iced in the ratio of 1:1 and transported to the laboratory within 20 minutes. The average length and weight of Common carp used in the present study was 50.55 (±1.12) cm and 2200 (±73.61) g respectively. The fish were later dressed to remove head and viscera. Meat was separated from dressed fish using rotary type deboner (Safe World, Malaysia). The deboned fish meat was minced using a mincer (Sirman, Italy) to obtain uniform size meat particles.

The fresh minced meat obtained from Common carp was used to prepare fish cakes. Other ingredients used were procured from the local markets. Each fish cake was composed of 45% fish meat, 10% maida, 20% sugar, 10% sunflower oil, 12% egg white, 1.5% baking powder and 1.5% pineapple essence. All the ingredients were mixed into a smooth cream, then turned into already oiled baking pan and placed in a pre-heated oven and baked at 370^0C for 10 minutes. The products were packed in HDPE pouches, sealed, labelled and stored at 4(± 1) °C for quality evaluation. The analyses were done on the every alternate day up to 15 days. The samples were drawn randomly for analyses and were performed in triplicate for biochemical and duplicate for microbiological parameters.

Moisture, fat, protein and ash were analyzed as per AOAC (2000). The pH value of the homogenate was recorded using a digital pH meter (M/s. Oakton, Eutech instruments, Malaysia). Total volatile base nitrogen (TVBN) was determined by the micro diffusion method of Conway (1962). Thiobarbituric acid value (TBA) was assessed by the method of Tarladgis et al. (1960), peroxide value (PV) and free fatty acid (FFA) were estimated according to Jacobs (1958) and Olley and Lovern (1960) respectively. All the microbial

analysis was enumerated as per the procedures described in APHA (1992). Samples were homogenized using stomacher (Lab-Med, England). Preparation of sample and serial dilutions were done near the flame in a horizontal laminar flow apparatus that was pre-sterilized by ultraviolet radiation observing all possible aseptic precautions.

Scores were assigned with '1' being the least and '10' being the highest for attributes as described by Vijayan (1984). The characteristics covered under the taste panel were appearance, color, flavor, taste, texture and overall acceptability. Scores 10,9,8,7,6,5,4,3,2,1 were taken for excellent, like 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. The observations were converted to equivalent numerical scores and a sensory score of 4 was taken as the borderline of overall acceptability. The SPSS 19 (Statistical Package for Social Sciences, IBM 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. One way ANOVA was performed by the Duncan test to find the significance difference between storage days.

Result and Discussion

The yield of mince was 32.85% from the whole Common carp and the initial moisture, protein, fat and ash content of Common carp mince were found to be 77.84 (±0.31) %, 16.95 (±0.10) %, 3.15 (±0.07) % and 1.17 (±0.03) % respectively.

Proximate composition

The proximate composition of the fish cake during the refrigerated storage was given in Table 1. The moisture content in fish cakes decreased significantly at 0.01% level ($P < 0.01$) from 52.28 % to 48.46 %. An increase in the fat and ash content has been observed from 12.27 to 13.32 % and 1.51 to 2.12 % respectively ($P < 0.01$). The increase in fat can be attributed to the decrease in moisture content as they are inversely proportional. Similar observation was found by the Ucak *et al.* (2011) during the refrigeration storage of mackerel fish burgers for 15 days. During storage, crude protein decreased significantly at ($P < 0.01$). The decrease can be attributed to the leaching out of the water soluble nitrogenous components, during storage along with moisture. 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

cake. The remaining percentage of the proximate composition is thought to be due to carbohydrates (Tokur *et al.* 2006).

Table 1: Changes in the proximate composition* of fish cake during refrigerated storage.

Storage period (Days)	Moisture (%)	Crude Protein (%)	Fat (%)**	Ash (%)
0	52.28±0.23^{h}	6.47±0.04^{g}	12.27±0.04^{a}	1.51±0.02^{a}
1	51.41±0.15^{g}	6.36±0.03^{f}	12.42±0.04^{b}	1.55±0.02^{a}
3	50.92±0.11^{f}	6.15±0.03^{e}	12.57±0.04^{c}	1.63±0.01^{b}
5	50.49±0.09^{e}	6.00±0.06^{d}	12.72±0.03^{d}	1.69±0.02^{bc}
7	50.15±0.06^{de}	5.90±0.04^{c}	12.92±0.02^{e}	1.75±0.03^{c}
9	49.84±0.09^{d}	5.63±0.04^{c}	12.97±0.02^{fg}	1.83±0.01^{d}
11	49.40±0.05^{c}	5.43±0.04^{b}	13.07±0.04^{g}	1.90±0.01^{e}
13	49.00±0.03^{b}	5.19±0.01^{a}	13.22±0.04^{h}	2.01±0.02^{f}
15	48.46±0.11^{a}	4.92±0.04^{a}	13.32±0.02^{h}	2.12±0.03^{g}

*Each value is represented as the mean±SD of n= 3.

^{abcdefgh} Means followed by the same superscript within a column are not significantly different ($P > 0.01$).

** On dry weight basis

Chemical analysis

The changes in pH, PV, FFA, TBA and TVB-N values of fish cakes prepared from Common carp during refrigerated storage are shown in Table 2. The pH values of fish cakes increased significantly ($P < 0.01$) from 6.42 to 6.83. The observed increase in the pH was probably because of the microorganisms and enzymes release free oxygen and hydrogen, increasing hydroxyl ion concentration and thus causing a rise in pH (Turhan *et al*., 2001). During the initial storage period, PV of fish cake was found to be 6.12 meqO_2/kg of fat and it increased to 9.97 meqO_2/kg of fat at the end of the 5th day of storage and subsequently decreased to 7.86 meqO_2/kg of fat, at the end of the 15 days of storage period. The decrease of the PV at the end of the storage may be 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 FFA content increased from 0.19 to 0.75 % of Oleic acid. Increase in FFA results is attributed due to the enzymatic hydrolysis of esterified lipids (Hwang and Regenstein, 1993). A similar observation was made by Sowmya Praneetha (2012) in Rohu and Sandhya Rani (2014) in Mrigal during refrigerated storage of fish cutlets and fish fingers. TBA content showed an increasing trend in fish cake from the initial value of 0.88 mg MA/kg to 1.42 mg MA/kg by the end of storage period. The increase in TBA value during the refrigerated storage of fish cake was significant at 0.01% level ($P <$

0.01). Similarly, Inanli *et al*. (2013) observed an increasing trend of TBA results was observed in anchovy fish cake, from 0.85 to 1.25 mg MA/kg and also reported that, the reason for quite low TBA amounts obtained during the production and storage was the fact that the product consists of other ingredients along with fish. The TVBN content increased in fish cake from an initial value of 4.79 to 6.19 mg /100g sample, during 15 days storage period at refrigerated temperature. Inanli *et al*. (2013) reported that fish cake prepared from anchovy also showed an increase in the TVBN from 19.59 to 24.09 mg /100g of sample during the entire refrigerated storage up to 12 days and also stated that, the value did not exceed the limit during storage because the fish was not the only ingredient in the preparation. In fish cake, the L* and Hue angle increased from 69.14 and 13.90 to 69.98 and 14.85, whereas, a*, b* and saturation index decreased from 2.21, 30.84 and 30.92 to 1.99, 29.49 and 29.56 respectively, from 0^{th} day to 15^{th} day. The change in color may be due to the action of micro organisms and enzymes of the product and due to the denaturation of haeme proteins. (Figure 1)

Table 2: Changes in the biochemical parameters* of fish cake during refrigerated storage.

Storage period (Days)	pH	PV (meqO_2/kg fat)	FFA (% of Oleic acid)	TBA (mg MA/kg of sample)	TVBN (mg/100g of sample)
0	6.42±0.02^{a}	6.12±0.03^{a}	0.19±0.01^{a}	0.88±0.02^{a}	4.79±0.03^{a}
1	6.47±0.01^{ab}	7.28±0.03^{b}	0.23±0.01^{ab}	0.91±0.01^{ab}	4.88±0.01^{a}
3	6.51±0.01^{bc}	8.51±0.04^{e}	0.27±0.02^{bc}	0.96±0.02^{b}	5.02±0.02^{b}
5	6.57±0.01^{cd}	9.97±0.04^{i}	0.33±0.01^{c}	1.07±0.02^{c}	5.16±0.03^{c}
7	6.63±0.01^{de}	9.54±0.06^{h}	0.39±0.02^{d}	1.15±0.01^{d}	5.35±0.04^{d}
9	6.66±0.02^{ef}	9.31±0.04^{g}	0.46±0.01^{e}	1.21±0.02^{e}	5.56±0.04^{e}
11	6.71±0.03^{f}	8.70±0.07^{f}	0.55±0.03^{f}	1.30±0.02^{f}	5.76±0.02^{f}
13	6.78±0.02^{g}	8.22±0.04^{d}	0.62±0.01^{g}	1.38±0.02^{g}	5.94±0.03^{g}
15	6.83±0.02^{g}	7.86±0.04^{c}	0.75±0.03^{h}	1.42±0.02^{g}	6.19±0.02^{h}

*Each value is represented as mean±SD of n=3.

^{abcdefgh}Means followed by the same superscript within a column are not significantly different ($P > 0.01$).

PV: Peroxide Value; FFA: Free Fatty Acid; TBA: Thiobarbutric Acid; TVBN: Total Volatile Base Nitrogen; MA: Malonaldehyde

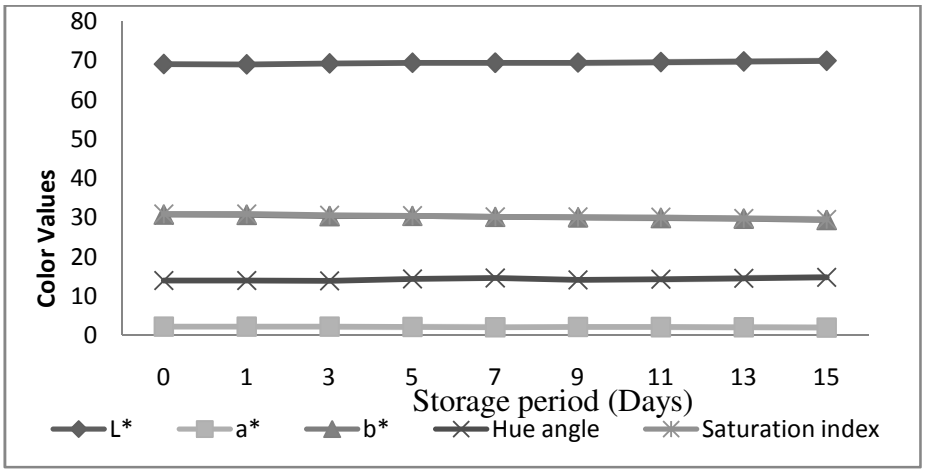

Figure 1: Changes in the color values of fish cake during refrigerated storage.

Microbiological analysis

The initial TPC of fish cake was 9.50×10^{1} cfu/g of sample. At the end of 15 days of storage, the counts increased to 3.63×10^{4} cfu/g of sample. TPC analyses of fish cake did not exceed the maximum levels (7 Log. cfu/g of meat) of microbiological criteria for fresh and frozen fish given by the ICMSF (1978). The increase in psychrophilic count values during the refrigerated storage of fish cake was significant at 0.01% level ($P < 0.01$). Inanli *et al*. (2013) reported that fish cake prepared from anchovy also showed an increase in the psychrophilic bacteria count from 1.0×10^{1} to 3.60×10^{4} cfu/g of sample during the entire refrigerated storage up to 12 days. The mould count in fish cake was initially estimated to be less than 1 up to 3rd day. At the end of the storage period these values reached 2.8×10^{3} cfu/g of sample. Inanli *et al.* (2013) found that, the mould content increased in anchovy cake from 1.0×10^{1} to 3.09×10^{4} cfu/g during the entire storage period of 12 days (Table 3).

Table 3: Changes in the TPC, Psychrophiles and Mould count in fish cake during refrigerated storage.

Storage period (Days)	TPC	Psychrophiles	Moulds
0	9.50×10^{1} (1.98)	1.80×10^{1} (1.26)	Est<1
1	2.29×10^{2} (2.36)	2.30×10^{1} (1.38)	Est<1
3	6.02×10^{2} (2.78)	8.30×10^{1} (1.92)	Est<1
5	1.04×10^{3} (3.02)	2.29×10^{2} (2.36)	1.17×10^{1} (1.07)
7	1.69×10^{3} (3.23)	6.45×10^{2} (2.81)	3.89×10^{1} (1.59)
9	3.25×10^{3} (3.51)	2.81×10^{3} (3.45)	8.12×10^{1} (1.91)
11	7.24×10^{3} (3.86)	9.77×10^{3} (3.99)	4.67×10^{2} (2.67)
13	1.47×10^{4} (4.17)	3.63×10^{4} (4.56)	9.77×10^{2} (2.99)
15	3.63×10^{4} (4.56)	9.77×10^{4} (4.99)	2.81×10^{3} (3.45)

*Each value is represented as mean of two estimates
Figures in the parenthesis indicates Log. psychrophilic count
cfu = colony forming units TPC: Total Plate Count

The results of present study showed that, the overall mean acceptability scores were found to decrease in the cake during the entire period of storage at refrigerated temperature. A negative correlation was observed between storage period and overall acceptability scores (Table 4). On comparing, the overall acceptability scores with refrigerated storage period, the fish cakes were acceptable for 12 days. The cake prepared from anchovy fish had a shelf life of 6 days (Inanli *et al.,* 2013). The results of correlation coefficient (r) and regression analysis between refrigerated storage period (days) and the overall acceptability scores for fish cake are presented in Table 5 and Figure 2.

Table 4: Changes in overall acceptability of fish cake during refrigerated storage.

Overall acceptability	
Storage period (Days)	Scores
0	9.21 ± 0.16^{g}
1	8.76 ± 0.17^{g}
3	8.41 ± 0.15^{fg}
5	7.64 ± 0.19^{f}
7	6.72 ± 0.15^{e}
9	5.26 ± 0.21^{d}
11	4.44 ± 0.18^{c}
13	3.50 ± 0.23^{b}
15	3.10 ± 0.11^{a}

^{abcdefgh}Means followed by the same superscript within a column are not significantly different ($P > 0.01$).

Table 5: Correlation coefficient and Regression equations for mean overall acceptability scores of fish cake during storage and shelf life of fish cake during refrigerated storage.

Fish cake	**Regression equation**	**Correlation coefficient**	**Shelf-life (Days)**
	Y = -0.43X+9.44	0.979*	12

*** =** Significance at 1% level

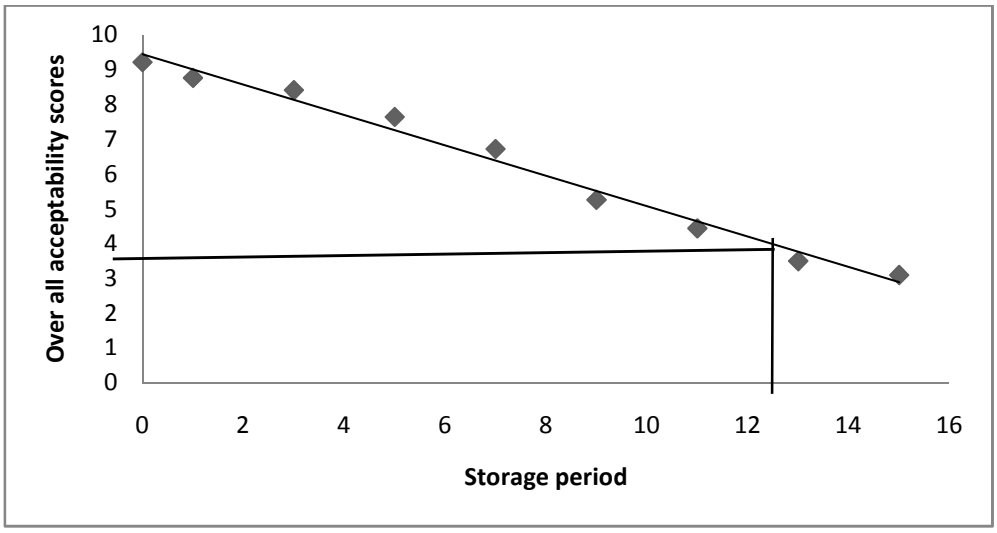

Figure 2: Regression equation of storage period on overall acceptability scores of Common carp fish cake during refrigerated storage.

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