Fishery Technology 50 (2013) : 139 - 145

Quality Evaluation of a Battered and Breaded Seafood Product under Chilled Storage

Femeena Hassan[1]*, C.G. Joshy[1] and Saleena Mathew[2]
[1] *Central Institute of Fisheries Technology, P.O. Matsyapuri, Cochin - 682 029, India*
[2] *School of Industrial Fisheries, Cochin University of Science and Technology, Cochin - 682 016, India*

Abstract

The quality evaluation and shelf life studies were conducted for a novel battered and breaded snack product named as 'Oyster pablano pepper fritter' prepared from edible oyster (*Crassostrea madrasensis*) under chilled storage. The organoleptic, chemical and microbiological quality attributes were evaluated for the product both in Ready-to-Fry (RTF) and Ready-to-Eat (RTE) form under chilled storage. There was significant decrease in moisture and organoleptic scores on storage. The levels of other indices like TMA-N, TBA-N, pH, TBA value, FFA value and PV showed significant increasing trend on storage for both the RTF and RTE products. Sensory quality attributes of products decreased on storage and under chilled storage, RTF samples got spoiled on 10th day and RTE products on 14th day as indicated by sensory scores.

Keywords: Quality attributes, oyster, ready to eat, ready to fry, chilled storage

Received 24 July 2012; Revised 18 December 2012; Accepted 20 December 2012

* *E-mail: femeenahassan@rediffmail.com*

Introduction

Oysters occur all along the Indian coasts in backwaters, bays and estuaries forming subsistence fisheries. A considerable quantity of oysters is processed as frozen, canned, specialty and dried products. Oyster is a good source of protein, minerals and fat, though the protein content is not as high as in the case of fin-fish. Oyster contains glycogen which gives its characteristic flavour. Oysters are highly sought after delicacy of the developed world with great export potential. The vast potential, for both capture and culture of oysters existing in the country especially in the light of ever-increasing need for protein food, calls for greater emphasis on its harvest and post harvest technologies. The meat is consumed locally and of late there is growing demand for it in some other parts of the country. Oyster based value added products are picking much momentum among consumers in various regions of the country. Oyster meat is useful for production of battered and breaded products. (Nair & Girija, 1993). Breading and battering has been extensively employed for value addition of food products. In essence, battering and breading enhances a food product's characteristics such as appearance, flavour and texture. These advantages offer consumer appeal by improving sensory value of the processed items.

Although organoleptic analysis is the most common and fastest method to detect the freshness, issues like the subjective nature of this method and the need to obtain and train people who are able to carry out with higher degree of accuracy indicates the need for other methods of analyzing freshness.

Many researchers have made in-depth study on the toxicological and bacteriological aspects of oysters and processed products thereof**.** As the market demand for oyster based value added products is high, the study about shelf life and freshness quality is of interest to both retailers and consumers. The aim of this study is to evaluate the shelf life of a novel battered and breaded oyster product under chilled storage in Ready-to-Eat (RTE) and Ready-to-Fry (RTF) form.

Materials and Methods

Edible oyster (*Crassostrea madrasensis*) of commercial size, measuring 10-12 cm in shell length harvested from the culture site near Kochi were procured, depurated in running water for 12 hours and were shucked and packed in polyethylene covers. These covers were brought to the laboratory under iced condition in 2 hrs.

Squid, *Loligo duvauceli* (Orbigny, 1848) were procured from Cochin Fisheries Harbour, Cochin, India. They were immediately iced (1:1 ratio) and transported in an insulated container to the laboratory. They were de-iced and thoroughly washed to remove slime and dirt with chilled potable water (0-2^{0}C). The tubes were separated manually and used for the product preparation.

The ingredients used for the preparation of *oyster pablano pepper fritter* are given in Table 1. The oyster meat and squid meat were cut into small pieces, steam cooked with salt and a pinch of turmeric powder for 5 min and kept aside. For preparing the stuffing masala mixture, chopped onions, ginger-garlic paste, masala powder, curry leaves, chilly powder, pepper powder etc were sauted in refined oil to a brownish tint. The cooked oyster meat and squid meat were added to the mixture and thoroughly mixed for a few seconds.

For batter mix 3:1:1 proportions of refined wheat flour, corn flour, gram flour, and salt to taste were mixed with water (1:2 ratio). The Pablano peppers (*Capsicum annuum*) were slit and deseeded and stuffed with the equal quantity of oyster masala mixture. It was then dipped in the batter mix and on bread crumbs. The prepared battered and breaded product was divided into 16 lots. Half of the lots were fried at 180-200^{0}C for 2 min. Each lot, both RTF and RTE form of *oyster pablano pepper fritter* was packed in low density polyethylene (LDPE) of 60 μm thickness, sealed and chilled stored at 5^{o}C.

The pick up and product yield of battered and breaded product was calculated as follows;

$$\text{Pickup (\%)} = \frac{\text{(Coated weight - raw weight) X 100}}{\text{Coated weight}}$$

$$\text{Product yield (\%)} = \frac{\text{Weight of finished product}}{\text{Initial weight}} \text{ X 100}$$

Both RTE and RTF *oyster pablano pepper fritter* were subjected to organoleptic, chemical and microbiological evaluation for a storage period of 14 days. Every alternate day samples were drawn for analysis. The samples were analysed in triplicates. Proximate composition of raw oyster, RTF and RTE products were estimated. The crude protein, fat, moisture and ash were determined by standard methods described in AOAC (2000). The carbohydrate content was estimated using anthrone reagent (Caroll et al., 1956). Total Volatile Base Nitrogen (TVB-N) and Trimethylamine Nitrogen (TMA-N) were determined by the Conway micro diffusion method of Beatty & Gibbons (1937). Peroxide Value (PV) and Free Fatty Acid (FFA) were determined according to AOCS (1989). Thiobarbituric Acid Value (TBA) was determined using AOAC (2000) method. pH was estimated using pH tutor (Butech instruments).

Microbiological parameters like Aerobic Plate Count (APC), *Escherichia coli*, coagulase positive Staphylococci, *Vibrio cholera* and *Salmonella* were determined as per standard methods (BAM, 1995). Analytical Grade Reagents supplied by E Merck (Damstardt, Germany) and Sigma (St. Louis, USA) were used for the experiments.

The sensory attributes of the battered and breaded oyster product were evaluated by a panel of ten trained panelists for a storage period of 14 days on a 9 point hedonic scale as described by Peryam & Pilgrims (1957). The chilled stored RTF samples were kept at room temperature for 20 min and fried in oil at 180-200^{0}C for 2 min and subjected to sensory

Table 1. Ingredients for *oyster pablano pepper fritter*

Ingredients	Quantity
Oyster meat	200 g
Squid meat	100 g
Pablano peppers	1 kg (approx. 40 Nos)
Chopped onions	100 g
Ginger	10 g
Garlic	30 g
Masala powder	2 g
Chilly powder	10 g
Pepper powder	2 g
Turmeric powder	2 g
Refined wheat flour	300 g
Corn flour	100 g
Gram flour	100 g
Refined oil	300 ml
Curry leaves	5 g
Salt	As per taste

evaluation. The fried (RTE) samples were served to the panelists after warming in a microwave oven for 3 min. The limit of acceptability was 5.

The data were analysed using 't' test for biochemical variables and Mann-Whitney U test for organoleptic variables. One way analysis of variance was performed separately for both RTE and RTC products to compare the effect during storage period. Simple linear regression of the form y=a+bx, where y= dependant variable and x=days, was fitted to the biochemical variables of both products to find rate of change as storage days advances. All the statistical analysis was carried out using SAS 9.2.

Results and Discussion

The proximate composition of raw edible oyster, RTF and RTE *oyster pablano pepper fritter* is given in Table 2. There was significant reduction in moisture, protein and carbohydrate content when products were fried. But the fat and ash content showed an increase in RTE product.

Product yield based on weight of pablano pepper for RTF was found to be 208%±10.2 (mean ± SD) and for RTE, it was 183.6 % ± 3.4 (mean ± SD). This value is based on the weight of pablano pepper, which was the base material and forms about 48 and 55% of RTF and RTE product. Pick up percentage of batter and bread crumbs based on weight of stuffed pablano pepper for the product was found to be 27.08% ± 0.9 (mean ± SD). Pick up percentage is an important physical property which determines the performance during frying (Shih & Daygle, 1983). Batter viscosity influences the quantity and quality of pick up. According to Dogan (2004), coating pick up is directly related to batter viscosity *viz*., as viscosity increases more batter remains on the sample. This has got a role in determining the handling properties of the battered product, its appearance and its final texture.

TMA can be used as a spoilage indicator since it appears after 3 or 4 days of storage. The concentration of TMA-N increased with storage in both RTF and RTE products (Table 3 & 5). Based on the fitted regression model, the rate of change of TMA-N was increasing for both products (Table 4 & 6). The fish is considered as stale when the amount of TMA is higher than 30 mg 100 g^{-1} cod, but the levels between 10-15 mg of TMA-N 100 g^{-1} of fresh were considered as the limit for fresh fish (Connell, 1995). In this study, The TMA-N content increased from 1.365 mg N g-1 to 12.315 mg N 100 g^{-1} and 1.383 mg N 100 g^{-1} to 14.068 mg N 100 g^{-1} respectively in RTE and RTF products during the storage period of 14 days. As the product come under the category of high risk products, the limit of acceptability was taken as 10 mg of TMA-N 100 g^{-1}. This limit was crossed for RTE form by 12th day and RTF by 10th day. From Tables (3-6) it is seen that on storage, there is increase in the value of TMA and TVB-N for both RTE and RTF products.

The variations in pH on storage of RTE and RTF products between days of storage are depicted in Table 3 and 5 and rate of change in Table 4 and 6. Changes in pH can be used as an indicator of degradation of muscle components, e.g., proteins and nucleotides during storage.

The TVB-N, a measure of decomposed protein and non-protein nitrogenous compounds (Huss, 1995) of all samples increased with storage time, which was probably caused by bacterial and endogenous proteolytic enzymatic actions (Hernandez-Herrero et al., 1999). Increase in TVB-N content with storage can be attributed to the breakdown of TMAO and some aminoacids. Another noteworthy finding is that although storage resulted in the increase of TVB-N, their levels in all the samples analyzed were within the acceptability limit of 35-40 mg N100g^{-1} (Conell, 1995) upto a storage period of 12 days. If

Table 2. Proximate composition of raw edible oyster, Ready-to-Fry (RTF) and Ready-to-Eat (RTE) *Oyster pablano pepper fritter*

Constituents	Raw oyster	RTF	RTE
Moisture (g 100 g^{-1})	80.10 ± 0.90	69.80 ± 0.70	48.59 ± 0.30
Protein (g 100 g^{-1})	12.60 ± 0.30	15.75 ± 0.20	13.13 ± 0.10
Lipid (g 100 g^{-1})	02.60 ± 0.02	10.46 ± 0.50	30.28 ± 1.20
Ash (g 100 g^{-1})	01.00 ± 0.10	01.07 ± 0.02	01.26 ± 0.02
Carbohydrate (g 100 g^{-1})	02.90 ± 0.01	02.92 ± 0.03	01.26 ± 0.04

Table 3. Change in biochemical parameters (Mean ± SD) in oyster product in RTF form

Storage Period (Days)	pH	TMA mg N 100 g^{-1}	TVBN mg N 100 g^{-1}	TBA mg malonaldehyde 100 g^{-1}	PV meq of O_2 kg^{-1} of fat	FFA mg% of oleic acid
0	6.77 ^{A} ± (0.001)	1.38 ^{F} ± (0.003)	7.35 ^{F} ± (0.004)	0.14 ^{F} ± (0.003)	3.82 ^{G} ± (0.005)	0.09^{F} ± (0.004)
2	6.83 ^{BA} ± (0.060)	2.36 ^{F} ± (0.330)	10.24 ^{F} ± (0.370)	0.24 ^{E} ± (0.030)	4.57 ^{G} ± (0.390)	0.12 ^{F} ± (0.030)
4	7.07 ^{BC} ± (0.060)	4.08 ^{E} ± (0.440)	16.83 ^{E} ± (1.550)	0.41 ^{D} ± (0.040)	6.13 ^{F} ± (0.120)	0.21 ^{E} ± (0.030)
6	7.33 ^{DC} ± (0.060)	6.57 ^{D} ± (0.620)	20.42 ^{ED} ± (1.55)	0.66 ^{C} ± (0.060)	7.98 ^{E} ± (0.150)	0.27 ^{D} ± (0.020)
8	7.83 ^{DC} ± (0)	9.13 ^{C} ± (1.040)	24.56 ^{CD} ± (0.820)	0.91 ^{CB} ± (0.100)	9.49 ^{D} ± (0.710)	0.33 ^{C} ± (0.005)
10	7.90 ^{DE} ± (0.100)	11.11 ^{B} ± (0.210)	27.46 ^{CB} ± (2.540)	1.11 ^{B} ± (0.210)	10.79 ^{C} ± (0.870)	0.37 ^{C} ± (0.005)
12	8.13 ^{E} ± (0.120)	12.97 ^{A} ± (0.720)	30.96 ^{B} ± (2.360)	1.30 ^{A} ± (0.72)	12.76 ^{B} ± (0.320)	0.44 ^{C} ± (0.020)
14	8.33 ^{F} ± (0.060)	14.07 ^{A} ± (0.004)	36.16 ^{A} ± (0.002)	1.41^{A} ± (0.004)	14.23 ^{A} ± (0.002)	0.51 ^{A} ± (0.004)

N=3, figures in paranthesis indicate standard deviation. Means within the column with different superscripts are significantly different.

good quality raw material is employed and an appropriate processing and preservation techniques is carried out, samples will have levels of volatile base nitrogen compounds within a satisfactory and acceptable limit for longer storage period. Murata and Shakaguchi (1986) studied with shucked oysters stored in ice, with an initial value of 10.5 mg N 100 g^{-1} and then on storage there was a low increase followed by a sudden increase of TVB-N up to mg N 100 g^{-1}.

TBA values of RTE and RTF product on chilled storage was found to increase as the storage days advances. Tarladgis et al. (1960) reported that malonaldehyde as the likely compound in fats which condensed with 2-TBA to form the red chromogen, which can be determined spectrophotometrically. Oyster fat is highly unsaturated and is easily oxidized, resulting in alteration in smell, taste, texture, colour and nutritional value. Oxidation starts immediately after the capture (Harris &Tall, 1989). The estimation of TBA value as a measure of the oxidative change remains the most widespread procedure for meat and meat products (Shahidi, 1994). The TBA values for the products under study, even after two weeks of chilled storage did not reach the maximum limit of 2.0 mg malonoldehyde kg^{-1}, indicating their freshness (Table 3 & 5). Although TBA values above the range of 0.5 to 1.0 is expected to produce a negative effect during sensory evaluation.

Table 4. Regression equation for RTF form

Variables	Parameter		
	b0 (Intercept)	bI (days)	R^2
P^H	6.692**	-0.056**	0.924
TMA	0.813**	0.985**	0.979
TVBN	7.529**	2.032**	0.974
TBA	0.072**	0.0515**	0.942
PV	3.332	0.769**	0.983
FFA	0.080**	0.030**	0.984

** Significant at 1% level

Both FFA and TBA values showed a gradual increase during storage though their values were very low and within the prescribed limit. This slow increase is due to the oxidation of unsaturated lipids to highly reactive peroxides. These peroxides hydrolysed to form FFA during storage. In the present study, FFA value rose from 0.085 to 0.507 and from 0.095 to 0.563 in RTF and RTE respectively.

Similarly PV levels although showed an increasing trend, were well within the limit (10 to 20 meq of O_2 kg^{-1} of fat) set for rancidity value with an increase in storage time. Peroxide value is a measure of the hydroperoxides contained in the oil, being the first product of oxidation. With further decomposition, short chain compounds are produced which are responsible for the off-flavour usually associated with PV measurement. Peroxide values of 20-22 meqO_2 kg^{-1} of lipid are said to correspond with noticeable rancid taste. In the present study, Peroxide value of no products reached in this level. Simple linear regression model was fitted with high R^2 value (0.969 and 0.983) to quantify the rate of change in Peroxide value in RTF and RTE under chilled storage and is given in Table 4 & 6.

The microbiological load of a product depends upon various factors such as the nature and quality of raw materials, sanitary conditions of the processing factories, storage conditions etc (Hassan et al., 2003). In the present study, initial total viable bacterial count of RTF and RTE product was found to be 6.6 x 10^3 cfu g^{-1} and 40 cfu g^{-1} respectively. On 10^{th} day, the TVC correspondingly rose to 5.9 x 10^4 cfu g^{-1} and 2.1 x 10^2 cfu g^{-1}. At the end of 14 days of chilled storage, the count was 6.47 x 10^4 cfu g^{-1} and 2.3 x 10^2 cfu g^{-1} respectively for RTF and RTE products. Bacteria of public health significance such as *Escherichia coli*, coagulase positive Staphylococci, *Vibrio cholerae* and *Salmonella* could not be detected in any of the samples (Table 7).

The mean scores of sensory attributes *viz*., appearance, colour, texture, flavour and overall acceptability of RTF and RTE *oyster pablano pepper fritter* is given in Table 8 & 9. It was found that sensory attributes of products slowly decreased on storage and RTF samples got spoiled on 10^{th} day and RTE products on 14^{th} day as indicated by sensory scores. Considering an acceptable score of 5.0, it was shown that all chilled stored oyster products could be kept for approximately 10 days in RTF form and 14 days under chilled storage. The odour, texture and overall acceptability scores for RTF product crossed the acceptable limit by 10^{th} day of storage. The corresponding attribute scores in RTE product crossed the acceptable limit only by 14^{th} day of storage. Sensory evaluation is the principal method to evaluate the freshness of food raw materials and final products. Sensory analysis aims to determine the probable product acceptance by consumers in the early development stages. Hedonic scores are especially suitable for evaluating direct taste preference and perceived product quality (Stefani et al. 2006).

This battered and breaded oyster product named as *oyster pablano pepper fritter* can be chill stored in pre fried or fried form. The present study illustrates that

Table 5. Change in biochemical parameters (Mean±SD) in oyster product in RTE form

Storage Period (Days)	pH	TMA mg N 100 g^{-1}	TVBN mg N 100 g^{-1}	TBA mg malonaldehyde 100 g^{-1}	PV meq of O_2 kg^{-1} of fat	FFA mg% of oleic acid
0	6.76 ^{A} ± (0.06)	1.365 ^{G} (0.003)	6.72 ^{F} ± (0.002)	1.37 ^{E} ± (0.003)	3.05 ^{G} ± (0.001)	0.095 ^{F} (0.002)
2	6.80 ^{A} ± (0.15)	2.153 ^{G} (0.231)	7.84 ^{FE} ± (0.574)	2.15 ^{ED} ± (0.23)	4.39 ^{F} ± (0.248)	0.14^{FE} ± (0.02)
4	6.94^{BA} ± (0.10)	3.87 ^{F} ± (0.53)	10.66 ^{E} ± (0.77)	3.87 ^{D} ± (0.53)	6.67 ^{E} ± (0.51)	0.19 ^{E} ± (0.01)
6	7.16 ^{BA} ± (0.06)	6.05 ^{E} ± (0.48)	14.42 ^{D} ± (1.02)	6.05 ^{C} ± (0.42)	8.55 ^{D} ± (0.51)	0.26 ^{D} ± (0.04)
8	7.43 ^{BC} ± (0.06)	7.23 ^{D} ± (0.39)	16.48 ^{D} ± (1.54)	7.23 ^{C} ± (0.38)	9.45 ^{DC} ± (0.21)	0.32^{C} ± (0.02)
10	7.76 ^{BC} ± (0.06)	9.39 ^{C} ± (0.53)	22.06 ^{C} ± (1.65)	9.33 ^{C} ± (0.54)	9.75 ^{C} ± (0.52)	0.38^{C} ± (0.03)
12	8.03 ^{DC} ± (0.06)	11.16 ^{BC} ± (0.51)	28.6 ^{B} ± (1.33)	11.17 ^{B} ± (0.51)	12.29 ^{B} ± (0.47)	0.49 ^{B} ± (0.02)
14	8.16 ^{D} ± (0.06)	12.32 ^{A} ± (0.002)	33.98 ^{A} ± (0.001)	12.32^{A} ± (0.002)	13.96 ^{A} ± (0.003)	0.56 ^{A} ± (0.004)

N=3, figures in paranthesis indicate standard deviation. Means within the column with different superscripts are significantly different at 5% level of significance

Table 6. Regression equation for RTE form

Variables	Parameters		
	b0 (Intercept)	b1 (days)	R^2
P^H	6.781**	0.0371**	0.861
TMA	0.881**	0.830**	0.986
TVBN	3.809**	1.969**	0.945
TBA	0.0073**	0.036**	0.952
PV	3.263**	0.750**	0.969
FFA	0.069**	0.034**	0.972

** Significant at 1% level

Table 7. Change in microbiological parameters in oyster product in RTF and RTE form

Storage Period (Days)	RTF					RTE				
	TVC Cfu g^{-1}	*E.coli* MPN g^{-1}	*Staphylo-coccus*	*V.cholerae*	*Salmonella*	TVC Cfu g^{-1}	*E.coli* MPN g^{-1}	*Staphylo-coccus*	*V.cholerae*	*Salmonella*
0	$6.6x10^3$	<3	ND	ND	ND	40	<3	ND	ND	ND
10	$5.9x10^4$	<3	ND	ND	ND	$2.1x10^2$	<3	ND	ND	ND
14	$6.47x10^4$	<3	ND	ND	ND	$2.3x10^2$	<3	ND	ND	ND

ND-Not Detected

Table 8. Change in organoleptic parameters (Mean±SD) in oyster product in RTF form

Storage days	Appearance	Color	Flavour	Texture	OAA
0	8.2^{A} ± (0.20)	8.5^{A} ± (0.50)	8.4^{A} ± (0.20)	7.97^{A} ± (0.06)	8.40^{A} ± (0.20)
2	7.97^{BA} ± (0.15)	8.3^{A} ± (0.44)	7.87^{B} ± (0.12)	7.90^{A} ± (0.10)	8.13^{A} ± (0.12)
4	7.6^{B} ± (0.20)	7.7^{A} ± (0.20)	7.77^{B} ± (0.15)	7.40^{A} ± (0.40)	7.97^{A} ± (0.15)
6	6.97^{C} ± (0.21)	6.4^{A} ± (0.22)	6.87^{C} ± (0.06)	6.20^{B} ± (0.20)	7.10^{B} ± (0.35)
8	6.77^{C} ± (0.12)	5.8^{C} ± (0.26)	5.20^{D} ± (0.20)	5.40^{C} ± (0.20)	5.40^{C} ± (0.20)
10	5.93^{D} ± (0.42)	4.8^{DC} ± (0.32)	4.80^{E} ± (0.10)	4.90^{DC} ± (0.10)	4.83^{DC} (0.15)
12	5.5^{D} ± (0.10)	4.0^{D} ± (0.42)	4.60^{FE} ± (0.10)	4.33^{DE} ± (0.23)	4.27^{DE} ± (0.31)
14	4.9^{E} ± (0.10)	3.8^{D} ± (0.44)	4.30^{F} ± (0.10)	4.30^{E} ± (0.10)	3.87^{E} ± (0.15)

N= 10x3, figures in parenthesis indicate standard deviation. Means within the column with different superscripts are significantly different at 5% level of significance

Table 9. Change in organoleptic scores (Mean±SD) in oyster product in RTE form

Storage days	Appearance	Colour	Flavour	Texture	OAA
0	8.70^{A} ± (0.10)	8.30^{A} ± (0.44)	8.40^{A} ± (0.10)	8.60^{A} ± (0.10)	8.80^{A} ± (0.20)
2	8.63^{BA} ± (0.06)	8.20^{A} ± (0.20)	7.73^{B} ± (0.12)	8.37^{A} ± (0.12)	8.53^{A} ± (0.15)
4	8.50^{B} ± (0.10)	7.83^{A} ± (0.06)	7.40^{B} ± (0.10)	7.33^{A} ± (0.15)	8.10^{A} ± (0.10)
6	7.90^{C} ± (0.10)	6.97^{A} ± (0.21)	6.97^{C} ± (0.15)	7.07^{B} ± (0.15)	7.60^{B} ± (0.20)
8	6.60^{C} ± (0.20)	6.20^{C} ± (0.20)	6.20^{D} ± (0.10)	6.47^{C} ± (0.25)	6.87^{C} ± (0.31)
10	5.93^{D} ± (0.25)	5.40^{DC} ± (0.40)	5.23^{E} ± (0.15)	5.40^{DC} ± (0.10)	5.90^{DC} ± (0.10)
12	5.53^{D} ± (0.31)	5.60^{D} ± (0.10)	5.03^{FE} ± (0.25)	5.03^{DE} ± (0.15)	5.27^{DE} ± (0.12)
14	5.47^{E} ± (0.12)	5.03^{D} ± (0.21)	4.80^{F} ± (0.36)	4.40^{E} ± (0.36)	4.93^{E} ± (0.06)

N= 10x3, figures in paranthesis indicate standard deviation. Means within the column with different superscripts are significantly different at 5% level of significance this product has a shelf life of 10 days in pre fried form and 14 days in fried form under chilled storage.

Acknowledgements

The authors are thankful to the Director, Central Institute of Fisheries Technology, for according permission to publish the paper. The assistance rendered by the technical staff of Quality Assurance and Management Division of the Institute is gratefully acknowledged.

References

AOAC (2000) Official Methods of Analysis. 17th edn., Association of Official Analytical Chemists, Washington, DC, USA

AOCS (1989) Official Methods of Recommended Practices of American Oil Chemists Society, Chempaign, USA

BAM (1995) Bacteriological Analytical Manual. 8th edn., AOAC International, USA

Beatty, S.A. and Gibbons, N.F. (1937) The measurement of spoilage in fish, J. Fish. Res. Bd. Can. 3: 70-91

Connell, J.J. (1995) Control of Fish Quality, 245p, Fishing News Books, London

Caroll, W. V., Longley, R. W. and Roe, J. H. (1956) The determination of glycogen in the liver and muscle by the use of Anthrone reagent, J. Biol. Chem: 220-229

Connell, J. J. (1980) Methods of assessing and selecting for quality. In: Control of Fish Quality, 3rd edn., pp 116-143, Fishing News (Books) Ltd., London

Dogan, F. (2004) Effects of Different Batter Formulations on Quality of Deep-fried Chicken Nuggets, M.S. Thesis, The Department of Food Engineering, Middle East Technical university, 06531, Ankara, Turkey

Haris, P. and Tall, J. (1989) Rancidity in Fish. In: Rancidity in Foods (Allen, J.C., Hamilton, R.J., Eds), pp 256-273, Blackie A&P, London

Hassan, F., Mathew, S. and Mukundan M.K. (2003) Gelling and storage performance of surimi prepared from tropical fish. Indian J. Fish. 50 (4): 431-437

Hernandez-Herrero, M. M., Roig-Sagues, A. X., Lopez-Sabater, E. I., Rodriguez-Jerez, J.J. and Mora-Ventura, M. T. (1999) Total volatile basic nitrogen and other physicochemical and microbiological characteristics as related to ripening of salted anchovies. J. Food Sci. 64: 344–347

Huss, H.H. (1995) Quality and Quality Changes in Fresh Fish, 342 p, Food and Agriculture Organization (FAO) of the United Nations, Rome

Murata, M. and Sakaguchi, M. (1986) Change in contents of free aminoacids, trimethylamine and non-protein nitrogen of oyster during ice storage. Bull. Japan Soc. Sci. Fish. 52(11): 1975-1980

Nair, M.K. and Girija, S. (1993) Quality control of molluscan shellfish products. Mar. Fish. Infor. Serv. T&E Ser. 125: 17-21

Peryam, D.R. and Pilgrim, F.J. (1957) Hedonic scale method of measuring food preferences, Food Technol.11 (9): 9

Shahidi, F. (1994) Flavor of meat and meat products - an overview. In: Flavor of Meat and Meat Products (Shahidi, F., Ed), pp 1-3, Blackie Academic and Professional, London

Stefani, G., Donato, R. and Cavicchi, A. (2006) Consumer expectations, liking and willingness to pay for specialty foods: Do sensory characteristics tell the whole story? Food Quality and Preference, 17(1–2): 53–62

Tarladgis, B.G., Watts, B.M., Younathan, M.T. and Dugan, L. (1960) A distillation method for the quantitative determination of malonaldehyde in rancid foods. J. Am. Oil Chem. Soc. 37: 44-48

Shih, F.F. and Daygle, K.W. (1999) Oil uptake properties of fried batters from rice flour. J. Ag Food Chem. 47: 1611-1615