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The study of microwave heating on proximate composition in fish fillets and balls

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Abstract
This research aims to study about the effect of microwave heating time on proximate composition of fish fillets and balls during storage times (15 days). The results revealed that cooking reduced the moisture content of products with subsequent increase in protein, fat and ash contents. As the duration of storage increased moisture content decreased and other traits increased. The products prepared from fresh water fish catla contain protein almost equivalent to other animal protein but relatively low in fat. Microwave cooked products lost more moisture as compared to conventional oven cooking. Protein and ash contents increased relatively depending upon the moisture lost during cooking and the inorganic matter substituted by the spices might have increased the ash content in the spiced fish products after cooking. This investigation will provide basic information which can be added to the current Indian food composition data on fresh water fish (catla) both raw and cooked.

Keywords: microwave, conventional cooking, fresh water fish, proximate composition, fillets, balls

Introduction
Fish is a cheap source of protein for the world's population. A thorough knowledge of its biochemical composition is required by the dieticians, nutritionists and food technologists for advice on the dietary intake and also for the formulation of products. In the developed world, fish and fishery products are gaining importance as a health food for which a baseline data is necessary about the nutritional aspects and for nutritional labeling of the fishery products. Being a highly perishable item of food, fish is immediately processed to various products to preserve the quality and to increase the shelf life. This chapter deals with the study on proximate composition of raw fish and restructured fish products along with their changes during storage up to the initiation of spoilage at 4±1˚C at an interval of 4 days. Fish fillets and balls without addition of preservatives can not be stored for many days because of off flavor in the product which affected the acceptance of consumers. Consequently this study is focused on use of spice mix for observing compositional changes in fish fillets and balls during storage. Use of synthetic antimicrobial agents may cause to form carcinogens and mutagens in human body (Sabater *et al*., 1999). Also microwave heating is one of the interesting methods for food products in which this radiation is safe and can be transferred into food composition (Tochampa *et al*., 2011). Microwave energy has been used to pasteurize or sterilize food at lower temperature and shorter times than necessary with conventional heating. Microwave heating is suitable for many kinds of food products, however, not much of work was done to study the effect of microwave cooking in spiced and non spiced fish products on proximate composition.

Materials and Methods
Fish fillet preparation
Four types of fillets (P0S0M0, P0S1M0, P0S0M1, P0S1M1) on the basis of method of cooking i.e. conventional and microwave oven cooking along with spice mix concentration i.e. with spices and without spices were prepared.
Fresh fish (catla) after procurement was washed thoroughly by running water and kept in deep freezer (-20°C) over night. On the next day, frozen fish was thawed at room temperature (35°C) and scaling, head removal, gutting and rinsing was done properly to get a clean mass of flesh. The whole fish was cut longitudinally, using a sharp knife to obtain pieces of 7-8 cm in length and 1-2 cm in thickness. Salt (2g), TSPP (0.4g) and spice mix (2g) were then sprinkled on the cut pieces. Each lot of 100g pieces were separated for preparing each treatment used with experimental work. After incorporating the additives (salt and TSPP), spice mix and

mustard oil (10 ml) in four lots of fish pieces (each weighing 100g), proper mixing was done and were kept for marination for half an hr. The prepared samples were then cooked separately in conventional and microwave oven. The temperature maintained in conventional oven was 140°C for 20 min. (10 min. one side, 10 min. other side) in which internal temperature (78±2°C) was recorded at the geometric centre of the cooked fillets with the help of thermometer to ascertain that the fish fillets had been cooked properly. In microwave oven the fish pieces were cooked for 2min. (2450 MHz, 800W). In this case internal temperature (70±2°C) was recorded. The cooked fillets weighing 8.2-8.6g were packed in each polypropylene pouches (100 gauge) and then heat sealed. The packaged samples were stored at refrigerated temperature (4±1°C) and shelf life evaluation was carried out up to 12 days at 4 days interval (0,4,8 and 12 days). Fillets were reheated in microwave oven for 30 sec. before analysing each parameter evaluation at different storage intervals.

Fish ball preparation

Fish balls were prepared by grinding muscle tissues along with salt, phosphate with or without spice mix using Food Processor. As fish ball is an emulsified restructured product, two types of emulsions were made in which salt (2%) and TSPP (0.4%) were taken as common ingredients in all the samples and this was further divided in two lots containing spice mix in one lot and no spice mix was added in the other lot. Afterwards these two lots of samples were kept in microwave and conventional oven for cooking. Likewise, four types of fish balls (P1S0M0, P1S0M1, P1S1M0, P1S1M1) were obtained. After washing, scaling, head removal and gutting clean fish pieces were cut longitudinally using a sharp knife followed by deboning manually, and the deboned mass was grinded in the mixer and grinder to achieve uniformity in terms of color and consistency. Salt (2g), TSPP (0.4g) and spice mix (2g) were then added to the mass and mixing was done properly using Food Processor. The mass was divided into two lots one was added with spice and the other remained without addition of spice mix with salt and TSPP as additives commonly added in both after adding mustard oil (10 ml) to each lot after proper mixing as in same manner and kept for marination for half an hr. Then balls were made by pressing and giving a shape of adhered rounded mass taking weight of approximately 10g for each ball. The prepared samples were then cooked separately in conventional and microwave oven. The temperature maintained in conventional oven was 140°C for 20 min. (10 min. one side, 10 min other side) in which internal temperature (78±2°C) was recorded at the centre of the cooked balls with the help of thermometer to ascertain that the products had been cooked properly. In microwave oven the fish balls were cooked for 2 min. (2450 MHz, 800W) and the internal temperature (70±2°C) was recorded. The cooked balls weighing 7.8-8.2 g were packed in each polypropylene pouches (100 gauge) and then heat sealed. The packaged samples were stored at refrigerated temperature (4±1°C) up to 12 days at 4 days interval (0,4,8 and 12 days) and further reheated in microwave oven for 30 sec. before evaluating the changes during storage, studied at various intervals.

Analysis of moisture, fat, protein and ash

Moisture, fat, protein and ash were determined by the method of AOAC (2005) [1].

Statistical analysis

The data was subjected to statistical analysis of variance using SAS (version 9.1). A significance level of 0.5 was chosen. Four factors, namely, spice mix, cooking method, product and storage duration were selected for the study as factorial arrangements in Completely Randomized Design (CRD). Each mean value presented in the tables is the average of six replications. There were two levels for each factor except duration which has four levels, i.e., S0 (without spice mix), S1 (with spice mix), M0 (conventional oven), M1 (microwave oven), P0 (fillet), P1 (ball), D0 (0 day), D4 (4^{th} day), D8 (8^{th} day) and D12 (12^{th} day) were selected.

Results and Discussions

Moisture

Data containing the effects of different treatments on moisture content of the products (0 day) are given in Table 1. On the day of preparation i.e. 0 day the highest moisture content (72.22%) was found in P0S1M0 and lowest (67.73%) was found in P1S0M1. At 0 day fish fillet with spice (P0S1M0) or without spice (P0S0M0) cooked in conventional oven showed (72.22 and 71.58% moisture) depicting that spices did not affect the moisture content in these treatments. Both these above treatments had higher moisture content than spiced (P0S1M1) and non spiced (P0S0M1) microwave cooked fillet (70.01 and 68.28% respectively) suggesting that microwave cooking undergo more moisture loss compared to conventional oven cooking. However, among microwave cooked fillets, non-spiced (P0S0M1) had lower moisture (68.28%) than spiced fillet (P0S1M1) i.e. 70.01% indicating the moisture retaining ability of spices. However, moisture content of fillet was more than balls ranging from 68.28% (P0S0M1) to 72.22% (P0S1M0) in fillets and 67.73% (P1S0M1) to 71.93% (P1S1M0) in balls. In case of fish ball contrary to fish fillets at 0 day of storage, conventional oven cooked spiced product (P1S1M0) had higher moisture (71.93%) than non-spiced (70.80%). Similar trend was attained in microwave cooked spiced (69.62%) and non-spiced balls (67.73%). On comparing the products with respect to method of cooking, conventional cooking (P1S1M0 and P0S0M0) retained more moisture (71.93% and 71.58%) than microwave cooking (P1S1M1, 69.62%) and (P1S0M1, 68.28%). At 4 days of storage highest (72.16%) and lowest moisture content (67.65%) was determined in the same treatments i.e. P0S1M0 and P1S0M1 respectively. In all the treatments the increase in the moisture content at 4 days of storage was non-significant. Similar results were obtained at 8 days of storage in different treatments i.e. P0S1M0 possessed highest moisture content (71.85%) and P1S0M1 contained the lowest (67.60%). However, storage duration exhibited non-significant effect on moisture content in either of the treatments. On12^{th} day also the same treatments i.e P0S1M0 possessed the highest (71.81%) and P1S0M1 the lowest (67.08%) moisture content similar to that of 0, 4^{th} and 8^{th} day.

There was a decreasing trend of moisture content (%) of fish products during storage as affected by spices and method of cooking. It is evident from our findings that cooking of products in conventional and microwave oven induces water loss in the products and this effect is dependent on the type of cooking. The study confirmed that microwave cooked products lost more moisture as compared to conventional oven cooking irrespective of the type of treatment. Similar was the finding of Wing and Alexander (1972) [13] and Janicki and Appledorf (1974) [9] who reported consistently higher

cooking losses in weight during microwave cooking due to more evaporation. Johansson *et al.* (1992) [10] also reported similar facts in cod fish fillets which had a greater weight loss when microwave cooked than cooked in the conventional oven and their finding matches with our results. The decrease in the moisture content during storage has been described as the most prominent change that makes the protein, fat and ash content significantly higher in cooked fish fillets as observed by Garcia Arias *et al.* (2003) [6].

In comparison to fillets, balls contained lower moisture which could be due to mincing of fish flesh during ball preparation leading to more moisture escape from increased surface area. Conventionally cooked fillets had non significant effect with or without addition of spices but in balls spice mix containing product had higher moisture than non spiced. The reason may be more homogenous mixing of spice mix in balls showing the better moisture retaining ability of spices in better way but in fillets only sprinkling of spice mix was done at the time of preparation. Fawzya (1992) [14] showed that the moisture content varied between 60 to 73% in the shark fish balls which correlated with our results. Huda *et al.* (2001) [8] revealed that the proximate composition of different brands of fish balls was significantly different ($p<0.05$) among all samples analyzed and the reason is mainly due to the different formulations used for fish ball production. Dutta (2009) [3] also observed the almost same moisture content in fish ball (73.84%) made from rohu which are in agreement with our results.

Protein

Data related to the effects of different treatments on changes in protein content during storage are presented in Table 2. On the day of preparation (0 day) of fish the highest protein content (20.65%) was found in P1S0M1 and the lowest (16.23%) in P0S1M0. It was observed that at 0 day spiced fillet both conventional (P0S1M0) 16.23% and microwave oven cooked (P0S1M1) contained almost similar protein content (16.23 and 16.82%) whereas microwave cooked non spiced fillets (P0S0M1) exhibited more amount of protein (20.45%) than conventional oven cooked (P0S0M0, 16.85%). It was observed that conventional oven cooked fillets with or without spices had non-significant difference in protein content however, in microwave cooking non spiced fillets (P0S0M1) showed more protein content (20.45%) than (P0S1M1, 16.82%). In case of fish balls, P1S1M0 showed lower protein content (16.3%) than P1S1M1 (17.37%). Similar results were also achieved for non spiced conventional oven cooked balls (P1S0M0) which possessed lower protein content (17.13%) than microwave cooked (P1S0M1) ball (20.65%). At 4th day the highest protein content was found in P1S0M1 (20.75%) and the lowest in P0S1M0 (16.03%). At 4th day both the products with or without spices had almost similar results i.e. more protein content in microwave than conventional oven cooking. Spice containing products had lower protein than non spiced ones after following any mode of cooking. Similar results were obtained at 8th and 12th day. At 8th and 12th day P1S0M1 had the highest protein content (20.85% and 21.00% respectively) but lowest protein content was observed in P1S1M0 (16.23%) on 8th day and in P0S1M0 (16.43%) on 12th day. Between fillets and balls, balls possessed higher protein content at 0, 4th, 8th and 12th day than fillets in all the treatments. As far as the duration of storage was concerned, non-significant effect was observed due to increased time of storage.

Table 2 expressed that the microwave cooked had higher protein than conventional oven cooked products. This could be due to more moisture loss in microwave cooked products leading to increase in protein content. Our results are in agreement with the findings of Salama (1993) [12] who also stated that products cooked in microwave were reported to have higher protein than conventional cooking. However, the non spiced products showed more protein content than spiced ones. The reason for this might be that spices had retained more moisture due to which protein content was reduced. Hassaballa *et al.* (2009) [7] also observed that a significant decrease of moisture lead to consequent increase in protein, fat and ash. Dutta (2009) [3] also observed 19.64% protein in fish ball made from rohu which goes almost similar with our treatment P1S0M1 (fish ball without spice cooked in microwave oven) in this study which showed 21% protein at 12th day of storage. So, it could be concluded that whether balls were cooked with or without spice microwave cooking leads to higher protein content. On comparing the spice effect irrespective of method of cooking non-spiced product contained more protein than spice mix containing product.

Fat

Effect of different treatments on fat content of fish products during storage is given in Table 3. The fat content at 0 day was lowest (6.83%) in P0S0M0 and highest (7.83%) in P1S1M1.The results showed that at 0 day fillets without spice cooked by either of the method were almost similar i.e. P0S0M0 (6.83%) and P0S0M1 (6.90%) but in spiced product cooked in microwave (P0S1M1) resulted in higher fat content (7.75%) than conventional oven cooking (7.0%). Microwave cooked fillet with spice (P0S1M1) exhibited more fat content (7.75%) than non-spiced fillets (6.9%). In case of balls, on comparing method of cooking, non-spiced cooked in microwave (P1S0M1) had higher fat content (7.22%) than conventional oven cooked (6.9%). Similarly in spiced ones, microwave cooking (P1S1M1) leads to higher fat content (7.83%) than conventional oven cooking (7.30%). Irrespective of the method of cooking spiced product had more fat content than non-spiced ones. The fish balls contained higher fat than fillets in all the treatments throughout the storage. At 4th, 8th and 12th day of storage similar trend was attained with highest fat content (7.88, 8.00 and 8.05%) in P1S1M1 and lowest (6.83, 6.93 and 7.02%) in P0S0M0. Storage duration exhibited non-significant effect on fat content. Just similar to moisture and protein contents. The mean value of fat increased from 6.83 (P0S0M0) at 0 day to 8.05 (P1S1M1) at 12th day of storage (4±1°C).

Data pertaining to the effect of different treatments as affected by spices and cooking method on fat content (%) of fish products during storage (Table 3) depicts that with increase in storage duration up to 12 days at 4 ±1ºC, the fat content increased in all the treatments irrespective of method of cooking, type of product, effect of spices and storage duration. However, P1S1M1 observed highest in fat at 0 day as well as after 12days of storage. Cooking induces water loss and in turn increases its lipid content and this effect is dependent on the type of cooking as explained by Gall *et al.* (1983) [5]. The high increase in fat content in fish balls rather than fillets may be attributed not only to water loss but also due to more oil absorption in which oil was mixed with fish mince during emulsion preparation. Almost similar facts were reported by Saguy and Dana (2003) [11] that the fat increase in fish products can be due to the oil penetration on food after

water is partially lost by evaporation. Due to more moisture loss in microwave oven cooking, the fat content in the products prepared in microwave showed a little higher value than the products prepared in conventional oven. It is most possibly due to protein and fat retention that are related to the ability of protein to retain water and bind fat (Bochi *et al.*, 2008) [2].

Ash

Ash content in different treatments throughout the storage are summarized in Table 4. The ash content varies from 2.50% (P1S0M0) to 3.02% (P0S1M1) at 0 day just after product preparation. At 0 day the fillets whether cooked in conventional oven or in microwave with or without spice showed non significant effect on ash content. Similar trend was found in case of balls except for balls cooked conventionally where balls containing spices (P1S1M0) were found to have higher ash content (3.00%) than non-spiced ones (P1S0M0) 2.50%. Also at 4th, 8th and 12th day of storage similar results were found in different treatments as that for 0 day. At 4th day the highest ash content (3.07%) was found in P1S1M1 and lowest (2.55%) in P1S0M0. At 8th and 12th day, the ash content was highest (3.08 and 3.10% respectively) in P0S1M1 and lowest (2.58 and 2.60% respectively) was found in P1S0M0.

It was found that except conventional oven cooked spiced balls all other treatments of balls showed lower ash content than fillets. Although the ash content increased during storage duration but the change was non-significant in all the treatments. The mean value of ash content decreased from 2.50% (P1S0M0) on zero day to 3.10% (P0S1M1) on 12 days of storage under refrigerated conditions (4°±1C).

As it is evident from Table 4 that although method of cooking had non-significant effect on ash content but conventional oven cooked spiced balls exhibited higher ash than non-spiced balls. This might be due to the contribution of inorganic matter from spices that increased the ash contents in spiced products. With the increase of storage period higher value of ash content was observed (non-significant), might be due to the decrease in moisture content. Similar finding is given by Garcia Arias *et al.* (2003) [6] who described that the decrease in moisture content is the most prominent change that makes the protein, fat and ash content higher in cooked fish fillets.

Table 1: Effect of different treatments as affected by spice and method of cooking on moisture content (%) of fish products during storage

Treatment	Moisture content (%)				
	Storage period (days)				
	0	4	8	12	Mean
P0S0M0	$_{a}71.58^{a}\pm0.93$	$_{ab}71.53^{a}\pm0.74$	$_{a}71.43^{a}\pm0.59$	$_{a}71.40^{a}\pm0.44$	71.59
P0S0M1	$_{abc}68.28^{a}\pm0.82$	$_{abcd}68.46^{a}\pm0.63$	$_{cd}67.95^{a}\pm0.74$	$_{d}67.90^{a}\pm0.85$	68.15
P0S1M0	$_{a}72.22^{a}\pm0.71$	$_{a}72.16^{a}\pm0.62$	$_{a}71.85^{a}\pm0.71$	$_{a}71.81^{a}\pm0.64$	72.01
P0S1M1	$_{ab}70.01^{a}\pm1.01$	$_{abc}69.96^{a}\pm0.43$	$_{ab}69.88^{a}\pm0.98$	$_{bc}69.81^{a}\pm0.90$	69.92
P1S0M0	$_{ab}70.80^{a}\pm0.73$	$_{ab}70.78^{a}\pm0.72$	$_{ab}70.60^{a}\pm0.81$	$_{b}70.55^{a}\pm0.77$	70.69
P1S0M1	$_{abc}67.73^{a}\pm0.65$	$_{de}67.65^{a}\pm0.49$	$_{cd}67.60^{a}\pm0.70$	$_{e}67.08^{a}\pm0.68$	67.52
P1S1M0	$_{a}71.93^{a}\pm0.76$	$_{a}71.85^{a}\pm0.48$	$_{a}71.81^{a}\pm0.74$	$_{a}71.73^{a}\pm0.88$	71.83
P1S1M1	$_{abc}69.62^{a}\pm0.63$	$_{abc}69.55^{a}\pm0.85$	$_{abc}69.25^{a}\pm0.68$	$_{bc}69.20^{a}\pm0.72$	69.40
Mean	70.30	70.27	70.05	69.94	
CD at 5%	p×s×M×D = 0.809, Duration (mean) = 0.285, P×S×M (mean)= 0.404				

P0S0M0 (Fillets without Spice cooked in Conventional oven)
P0S0M1 (Fillets without Spice cooked in Conventional oven)
P0S1M0 (Fillets with spice cooked in Conventional oven)
P0S1M1 (Fillets with Spice cooked in Microwave oven)
P1S0M0 (Balls without Spice cooked in Conventional oven)
P1S0M1 (Balls without Spice cooked in Microwave oven)
P1S1M0 (Balls with Spice cooked in Conventional oven)
P1S1M1 (Balls with Spice cooked in Microwave oven),
Mean values are the average of 6 replications
Similar superscripted letters along the row and subscripted letters along the column depicts non significant difference

Table 2: Effect of different treatments as affected by spice and method of cooking on protein content (%) of fish products during storage

Treatment	Protein content (%)				
	Storage period (days)				
	0	4	8	12	Mean
P0S0M0	$_{bc}16.58^{a}\pm0.75$	$_{b}17.07^{a}\pm0.747$	$_{b}17.10^{a}\pm0.65$	$_{bc}17.23^{a}\pm0.52$	17.06
P0S0M1	$_{a}20.45^{a}\pm0.77$	$_{a}20.58^{a}\pm0.79$	$_{a}20.58^{a}\pm0.57$	$_{a}20.61^{a}\pm0.52$	19.71
P0S1M0	$_{bc}16.23^{a}\pm0.72$	$_{c}16.03^{a}\pm0.70$	$_{c}16.25^{a}\pm0.66$	$_{bc}16.43^{a}\pm0.85$	16.24
P0S1M1	$_{bc}16.82^{a}\pm0.69$	$_{b}16.93^{a}\pm0.86$	$_{b}17.22^{a}\pm0.83$	$_{bc}17.22^{a}\pm0.55$	17.05
P1S0M0	$_{b}17.13^{a}\pm0.64$	$_{b}17.35^{a}\pm0.59$	$_{b}17.45^{a}\pm0.43$	$_{b}17.53^{a}\pm0.62$	17.37
P1S0M1	$_{a}20.65^{a}\pm0.60$	$_{a}20.75^{a}\pm0.53$	$_{a}20.85^{a}\pm0.62$	$_{a}21.00^{a}\pm0.99$	20.81
P1S1M0	$_{bc}16.30^{a}\pm0.74$	$_{c}16.03^{a}\pm0.70$	$_{c}16.23^{a}\pm0.57$	$_{bc}16.50^{a}\pm0.72$	16.27
P1S1M1	$_{b}17.37^{a}\pm0.67$	$_{b}17.67^{a}\pm0.52$	$_{b}17.68^{a}\pm0.64$	$_{b}17.73^{a}\pm0.50$	17.61
Mean	17.73	17.80	17.92	17.61	
CD at 5%	p×s×M×D = 0.77, Duration (mean) = 0.273, P×S×M (mean)= 0.386				

P0S0M0 (Fillets without Spice cooked in Conventional oven)
P0S0M1 (Fillets without Spice cooked in Conventional oven)
P0S1M0 (Fillets with spice cooked in Conventional oven)
P0S1M1 (Fillets with Spice cooked in Microwave oven)

P1S0M0 (Balls without Spice cooked in Conventional oven)
P1S0M1 (Balls without Spice cooked in Microwave oven)
P1S1M0 (Balls with Spice cooked in Conventional oven)
P1S1M1 (Balls with Spice cooked in Microwave oven)
Mean values are the average of 6 replications
Similar superscripted letters along the row and subscripted letters along the column depicts non significant difference

Table 3: Effect of different treatments as affected by spices and cooking method on fat content (%) of fish products during storage

Treatment	Fat content (%)				
	Storage period (days)				
	0	4	8	12	Mean
P0S0M0	$_{bc}6.83^{a}\pm0.23$	$_{bc}6.83^{a}\pm0.21$	$_{bc}6.93^{a}\pm0.27$	$_{abc}7.02^{a}\pm0.33$	6.90
P0S0M1	$_{bc}6.90^{a}\pm0.26$	$_{bc}7.03^{a}\pm0.22$	$_{bc}7.08^{a}\pm0.43$	$_{abc}7.12^{a}\pm0.29$	7.03
P0S1M0	$_{b}7.00^{a}\pm0.26$	$_{b}7.08^{a}\pm0.23$	$_{bc}7.10^{a}\pm0.42$	$_{abc}7.20^{a}\pm0.30$	7.09
P0S1M1	$_{a}7.75^{a}\pm0.24$	$_{a}7.80^{a}\pm0.28$	$_{a}7.85^{a}\pm0.29$	$_{a}7.88^{a}\pm0.33$	7.82
P1S0M0	$_{bc}6.90^{a}\pm0.30$	$_{bc}6.95^{a}\pm0.29$	$_{bc}7.13^{a}\pm0.47$	$_{abc}7.20^{a}\pm0.32$	7.05
P1S0M1	$_{b}7.22^{a}\pm0.31$	$_{b}7.37^{a}\pm0.33$	$_{b}7.43^{a}\pm0.27$	$_{ab}7.47^{a}\pm0.25$	7.37
P1S1M0	$_{b}7.30^{a}\pm0.26$	$_{b}7.35^{a}\pm0.27$	$_{bc}7.40^{a}\pm0.28$	$_{ab}7.55^{a}\pm0.29$	7.40
P1S1M1	$_{a}7.83^{a}\pm0.30$	$_{a}7.88^{a}\pm0.29$	$_{a}8.00^{a}\pm0.36$	$_{a}8.05^{a}\pm0.35$	7.94
Mean	7.22	7.29	7.37	7.44	
CD at 5%	p×s×M×D = 0.339, Duration (mean) = 0.119, P×S×M (mean)= 0.169				

P0S0M0 (Fillets without Spice cooked in Conventional oven)
P0S0M1 (Fillets without Spice cooked in Conventional oven)
P0S1M0 (Fillets with spice cooked in Conventional oven)
P0S1M1 (Fillets with Spice cooked in Microwave oven)
P1S0M0 (Balls without Spice cooked in Conventional oven)
P1S0M1 (Balls without Spice cooked in Microwave oven)
P1S1M0 (Balls with Spice cooked in Conventional oven)
P1S1M1 (Balls with Spice cooked in Microwave oven)
Mean values are the average of 6 replications
Similar superscripted letters along the row and subscripted letters along the column depicts non significant difference

Table 4: Effect of different treatments as affected by spices and method of cooking on ash content (%) of fish products during storage

Treatment	Ash content (%)				
	Storage period (days)				
	0	4	8	12	Mean
P0S0M0	$_{ab}2.63^{a}\pm0.40$	$_{ab}2.65^{a}\pm0.39$	$_{ab}2.67^{a}\pm0.37$	$_{ab}2.70^{a}\pm0.35$	2.66
P0S0M1	$_{a}2.80^{a}\pm0.36$	$_{a}2.80^{a}\pm0.32$	$_{a}2.83^{a}\pm0.30$	$_{a}2.85^{a}\pm0.33$	2.82
P0S1M0	$_{a}2.92^{a}\pm0.40$	$_{a}2.93^{a}\pm0.36$	$_{a}2.95^{a}\pm0.41$	$_{ab}2.70^{a}\pm0.35$	2.88
P0S1M1	$_{a}3.02^{a}\pm0.29$	$_{a}3.07^{a}\pm0.37$	$_{a}3.08^{a}\pm0.32$	$_{a}3.10^{a}\pm0.30$	3.07
P1S0M0	$_{ab}2.50^{a}\pm0.31$	$_{ab}2.55^{a}\pm0.34$	$_{ab}2.58^{a}\pm0.35$	$_{ab}2.60^{a}\pm0.35$	2.56
P1S0M1	$_{ab}2.63^{a}\pm0.30$	$_{ab}2.68^{a}\pm0.37$	$_{a}2.75^{a}\pm0.41$	$_{ab}2.75^{a}\pm0.38$	2.70
P1S1M0	$_{a}3.00^{a}\pm0.33$	$_{a}3.00^{a}\pm0.32$	$_{a}3.08^{a}\pm0.38$	$_{a}3.10^{a}\pm0.32$	3.05
P1S1M1	$_{a}2.90^{a}\pm0.40$	$_{a}2.88^{a}\pm0.32$	$_{a}2.92^{a}\pm0.33$	$_{a}2.93^{a}\pm0.33$	2.91
Mean	2.80	2.82	2.86	2.84	
CD at 5%	p×s×M×D = 0.339, Duration (mean) = 0.114, P×S×M (mean)= 0.163				

P0S0M0 (Fillets without Spice cooked in Conventional oven)
P0S0M1 (Fillets without Spice cooked in Conventional oven)
P0S1M0 (Fillets with spice cooked in Conventional oven)
P0S1M1 (Fillets with Spice cooked in Microwave oven)
P1S0M0 (Balls without Spice cooked in Conventional oven)
P1S0M1 (Balls without Spice cooked in Microwave oven)
P1S1M0 (Balls with Spice cooked in Conventional oven)
P1S1M1 (Balls with Spice cooked in Microwave oven)
Mean values are the average of 6 replications
Similar superscripted letters along the row and subscripted letters along the column depicts non significant difference

Conclusions

Regular consumption of fish products is therefore recommended for elderly and people with hypercholesterolemia and coronary heart diseases. It is well recognized that uncontrolled variables, such as the geographical location of fish, season of the year, sex, feeding habits and reproductive status affect the nutrient composition of fish. This investigation will provide basic information which can be added to the current Indian food composition data on fresh water fish (catla) both raw and cooked. The data can also be used as a guideline for promoting fish consumption and for further detailed study.

References

1. AOAC. Official methods of Analysis, 18th edition. The Association of Official Analytical Chemists International, Maryland, 2005.
2. Bochi VC, Weber J, Ribeiro A, Victorio M de, Emanuelli. Fish burger with silver catfish filleting residue. *Bioresource Technol.* 2008; 99:8844.

3. Dutta C. Storage characteristics of fish balls from rohu, Labeo rohita at -20°C. Indian J. Fish. 2009; 56(1):39.
4. Fawzya YN. In: Kumpulan Hasil-Hasil Peneletian Pasca Panen Perikanan (Suparno, S.N. and Setiabudi, E., Eds.), Balai Penelitian dan Pengembangan Perikanan, Jakarta, Indonesia, 1992.
5. Gall KL, Otwell WS, Koburger JA, Appledorf J. Effects of four cooking methods on the proximate, mineral and fatty acid composition of fish fillets. J. Food Sci. 1983; 48:1068.
6. Garcia-Arias MT, Pontes EA, Gracia-Fernandez MC, Sanchez-Muniz FJ. Grilling of sardine fillets. Effects of frozen and thawed modality on their protein quality. *Lebensmittel-Wissenchaft und Technologie.* 2003; 36:763.
7. Hassaballa AZ, Mohamed GF, Ibrahim HM, Abdelmageed MA. Frozen cooked cat fish burger: Effect of different cooking methods and storage on its quality. *Global Veterinaria.* 2009; 3(3):216.
8. Huda N, Abdullah A, Babji AS. Physicochemical properties of Malaysian fish balls. *Fishery Technol.* 2001; 38(1):14.
9. Janicki LJ, Appledorf H. Effect of broiling, grill frying and microwave cooking on moisture, some lipid components and total fatty acids of ground beef. J. Food Sci. 1974; 39:715.
10. Johansson L, Ruderus H, Bielby RI. Optimum Internal Temperature established by sensory evaluation for fish prepared in conventional and microwave ovens. Family and Cons. Sci. Res. J. 1992; 21(2): 205.
11. Saguy IS, Dana D. Integrated approach to deep fat frying: engineering, nutrition, health and consumer aspects. J. Food Eng. 2003; 48:1068.
12. Salama NA. Evaluation of two cooking methods and precooking treatments on characteristics of chicken breast and leg. *Grasa-y-Aceites*. 1993; 44:25.
13. Wing RW, Alexander JC. Effect of microwave heating on vitamin B_6 retention in chicken. J. Am. Diet Assoc. 1972; 61:661.