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QUALITY EVALUATION OF VALUE ADDED MINCE BASED PRODUCTS FROM CATLA (CATLA CATLA) DURING FROZEN STORAGE

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Abstract: *Catla catla* form a major component of Indian aquaculture, with a market share of over 90%. However, the fish has limited scope for consumption in the fresh form due the presence of intramuscular bones. This study is an attempt to explore the possibilities of better utilization of this species by development of mince based value added products and the evaluation of shelf life during frozen storage. Mince from catla was used for the preparation of value added products viz., fish cutlets and fish burgers. The biochemical and sensory parameters of these products were analyzed to study the quality changes and shelf life of these products in frozen storage at -20^{0}C. Fish cutlets and fish burgers remained acceptable upto 180 and 176 days of storage after which loss in over all acceptability was noticed.
Key words: *Catla catla*, Mince Based Products, Chemical quality, Sensory, Shelf life.

PRACTICAL APPLICATION

The study aims in value addition of catla (*Catla catla*) which at present has only limited scope for consumption in fresh form. Earlier studies showed that the mince yield of this species is 35 – 40 %. The utilization of the mince for the production of fish cutlets and fish burgers are simple and cost effective means of converting catla to value added convenience products. Shelf life studies indicate that in frozen storage, the products can retain the sensory qualities for 175-180 days. Commercialization of these products can contribute to diversification in the fish processing industry through better utilization of this species.

INTRODUCTION

Value addition is the most promising sector in food processing industry. Value addition means ‘any addition activity that in one way or the other change the nature of a product thus adding to its value at the time of sale. The presence of intramuscular bones in

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carps leads to low consumer preference for these species. Hence, there is a need to develop some convenience products from the meat of carps to enhance their consumer acceptability (Gopakumar, 1997). Processing and value addition to carps is the need of the hour to sustain carp culture system and to make it more profitable. Seafood products, such as fish fingers, fish cutlets and fish burgers could supply a variety of healthy food to increase the per capita consumption (Elyasi *et al., 2010)*. Fish patties and fingers made from carps have been suggested as convenience products, as they are preferred to traditional preparations of this fish (Sehgal & Sehgal, 2002). Efforts have also been made to improve the quality and stability of ready to eat foods (Cakli *et al.,* 2005). Freezing and frozen storage of fish cutlet, fish finger and fish burger are commonly used because of the consistent, reliable quality, ease of transportation and the fact that they are very close to fresh equivalents (Sharma *et al*., 2000 and Tokur *et al.,* 2004).

The demand for ready to eat and/or ready to cook products are gradually growing because of their convenience (Yerlikaya *et al.,* 2005). Burgers are simple and a cost effective means of converting carps into value added convenience products. 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). Coatings of meat products with edible materials provide better protection against oxidation and microbiological deterioration. It can also significantly enhance the sensory quality of meat products and could be an effective method of value addition with better consumer acceptability (Ahamed *et al.,* 2007). Considering the demand for ready to eat fish products especially in developing countries like India, there is an instant need to diversify our seafood based products. Preparation of fish cutlets and fish burgers is one such technology for diversification.

The objective of the present study is to evaluate mince based products viz., fish cutlet and fish burger from catla and assess the quality during frozen storage.

MATERIAL AND METHODS

Fish Mince

Fresh calta with an average length and weight of 35.83 ± 2.27 cm and 625.01 ± 30.74g respectively was collected from the local market near Muthukur, Nellore was used for the study. The fish was brought in iced condition and was processed manually into dressed fish and which was later converted to mince using a 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 catla was used for the preparation of fish cutlets and fish burgers. The recipes for the products were selected by comparing the acceptability of different formulations of ingredients by sensory evaluation.

Preparation of Fish Cutlets

The ingredients used for the preparation of fish cutlets are given in Table 1. Minced fish meat obtained from catla fish was cooked under 0.5 kg/cm^2 steam pressure for 20 minutes and cook drip was drained out. Boiled and peeled potatoes were mashed and made into fine paste and mixed with blanched shrimps, cooked minced meat, salt, baking powder, chilly powder, pepper powder, garam masala and coriander powder. Fried onion, garlic and ginger paste were also added and all the ingredients were mixed thoroughly. 25 grams of the above mixed material was taken, shaped into ball and flattened into 1cm thickness of round shape. Battering was done by dipping in egg white and then rolled in the bread crumbs powder until uniform coating of breading material was formed on the surface. Freshly prepared six fish cutlets (frozen at - 40^{0}C for 2 hours by placing in thermoformed trays) were packed in each HDPE pouches, sealed and stored at -20^{0}C for its quality evaluation.

Table 1: Ingredients (final recipe) used for the preparation of fish cutlets from catla mince

Ingredients	Quantity (%)
Fish mince	50.0
Shrimps	15.0
Potatoes	5.0
Wheat flour	3.0
Salt	1.5
MSG	0.2
Onion	5.0
Baking powder	0.1
Egg white	8.0
Bread crumbs	9.0
Chilly powder	1.0
Ginger	0.2
Pepper	0.3
Garam masala	1.5
Coriander leaves	0.2

Preparation of Fish Burgers

Ingredients used for the fish burgers preparation are presented in Table 2. Minced fish meat was cooked under 0.5 kg/cm^2 steam pressure for 20 minutes and cook drip or exudates was drained out. Boiled and peeled potatoes were made into fine paste and mixed with cooked minced meat along with salt, sugar, corn flour, pepper powder. Fried onion, green chilly, garlic and ginger paste were mixed. All the ingredients were mixed thoroughly with chilled water and 25 grams of material was shaped into ball and flattened into 1cm thickness of round shape. Battering was done by dipping in egg white and then rolled in the bread crumbs powder until uniform coating of breading material was formed on the surface. Freshly prepared six fish burgers (frozen at - 40^{0}C for 2 hours by placing in thermoformed trays) were packed in each HDPE pouches and stored at -20^{0}C for its quality evaluation.

Table 2: Ingredients (final recipe) used for the preparation of fish burgers from catla mince

Ingredients	**Quantity (%)**
Fish mince	72.72
Salt	1.22
Sugar	1.50
Corn flour	4.36
Ginger	0.29
Pepper powder	0.14
Onion	7.27
Green chilly	1.69
Bread crumbs	2.32
Potatoes	4.72
Sodium tripolyphosphate	0.14
Chilled water	3.63

Experimental Design

From the frozen stored lot, three pouches each of fish cutlets and fish burgers were randomly chosen, and from each pouch samples were analyzed in triplicate for biochemical, microbiological and sensory attributes as described in the following sections. Samples were drawn seven times within a period of 90 days with a 15 days interval between samplings.

Biochemical and microbial analyses

Crude protein (TN x 6.25) and fat contents were determined by the micro-kjeldahl and soxhlet method respectively. Crude ash was determined by heating an incinerated sample in a muffle furnace (550^{0}C for 16 hr) and moisture was determined using the method of AOAC (2000). Total volatile base nitrogen (TVBN) was determined by the micro diffusion method of Conway (1962). Thiobarbituric acid value (TBA) was determined by the method of Tarladgis *et al.* (1960), peroxide value (PV) and free fatty acid (FFA) were determined according to Jacobs (1958) and Olley and Lovern (1960) respectively. Microbiological examinations were carried out as per APHA (1992) methods.

Sensory analyses

Sensory analysis was carried out by a seven number trained panel using a 10 point hedonic scale (IS: 6273[II], 1971; Vijayan, 1984). Frozen Fish cutlets and Fish burger samples were thawed and deep fried in refined vegetable oil at 180-200^{0}C for 1-2 min until the coated surface became a uniform brown in color. The sensory attributes covered by the taste panel were appearance, colour, flavor, taste, texture and overall acceptability. The observation was converted to equivalent numerical scores and a sensory score of 4 was taken as the borderline of overall acceptability.

Statistical analysis

The SPSS (Statistical Package for Social Sciences) 19 (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 37.3% from the whole catla. The raw minced meat yield of fresh water fishes like common carp and silver carp varies from 40-47% (Arekere, 1993 & Siddaiah *et al.,* 2001). The initial moisture, protein, fat and ash content of catla mince were found to be 78.65 ± 0.72%, 16.64 ± 0.34%, 2.23 ± 0.08% and 1.05 ± 0.03% respectively. The proximate composition of catla is comparable to the other fresh water fishes (Arekere, 1993, Siddaiah *et al.,* 2001, Sehgal *et al.,* 2010 and Elyasi *et al.,* 2010).

Proximate Analyses

The proximate composition of the products is given in Table 3 & 4. During frozen storage of fish cutlet moisture content decreased from 65.89% to 62.47%. On the contrary, the moisture content in fish burger increased from 61.39 to 63.52%. Mahmoudzadeh *et al.* (2010) observed an increase in moisture content of fish burger of deep flounder and brush tooth lizard fish during the storage period of 5 months. Ninan *et al.* (2010) reported no variation in fish cutlet during the frozen storage. Pandey & Kulkarni (2007) reported the decrease in the moisture content in grass carp cutlets and fish fingers during the frozen storage at -18^{0}C for 6 months. The protein content of fish cutlets and fish burgers increased from an initial value of 17.66 to 18.84 and 18.67 to 19.63 % at the end of 90 days frozen storage period. Lakshminatha *et al.* (1992) observed a significant increase in the protein content of fish finger from perches during frozen storage for 22 weeks. Ninan *et al.* (2010) reported the initial protein percentage of tilapia fish cutlets as 17.51. During the frozen storage of fish burger Al-bulushi *et al.* (2005) recorded the protein content as 18.88%. Raju *et al.* (1999) observed a significant increase in the protein content from 18.72 to 20.62% during the frozen storage of fish sticks for 12 weeks. Crude fat increased from 3.41and 4.63 % to 6.58 and 6.47% at the end of 90 days in fish cutlet and fish burger. Lakshminatha *et al.* (1992) observed a significant increase in the fat content of frozen fish fingers prepared from croakers during the frozen storage at -20^{0}C for 22 weeks. Raju *et al.* (1999) observed increase in the fat content during the frozen storage of fish sticks for 12 weeks. Mahmoudzadeh *et al.* (2010) reported the initial fat content of brush tooth lizard fish burger as 5.45% during the frozen storage for 5 months. Ninan *et al.* (2010) reported the initial fat content of tilapia fish cutlet as 2.14% during the frozen storage for 21 weeks. Fish cutlet and fish burger were having an initial ash content of 2.58 and 1.72% increased during storage to 3.71 and 2.84 %. This may be due to the loss of soluble inorganic constituents during thawing. Raju *et al.* (1999) observed the increase in the ash content during the frozen storage of fish sticks for 12 weeks. Lakshminatha *et al.* (1992) also found the increase in the ash content during the frozen storage of fish fingers made from croakers during the frozen storage at -20^{0}C for 22 weeks. Hassaballa *et al.* (2009) observed the initial ash content of catfish fish burger as 1.70 during the frozen storage.

Table 3: Changes in the proximate composition of fish cutlets during frozen storage

Storage period (Days)	Fish cutlets			
	Moisture	Crude protein	Crude Fat	Ash
0	65.89 ±0.12[b]	17.66±0.09[a]	3.41±0.03 [a]	2.58±0.19[a]
15	65.88±0.59[b]	17.92±0.04[b]	3.55±0.06 [a]	2.97±0.17[b]
30	64.51±0.74[ab]	18.05±0.06[b]	3.89±0.06 [b]	3.23±0.12[bc]
45	64.26±0.14[ab]	18.29±0.06[c]	4.56±0.07 [c]	3.32±0.13[bcd]
60	65.88±0.59[ab]	18.62±0.02[d]	5.51±0.04 [d]	3.55±0.05[cde]
75	63.68±0.85[a]	18.79±0.03[de]	6.33±0.08 [e]	3.67±0.06[de]
90	62.47±0.97[a]	18.84±0.01[e]	6.58±0.05 [e]	3.71±0.21[e]

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

[abcdef]Means followed by the same superscript with in a column are not significantly different (P > 0.01).

Table 4: Changes in the proximate composition of fish burgers during frozen storage

Storage period (Days)	Fish burger			
	Moisture	Crude protein	Crude Fat	Ash
0	61.39±0.71[a]	18.67±0.02[a]	4.63±0.08[a]	1.72±0.06[a]
15	61.55±0.84[a]	18.88±0.02[b]	4.96±0.08[b]	1.96±0.16[ab]
30	62.26±0.39[a]	19.07±0.01[c]	5.36±0.06[c]	2.21±0.09[bc]
45	62.43±0.37[a]	19.24±0.04[d]	5.63±0.07[d]	2.38±0.05[c]
60	62.45±0.44[a]	19.37±0.03[e]	5.79±0.06[d]	2.53±0.11[cd]
75	63.24±0.57[a]	19.53±0.01[f]	6.13±0.09[e]	2.54±0.09[cd]
90	63.52±1.06[a]	19.63±0.04[f]	6.47±0.05[f]	2.84±0.10[d]

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

[abcdef]Means followed by the same superscript with in a column are not significantly different (P > 0.01).

Chemical Analysis

The change in TVBN content of the products during frozen storage is given in Table 5 & 6. In fish cutlets, TVBN reached 4.25 mg% from the intial 3.48 mg% by the 90 days of storage. In Fish burger, change in TVBN during frozen storge was almost in the same pattern as that of fish cutlets, expect the peak value was 4.63 mg% after 90 days. For all the products the TVBN value did not exceed the acceptable limits during frozen storage. The changes in the TVBN content of the products during frozen storage increased significantly in fish cutlets, fish burgers ($P < 0.05$). In fish burgers produced from Nile tilapia, the TVBN values were found to be fluctuating during 8 months of frozen storage at -18^{0}C (Bahar *et al*., 2004). Ninan *et al.* (2010) observed a significant increase in TVBN during the frozen storage of fish cutlet prepared from tilapia meat. Bengigirey *et al.* (1999) reported that in frozen albacore tuna, TVBN showed an increase during the first 3 months of frozen storage followed by a decrease during further storage. Similar results were obtained by Mahmoudzadeh *et al.* (2010) in fish burger prepared from deep flounder and brush tooth lizard fish. Leaching out phenomena of volatile bases could be a cause for the decrease of TVBN values when samples are packed in improperly sealed bags (Ozogul & Ozogul, 2000). Pandey & Kulkarni (2007) observed a significant increase in the TVBN value of grass carp fish cutlet and fish finger during the frozen storage for 6 months.

Table 5 & 6 illustrates the change in PV. Among the frozen products a significant increase in the peroxide value of the fish cutlets ($P < 0.01$) and fish burgers ($P < 0.05$) were observed during storage at -20^{0}C. For fish cutlets the PV was 9.33 meqO_2/kg of fat and for fish burgers it was 11.44 meqO_2/kg of fat by 90 days. This might be due to mechanical mincing of fish meat which accelerates oxidation due to the incorporation of oxygen in the tissue or the disruption and intermixing of tissue components. A similar increase in the PV content was observed by Tokur *et al.* (2004) during the frozen storage of fish burger produced from tilapia. Al-Bulushi *et al.* (2005) found an increase in PV from 14 to 23.7 meqO_2/kg of fat during storage of fish burgers. PV increased to 12.88 meqO_2/kg at the end of 12 weeks in case of frozen fish cutlet (Ninan *et al.,* 2010).

A steady increase in the TBA number (Table 5 & 6) was observed in all samples during frozen storage. The TBA increased from 0.47 to 0.8 and 0.29 to 0.67 mg MA/kg of sample in fish cutlet and fish burger, respectively at the end of 90 days storage period. The TBA value is widely used as an indicator of the degree of the lipid oxidation. In the present study, the TBA value increased in the fish cutlets, fish burgers ($P < 0.01$). A significant increase in the TBA value during frozen storage has been demonstrated by Tokur *et al.* (2004) in fish burger made from tilapia and by Yanar & Fenercioglu (1999) in fish balls made from carps. Similar observations were made by the Ninan *et al.* (2010) in fish cutlet stored at -20^{0}C for 21 weeks.

Change in the FFA values of the products during frozen storage is given in Table 5 & 6. FFA content was generally low for all the products in the frozen storage. FFA increased from 0.20 to 0.80 % of oleic acid in case of fish cutlet. In fish burger it increased from 0.24 % of oleic acid to 0.73 % of oleic acid, after 90 days. In the present study, the FFA values increased significantly ($P < 0.01$) throughout the period of storage. A significant increase in the FFA was observed by Tokur *et al.* (2004) during the frozen storage of fish burger up to 8 months. Ninan *et al.* (2010) found that FFA concentration increased in fish cutlet prepared from tilapia minced meat stored at -20^{0}C. It was also found that the FFA concentration of mackerel (*Scomber scombrus)* mince in frozen storage (-10^{0}C) increased with the duration of storage and the degree of mincing of the meat (Brake and Fennema 1999). Oxidative hydrolysis of lipids in the meat during storage could cause deterioration in the quality of the meat resulting in the formation of FFA (Huss, 1971). Pandey & Kulkarni (2007) found that the FFA concentration in grass carp fish cutlet and fish finger increased during the frozen storage for 6 months.

Table 5: Changes in the chemical quality of fish cutlets during frozen storage

Storage period (Days)	Fish cutlets			
	TVBN (mg /100g of meat)	PV(meqO_2/kg of fat)	FFA(% of oleic acid)	TBA (mg MA/kg of sample)
0	3.48 ± 0.03^{bc}	4.17 ± 0.12^{a}	0.20 ± 0.01^{a}	0.47 ± 0.01^{a}
15	3.38 ± 0.02^{ab}	4.97 ± 0.12^{b}	0.28 ± 0.01^{b}	0.52 ± 0.00^{b}
30	3.27 ± 0.02^{a}	5.59 ± 0.21^{c}	0.35 ± 0.01^{c}	0.58 ± 0.01^{c}
45	3.61 ± 0.02^{c}	6.57 ± 0.12^{d}	0.43 ± 0.01^{d}	0.61 ± 0.02^{c}
60	3.78 ± 0.03^{d}	7.73 ± 0.21^{e}	0.55 ± 0.01^{e}	0.66 ± 0.00^{d}
75	3.98 ± 0.05^{d}	8.26 ± 0.21^{e}	0.68 ± 0.02^{f}	0.73 ± 0.01^{e}
90	4.25 ± 0.04^{e}	9.33 ± 0.21^{f}	0.80 ± 0.02^{g}	0.80 ± 0.02^{f}

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

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

Table 6: Changes in the chemical quality of fish burger during frozen storage

Storage period (Days)	Fish burgers			
	TVBN (mg /100g of meat)	**PV(meqO_2/kg of fat)**	**FFA(% of oleic acid)**	**TBA (mg MA/kg of sample)**
0	2.07±0.04[a]	4.53±0.21[a]	0.24±0.00[a]	0.29±0.01[a]
15	3.45±0.06[b]	5.95±0.12[b]	0.32±0.02[b]	0.32±0.02[b]
30	3.71±0.03[c]	7.73±0.21[c]	0.42±0.15[c]	0.39±0.02[c]
45	4.00±0.02[d]	9.77±0.33[d]	0.48±0/01[d]	0.50±0.02[d]
60	4.28±0.04[d]	10.76±0.46[e]	0.56±0.01[e]	0.52±0.02[d]
75	4.43±0.03[d]	10.95±0.33[f]	0.64±0.01[f]	0.59±0.02[e]
90	4.63±0.02[d]	11.44±0.54[g]	0.73±0.01[g]	0.67±0.01[f]

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

Microbiological Analysis

Changes in the total plate count (TPC) of the products during frozen storage are shown in Fig. 1. The TPC in fish burger decreased from 3.16 x 10^4cfu/gram of sample to 1.92 x 10^3cfu/gram of sample. On the contrary, the TPC in fish cutlet showed an increasing trend from 8.24 x 10^2cfu/gram of sample to 7.34 x 10^4cfu/gram of sample. The products were found to be free from *E.coli*, *Staphylococci aureus*, *Faecal streptococcii*, *Salmonella* and *Vibrio cholera*. The total plate count decreased significantly in fish burger (P < 0.01) during frozen storage. Reduction in the microbial load could be explained initially due to the freezing and the powerful antimicrobial properties of food additives. Liston (1980) observed that freezing generally causes a reduction in bacterial count and the number will continue, in most cases, to fall during storage. A similar decrease in the TPC count was found by the Al-bulushi *et al.* (2005) and Ninan *et al.* (2010) during the frozen storage of fish burger from Arabian sea meagre at -20^0C for 3 months and frozen storage of value added products from tilapia, respectively. Lethal effects of temperature just below the freezing point are more deleterious than the very low storage temperature for the survival of bacteria (Arafa & Chen, 1976). Similar results have been reported by the many scientists during the frozen storage of different products (Mahmoudzadeh *et al.,* 2010a; Al-bulushi *et al.,* 2005; Ninan *et al.,* 2010; Raju *et al.,* 1999 and Ahamed *et al.,* 2007)

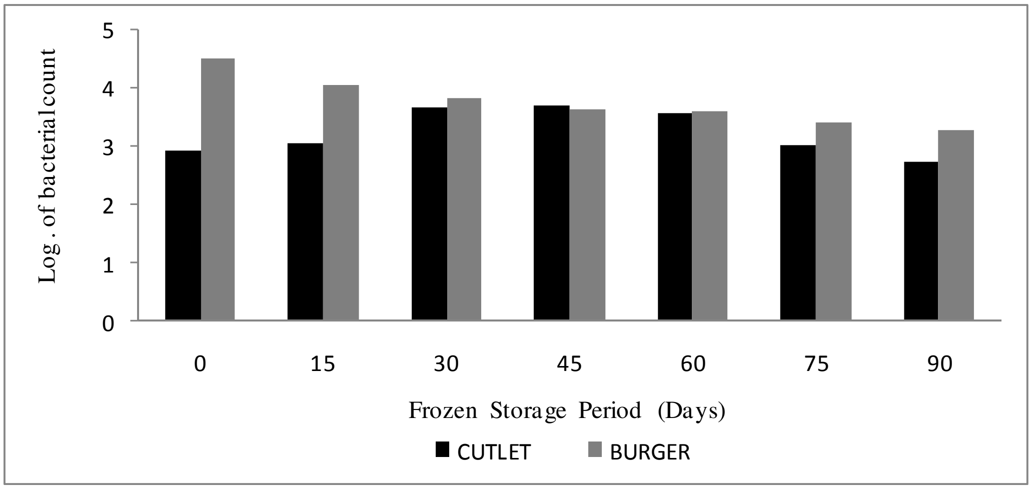

Figure 1: Changes in the total plate count (TPC) of fish products stored at frozen temperature

Sensory Analysis

Fig. 2 shows the change in sensory scores of the products during frozen storage. Fresh products received initial scores above 8 and were rated as good to excellent. Fish cutlets and fish burgers were highly acceptable even at the end of 90 days of storage. Based on the linear regression curve, the shelf life of fish cutlets and fish burgers was found to be 180 and 176 days, respectively. Joseph *et al.* (1984) has reported the shelf life of 19 weeks for raw cutlets in frozen conditions prepared from the cooked mince of different marine fishes. Cakli *et al.* (2005) has reported the shelf life of 8 months for fish fingers in frozen storage prepared from mince of different fish species. Raju *et al.* (1999) reported a shelf life of 12 weeks for fish sticks prepared from pink perch stored at -20^{0}C. The shelf life of crab cutlets and crab sticks were 24 weeks during frozen storage (Raju *et al*., 2000). Pandey & Kulkarni (2007) reported the shelf life of five months for fish cutlets and four months for the fish finger prepared from grass carp during the frozen storage for 6 months. Addition of various ingredients that have antioxidant properties such as polyphosphate (Huffman *et al.,* 1987), egg white (Yetim & Ockerman, 1995) and dry spices & ginger (Abd-El-Alim *et al.,* 1999) might have protected the products from development of rancidity during the storage period. However, the product had acceptable flavor and odour with a sensory score of 4, which was on the borderline of acceptance.

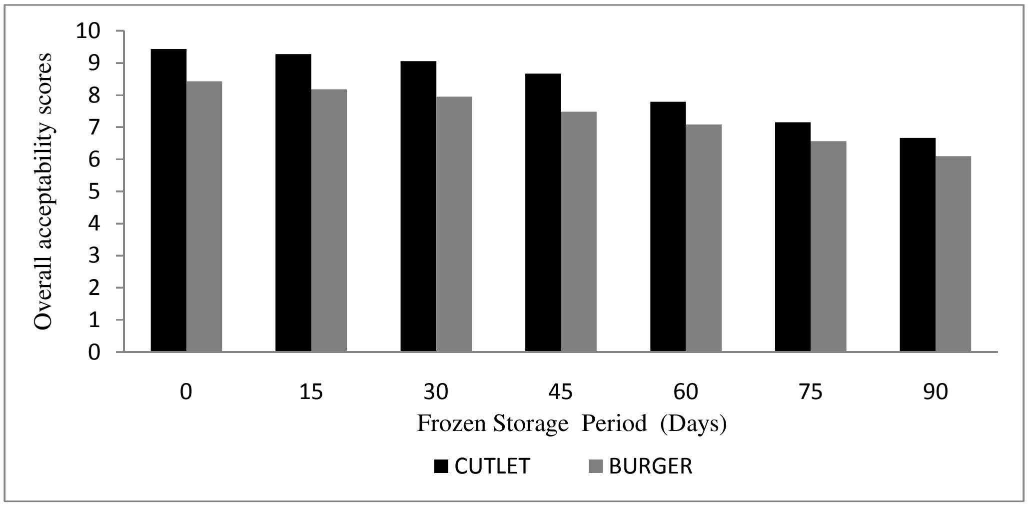

Figure 2: Changes in the overall acceptability scores of fish products stored at frozen temperature

The above study outlines the scope for the development of mince based products from catla. The products have a shelf life of 180 and 176 days in frozen conditions. Because the fish has only limited scope for consumption in the fresh form, development of mince based products is a better option for the utilization of this species.

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