Species specific interventions in value addition of commercially important and emerging species of fresh water fish - An Overview

ICAR Project 1000661028[P-90/2011(3)]
(April 2011 to March 2014)

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Final Report

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Foreword

Indian Fisheries is a flourishing sector with varied resources and potentials. The vibrancy of the sector can be visualized by the 11–fold increase that India achieved in fish production in just six decades, i.e. from 0.75 million tonnes in 1950-51 to 9.6 million tonnes during 2012–13. As the second largest country in aquaculture production, the share of inland fisheries and aquaculture has gone up from 46 percent in the 1980's to over 85 percent in recent years in total fish production. The three Indian major carps, viz., catla (*Catla catla*), rohu (*Labeo rohita*) and mrigal (*Cirrhinus mrigala*)

contribute the bulk of production to the extent of 70 to 75 percent of the total fresh water fish production, followed by silver carp, grass carp, common carp, catfishes forming a second important group contributing the balance of 25 to 30 percent. *Pangasionodon hypophthalmus*, the swift growing catfish species has been introduced in India in 1995-1996 and it is estimated that Pangasius is being farmed in an area of about 40 000 ha with an expected production of 1.80 to 2.20 lakhs tonnes. However post-harvest processing and value addition interventions in this sector has been minimal when compared to the marine sector which has an organised industry with a number of processing units and marketing network along the Indian coastline. There are many reasons; Quality issues, lack of processing infrastructure & value addition options, negligible export potential are to name a few important ones.

With this background, the Central Institute of Fisheries Technology has taken up the Project on "Species specific interventions in value addition of commercially important and emerging species of fresh water fish" with the primary objective of developing a package for the total utilization of the freshwater fishery resources. The project activities were species specific with emphasis on local and emerging species of commercially important freshwater fishes. The outputs in the form of optimised technologies for value addition can be utilised for better value realisation of freshwater resources. This overview is a brief description of the salient findings and achievements in this Project, the technologies developed, and knowledge inputs created in the form of research publications. This publication will be useful for the researchers, entrepreneurs and administrators in understanding the value addition potential of freshwater fishery resources and will serve as a Benchmark in the future programmes for implementing an effective utilisation package for the Aquaculture resources.

Cochin -29 **Dr.T.K Srinivasa Gopal**

30-06-2014
Director

Central Institute of Fisheries Technology (ICAR)

Executive Summary

The ICAR Research Project on "Species specific interventions in value addition of commercially important and emerging species of fresh water fish" have been undertaken with the primary objective of developing and optimizing a package of practices for species specific value addition in fresh water fish, which has been hitherto a neglected area in the Indian Fisheries Sector. Compared to Marine fisheries, the Inland fishery Sector of India is largely unorganized to promote any viable Business options in the post-harvest sector. Many new species are being introduced in the Indian aquaculture; a comprehensive study on the suitability of these species for value addition has to be carried out to suggest an effective utilization package for the aquaculture resources.

The Project has met most of the objectives outlined in the proposal within the three years duration. Many technologies for value addition of freshwater fish were optimised and fine-tuned so as to make adoptable for a commercial production process. Consultancies offered for the establishment of freshwater fish processing unit in different regions of the country was an important outcome. Detailed studies were carried out on the quality, shelf life and value addition prospects of emerging species viz., *Pangasianodon hypophthalmus* and other commercially important freshwater species like *Ompok pabda*. This was effectively transferred to production units through brainstorming sessions and training programmes. Training programmes on value addition and business opportunities in freshwater fisheries were carried out in diverse regions; Champawat in Uttarakhand, Patna in Bihar, Ranchi in Jharkhand to mention a few. The Project has also brought publications in the form

research papers in peer reviewed Journals, Technical & Popular articles, Detailed Project Reports and many presentations in Seminars & symposia.

The Project was funded by the Indian Council of Agricultural Research and had duration of three years which commenced from 01 April 2011. Fifteen scientists were associated with this project as co-investigators from the different Divisions and Research Centres of the Central Institute of Fisheries Technology, Cochin. This final report presents the salient findings of the Project and other notable achievements. The Project team gratefully acknowledges the support given by the Director, CIFT, Heads of Divisions and the Scientists –in charge of the Research Centres for carrying out the envisaged activities. The positive interventions and timely guidance of the Project Management Committee of the Institute has helped the Project to reach the milestones and achieve the targets. The financial assistance and support of the Indian Council of Agricultural Research had immensely helped in the successful culmination of the Project.

Dr.George Ninan

Senior Scientist & Principal Investigator

1. Introduction

Fresh water fish farming and allied processing activities are going to play a major role in enhancing the revenue from fishery sector in India. Expansion of inland aquaculture, enhanced capture fisheries and introduction of new species may lead to large-scale increase in production of freshwater fishes. There is a felt need for value addition and process optimization for the development of convenience products from freshwater fish. The project was aimed to bring about the optimization and refinement of process parameters for the development and preservation of value added and convenience products from freshwater fish that can be easily adopted in a commercial value chain.

2. Objectives

The project was conceived with the following major objectives:

- Preparation and process optimization of value added products from commercially important freshwater fishes and other emerging species.
- Low temperature preservation characteristics of value added products with emphasis on quality and shelf life.
- Changes in the nutritional profile during handling and processing and nutritional labelling of the products.

- Standardization and process optimization of thermal processed products.
- Modification of flavour/off-flavour of fresh/processed foods by way of treatment with specific flavour scavengers.
- Microbiological changes during preservation and standardisation of processing parameters of freshwater fish and fishery products.
- Design & development of equipment / machinery for fish processing and value addition

3. Materials & Methods

The work components of the project were carried out in the Fish Processing, Biochemistry & Nutrition and Microbiology Divisions and in the Mumbai research Centre of CIFT. For product development, standard protocols were followed with modifications to suit freshwater fish. Processing, product development shelf life studies were carried out in the Fish processing Division at the Headquarters and in Mumbai research Centre. Studies on microbial profile were carried out in the Microbiology Division of CIFT. Studies on the amino acid composition were carried out in in the Biochemistry & nutrition Division of CIFT. Product development and pilot scale studies were carried out in the Pilot Plant facility of the CIFT. All the equipment and instruments necessary to carry out the work were available in the Fish Processing, and Microbiology Divisions of the Institute. For biochemical and microbiological analysis Standard methods & protocols based on AOAC, AOCS, APHA and FDA were followed.

The following were the major equipment used in the Project.

Meat bone separator	Food Texture Analyser	Silent Cutter
Batter & Breading machine	Fish Filleting machine	Pin bone remover
Fish Descaler	Sausage stuffer	Overhead pressure Autoclave
Blast Freezer	Deep Freezers	Cold Store
Vacuum sealing machine	Freeze Drier	Solar Drier
Kerry's Smoke Kiln	Vacuum drier	Tray sealing machine

Hobart mincer	Gas Chromatograph	Flake ice machine
HPLC	Amino Acid Analyser	SDS PAGE unit
Spectrophotometer	Flash Evaporator	Atomic Absorption Spectrometer

The following major activities were carried out under the Project

- Collection of fish from different locations including farms, reservoirs, rivers for product development.
- Studies on low temperature preservation characteristics of value added products.
- Standardization, process optimization and storage studies of mince and fillet based value added products.
- Studies on the suitability of different packaging materials viz., PP, PE and laminates for the low temperature preservation of fish fillets and products.
- Studies on the changes in nutritional profile during handling and processing and nutritional labelling of the value added products.
- Standardization and process optimization of thermal processed products including smoked , canned and retort pouch processed products.
- Studies on muddy flavour in freshwater fish and methods to remove the muddy flavour during processing
- Microbiological changes during preservation and processing of freshwater fish and fishery products

4. Results and discussion

Prepared a ready to eat flash fried fish paste product from rohu mince incorporating the essential oils of clove and curry leaf. The effect of incorporating the essential oil at a single concentration of 0.05% (w/w) to the fish mince was evaluated based on shelf life and flavor development. Addition

of essential oil improved the flavor and shelf life of the product compared to that of control in chilled conditions. Extension of shelf life for five days and three days was observed in samples

The quality and shelf-life of fresh Sutchi catfish (*Pangasius hypophthalmicus*) fillets treated with potassium sorbate, essential oils from clove and curry leaf and packed under vacuum were compared with untreated vacuum and air packed fillets. Potassium sorbate (0.5 %) was added in

combination with 0.2% sodium citrate and essential oils were added at a single concentration of 0.1% (v/v). All the treated samples were packed under vacuum and stored at 2- 4^{o}C. Separate vacuum packed and air packed samples were maintained as controls. The biochemical and sensory analyses of samples were carried out at periodic intervals. Results indicated that treated samples exhibited extended shelf life compared to untreated vacuum and air packed samples. Among the treatments, samples treated with essential oil from curry leaf showed maximum shelf life of 15 days followed 13 days for samples treated with essential oils from clove and potassium sorbate. Vacuum fillets gave less satisfactory results of 11 days shelf life; however was better than fillets maintained in air with shelf life of 9 days.

Microbial attributes of ice stored farmed catfish *Pangasianodon hypophthalmus* collected from freshwater farm and treated with clove oil, curry leaf extract and potassium sorbate were studied. In all the samples including control, the microbial counts increased gradually during storage. In control samples (without treatment)and sample treated with clove oil, the aerobic mesophilic counts reached >10^7 cfu/g on day 9 where as in samples treated with curry leaf extract and potassium sorbate, the counts were < 10^7 cfu/g. Faecal streptococci levels also increased gradually in all the samples and reached a level of 10^4-10^5 cfu/g. The results indicate that all the samples were acceptable up to day 5. The count of *Escherichia coli* was > 100 cfu/g initially and was detected throughout the storage. The proximate composition of two length weight classes of farmed *P. hypophthalmus* was studied. The marketable size of fish is up to 2Kg. Specimens above 2Kg size has significant fat content (3-4.5%) which will reduce the quality of meat.

Length–weight class	Moisture	Protein	Fat	Ash
Length-35 to 50cm Weight- 1to 2 Kg	78 – 79.5 %	17- 18.5 %	2- 2.3 %	2- 2.5 %
Length-50 to 70cm Weight- 2to 5 Kg	76 – 78.2 %	16 - 18.5 %	3- 4.2 %	1.8 - 2.4 %

Protein enrichment of Pangasius wafers with soy flour: Commercial soy flour at a rate of 20 % is used for preparation of fish wafers with pangasius fish mince. The final product is having light greenish color which disappears after frying. Protein content of the soy flour incorporated wafers increased from 33% to 48.5 %. The fatty acid profile of the wafers before and after frying for 1-2 min. is determined by gas chromatography. EPA + DHA content decreased from 2.3 % to 1.0 % due to frying.

The shelf life of microwave processed *Pangasianodon hypophthalmicus* fillets during chilled storage was evaluated. The fillets were given dip treatment in chlorinated water (2 ppm) for 10 minutes and packed under vacuum and air. The fillets were further processed in a Microwave processor for 18 seconds under medium mode at a power of 488 Watts and stored at a temperature of 2 to 4^0C. The samples were withdrawn at periodic intervals for biochemical analysis. On the whole, the biochemical and sensory evaluation of microwave processed –vacuum packed fillets showed maximum extension in shelf life of 19 days followed by control vacuum packed samples of 12 days. On the contrary, air packets samples showed much lesser shelf life of 10 days irrespective of the treatment given.

Experimental design was set up based on the fractional factorial design of experiment to standardize the Treatment time and Acetic acid concentration of marination and microwave processing of Pangasius fillets. Based on the sensory evaluation of fish fillets, the optimum combination of process variables were found to be 0.2 ppm acetic acid concentration for 10 minutes

of dip treatment. The optimum combination of power and treatment time of microwave processing was 488 watts and 18 seconds in terms sensory evaluation of fish fillets.

Effect of short time marination on the quality and shelf life of chilled stored *Pangasianodon hypophthalmicus* fillets was evaluated. Marination was done by immersing the fish fillets in solutions containing 0.2% acetic acid and 10%NaCl for a period of 10 min. The marinated and control fillets were further packed under air and vacuum and stored at 2-4^{o}C. The biochemical and sensory quality of fish fillets were evaluated at periodic intervals. In general, a sharper decline in overall quality was experienced by 10th day of storage in the case of control samples, whereas marinated samples developed off-flavour only by the end of 14th day of chilled storage.

Enrichment of Pangasius fish wafers with Sardine oil: The standard fish wafers developed at CIFT was used as control wafers. To enrich EPA and DHA, sardine oil at 0.5 %, 1 %, 1.5 % and 2 % was used in wafers. These four types of wafers were analysed for sensory acceptability. Wafers with 1.5 % oil were found to be acceptable. The fatty acid profile of wafers was determined by gas chromatography. EPA + DHA content increased from 5 % to 8.5 % by incorporating sardine oil at 1.5 % level. The raw wafers were fried in cooking oil: one set for 1-2 min and another for 4-5 min. EPA + DHA content decreased from 8.5 % to 5.1 % by frying for 1-2 min. However, frying for 4-5 min has reduced the content to 0.2 %. Longer frying time has drastic effect on EPA and DHA content because the wafers are very thin.

Microbial profile of marinated farmed catfish Pangasianodon hypophthalmus collected from freshwater farm situated at Kodungalloor, Trichur district, Kerala was studied during storage under air and vacuum. In non- marinated samples stored under air, the count exceeded the limit count on day 6 limiting the shelf life to 3days. In marinated samples packed and stored under vacuum, the shelf life was 3d. In non- marinated samples stored VP and in marinated samples stored under air, the count exceeded the limit count on day 3 and shelf life was <3 days.

The effect of washing with organic acids and banana leaf ash solution on the removal of muddy flavor of rohu fillets was evaluated based sensory and instrumental methods. Fish fillets were treated with banana leaf ash and organic acids viz.citric acid and tartaric acid at different levels and durations. There was a marked improvement in flavor and colour of fish treated fillets compared to controls and the fillets treated with a combination of banana ash and organic acids were found to be more palatable. The colour was significantly improved by washing especially with higher concentration of banana leaf ash.

Fish croquette, a mince based coated product was prepared with Rohu mince and incorporating soy powder as a partial replacer for fish mince in different combinations. The fish mince was replaced with soy flakes (prepared by soaking the soy chunks in hot water and flaked mechanically) at 25% 50%, 75% and 100%. The croquette prepared by using 25% soy flakes in place of fish mince was found to be better than 100% fish mince based croquette in terms of sensory and texture properties. Shelf life evaluation at chilled storage was carried out and the product had 16 days of storage life.

The combined effect of modified atmosphere with flexible packaging material (Polyester/Polyethylene laminates) was studied on skinless *Pangasionodon hypothalmicus*. Five different gas combinations with oxygen and carbon dioxide gases mixed in various ratios were used for the study along with air pack as control. Among these the best gas combination mixture selected was 80% CO_2: 20% O_2 based on total plate count reduction and other biochemical and textural parameters. The shelf life of the product was 24 days compared to 16 days for air packed control samples.

The effect of vacuum packaging on the keeping quality of liquid smoked Catla fillets packed in polyester/polythene was studied. The vacuum packed liquid smoked product had a shelf life of 18 days compared to air packed liquid smoked control samples which was rejected at 15 days. The control sampled without any treatment was acceptable up to 12 days only.

Developed an instant fish gravy mix for two types of fish curry. This gravy paste was dried under three different conditions. viz., mechanical, vacuum and freeze-drying. Vacuum dried product had higher sensory score. Shelf life evaluation of ready to constitute fish curry from instant fish gravy mix was carried out. The product had a shelf life of 30 days in chilled conditions whereas the control samples had 25 days of shelf life

Vacuum packaging studies of gutted pabda fish (*Ompok pabda*) under iced condition was carried out. Separate samples packed in PE pouches were maintained as control. Samples were drawn at regular intervals for biochemical, microbial and sensory analysis. Results indicated that samples remained in acceptable condition till 24 days of storage in ice, whereas control samples packed in PE pouches gave less satisfactory results and were rejected after 18 days of storage in ice.

A prototype of Fish de-scaling Machine was developed in order for descaling of fishes. Trials conducted have shown that 98% of the scales can be removed using de-scaling machine. For carps, the de-scaling process requires 10 minutes at 30 rpm and for tilapia it is 8 minutes at 25 rpm. A patent has been applied for the design and process.

A study on the partial replacement of fish meat in fish cutlet by soy protein was carried out. It was observed that the product with a combination of 70% meat and 30% soy had better acceptability, textural parameters and storage stability than the conventional fish cutlet.

A comparative evaluation was carried out on the quality characteristics of *Ompok pabda* fish processed by sous vide technique employing two different modes of heating viz. microwave oven heating and conventional heating. The core temperature of the samples were allowed to reach at 70^{o}C and maintained at different temperatures. The time-temperature combinations were selected based on a separate preliminary experiment. The fish samples were vacuum packed before heating and separate control was maintained for comparison. Further, after heating, the samples were quick chilled using crushed ice and were further stored at 50C. The microbiological parameters were

analysed at regular intervals for total mesophilic, psychrophilic and thermophilic count, Enterobacteriaceae in addition to common pathogenic /spoilage organisms like E .coli, Streptococcus, Vibrio parahaemolyticus, Salmonella, Listeria and Staphylococcus. The biochemical parameters analysed included TVBN, NPN, alpha amino Nitrogen, FFA, PV, TBA, Histamine, Drip Loss, pH and haeme iron content. Results indicated that both microwave heated and conventionally heated samples remained in acceptable condition for more than a month; however, conventionally heated samples excelled in quality during the initial 15 days of storage and thereafter showed similar trend for both the samples. On the other hand control vacuum packed samples were rejected after 20 days of storage under chilled condition.

The protocol for canning pangasius in TFS cans was worked out. Steaks from skinless boneless fillets were cold blanched and flash fried for different time intervals of 1, 2 & 3 minutes. The steaks were then canned with refined oil as medium. The cans were heat processed to F_o value of 8 min. Sensory evaluation of quality characteristics, bacteriological quality, texture profile analysis and thermal process validation of canned products were carried out. The canned product with steaks flash fried for 3 minutes gave the best results on sensory evaluation. This product had good textural properties and the water content was less than 10% which is a requirement for canned product.

An intermediate moisture containing product from Pangasius catfish fillet was prepared by a combination of pH modification (potassium sorbate and citric acid), controlled microwave heating and drying technique. Moisture content in the range of 40-50% was achieved by varying the treatment durations. The product was further tray packed under vacuum and stored at two different conditions, viz. room temperature and chill storage at 3^0C. The microbiological parameters were analysed at regular intervals for total mesophilic and psychrotrophic bacteria, enterobacteriaceae, and total anaerobic sulphite reducing Clostridia, Pseudomonas spp, and total lactics in addition to common pathogenic /spoilage organisms like *E.coli*, Streptococcus, *Vibrio parahaemolyticus*, Salmonella, Listeria and Staphylococcus. The biochemical parameters analysed included pH,

protein solubility, TVBN, NPN, alpha amino Nitrogen, FFA, PV, TBA and haeme iron content. The results indicated that the chill stored samples remained in acceptable condition for more than 45 days, whereas the samples stored at room temperature showed shelf life of 12-15 days.

Antioxidant activity of aqueous extracts of Ginger (*Zingiber officinale*), Mint (*Mentha arvensis*) and Chilli (*Capsicum annuum*) were examined. Among the antioxidant sources, mint extract had the highest phenolic content (87.33± 2.74 mg phenols/100g) followed by ginger extract (74.22 ± 0.52 mg phenols/100g) and chilly extract (74.56 ± 0.56 mg phenols/100g).

The effect of spice extracts on preservation of Pangasius fillet during chilled storage was evaluated. Spice extracts were prepared at 20% concentration (20g in 100 ml of water) and boiled for 5 minutes. After cooling, extracts were filtered. Then the fillets were subjected to dip treatment for 30 min and stored in chilled condition (4^0C). The samples were withdrawn at periodic intervals for biochemical and sensory evaluation. Fillet treated with spice extracts had lower TVB-N, TMA-N, PV and TBARS than the control. Sensory evaluation revealed that storage period up to 9th day no significant difference in overall acceptability of fillet. Further, gradual decrease in overall acceptance was observed in control and fillet treated with chilly extracts. However, fillet treated with ginger and mint extract were found to be acceptable up to 15 days.

Fresh water fish viz., Catla, Rohu, Tilapia, Ompok pabda, *Wallago attu* and Cat fish were collected from the local fish market of Navi Mumbai in Maharashtra region and analyzed for all microbiological parameters and pathogenic bacteria. All the samples were negative for the Salmonella, *V. cholera*, *V. parahaemolyticus* and *L. monocytogens*. The aerobic plate count (APC) for all the samples were within the limit, i.e., 11600 to 95000 cfu/g of sample. Three samples *E. coli* count were more than the recommended level. All the samples were positive for the Staphylococcus aureus and negative for one sample; but, the count was within the limit. The average count of the faecal streptococcus was 30 cfu /g of sample. In eight samples Sulphur reducing clostridia counts were higher than the recommended limit.

Gelation characteristics of surimi from *P. hypophthalmus* as affected by microwave heating were evaluated. Gels were prepared by heating at 2450 Hz for 30, 60 and 90 sec. The nature of the gel network formed during heating was evaluated based on solubility profile of the heat induced gel in distilled water, high ionic strength buffer, TCA and SDS buffer. The results indicated significant reduction in solubility values of heat induced gel subjected for 60 and 90 sec durations, whereas the gel heated for 30 sec showed higher solubility values similar to unheated sol.

Standardized the ingredients for the development of restructured products from pangasius fish mince. A central composite design 12 runs was planned for the preparation of restructured products from Pangasius. Optimization was done using qualitative descriptive analysis of sensory characteristics. In order to find out the suitable concentration of starch and chitosan for the development of restructured product, various concentration of corn starch (4-9.6%) and chitosan (0.75-1.81%) were added into the pangasius fish mince based on statistical design. Salt (1%) and sodium tripolyphosphate (0.25%) were added at same concentration in all the treatments. After mixing of all the ingredients, they were subjected to steam cooking for 15 minutes. After cooling, they were cut in to required shape and fried in oil after battered and breaded. Sensory evaluation revealed that combination of 4% corn flour and 0.75% chitosan was more acceptable among the different treatment.

Attempts were made with selected concentration of chitosan (0.75%) with different starch includes corn flour, maida, tapioca flour and wheat flour for the development of restructured product. Sensory evaluation revealed that combination of 4% corn flour and 0.75% chitosan was more acceptable than the other treatment.

Pangasius fillets were subjected to a partial drying process under hot air oven for 1 hr followed by quick chilling before being stored under chill storage. Drying under forced circulation of hot air reduced the moisture content of the fillets by 13-15%. In addition, drying enhanced the texture

characteristics of the fillets compared to the soft fresh fillets. Further, the dried fillets showed superior color characteristics during chill storage.

Microbial attributes of farmed catfish Pangasius subjected to microwave-heating (medium power) for 60sec, 75 sec and 90 sec were studied along with control (raw) sample. Total aerobic mesophilic bacteria (TPC) and Enterobacteriaceae were enumerated. In control sample, TPC was $\leq 10^5$ cfu/g and Enterobacteriaceae count was$\leq 10^4$ cfu/g. Two log reductions was observed in TPC of catfish microwave-heated for 60 sec, 75 sec and 90 sec. Enterobacteriaceae could not be detected in catfish microwave-heated for 75sec and 90sec.Two log reduction was observed in Enterobacteriaceae count for samples microwave-heated for 60 sec.

A preliminary study was conducted to find out the effect of cooking methods on the quality of Rohu meat during chill storage. For this, Rohu steaks were steam cooked by two methods 1) fish was put into the steamer and cooked for 5 and 10 m and 2) fish was cooked in full steam for 5 and 10 m. Similarly, the fish was boiled by two methods 1) fish and water together cooked for 5 and 10 m and 2) fish put into the boiled water and then cooked for 5 and 10 m. Cooking yield and proximate composition of the Rohu meat was analysed. Cooking yield was lower in samples cooked for 10 m than that cooked for 5 m by both the methods. Based on the sensory analysis, cooking for 5 m in boiled water and in full steam for 10 m was selected for further study.

The cooked meat of Rohu was packed in polyethylene pouches and stored at 4^0 C in a vertical chiller. Microbiological, biochemical and sensory analyses of the steamed and boiled meat was done at 4 days interval. Biochemical parameters like TVBN, TBA, PV, and FFA were within the acceptable limit. The meat was found to be slimy towards the end of storage period. Microbiological analysis revealed a shelf life of 12-14 days and 14-16 days, respectively for boiled and steamed meat during storage at 4^0 C.

Farmed catfish is characterised by strong muddy flavor on cooking. Hence, the modification of the flavor characteristics of Pangasius catfish was attempted using various plant extracts such as oregano, rosemary, sage, turmeric, and green tea extracts on partially dried Pangasius catfish fillets. Out of the various plant extracts tested, essential oil from oregano was found to be most effective with respect to sensory evaluation, whereas the fillets treated with turmeric scored the least. The shelf life analysis of the fillets is in progress.

Pangasius meat was sterilized by 121^{o} C for 15 minutes than cooled to 4^{o}C. One ml of *V. parahaemolyticus* (4.65 X 10^{9}/ml) was added in the fish meat and heated in microwave oven at different intervals such as 0, 20, 40, 60, 80,100 and 120 seconds. After the micro-oven heat treatment, each fish meat portion was analysed for the number survived *V. parahaemolyticus* in fish meat. Likewise separate experiment was carried out using Salmonella culture (3.85 X 10^{7}). Each 20 seconds of microwave heat treatment one log reduction of the in *V. parahaemolyticus* population and after heating of one minute all the *V. parahaemolyticus* were killed. Death rate of Salmonella is slower than the *V. parahaemolyticus*, after one minutes heating one log reduction was observed. Two minutes is insufficient to kill all the Salmonella. It need more time in micro oven to destroy the Salmonella.

The proximate composition study of Monosex Tilapia indicated a moisture content of 73.44±0.24%, 17.11±0.16% protein, and 6.75±0.04% fat and 1.18±0.01% ash. The fatty acid composition study indicated that oleic and palmitic acid were found in higher levels whereas caprylic acid was the most limiting one. The amino acid analysis indicated higher levels of aspartic acid, glutamic acid, lysine and alanine whereas tryptophan was the most limiting amino acid. Proline, tyrosine and methionine were also found in low levels.

Ice storage studies of Monosex tilapia was carried out. The sample was divided into three lots viz., whole cleaned (Sample A), gutted and cleaned (Sample B) and Steaks (Sample C) which were

further packed in polythene bags and were layered between ice in insulated ice boxes. Ice was filled periodically throughout the sampling period. Considering two day sampling interval, the sample lots were analysed for quality parameters viz., pH, TBA, PV, FFA, TMA, TVBN as well as colour and texture. The moisture content of all the samples remained steady throughout the storage period whereas in all the samples there was a slight increase in pH values. The TBA values showed an increasing trend during the storage. TBA increase was less in sample A compared to sample B and C where the increase were sharper. Peroxide value and free fatty acids were also on an increase for all the samples indicating oxidation of fish lipids taking place during the storage. TMA and TVBN values showed a slight increase during the study. Sensory evaluation showed a gradual reduction in the quality during ice storage of the sample. Sample C developed a marked off taste towards the 19th day whereas sample B was rejected on the 23rd day. Sample A was acceptable till 27 days.

Freshness condition of iced whole Pangasius fish was evaluated. Solubility changes of sarcoplasmic and myofibrillar proteins were analysed at an interval of two days. Extracts of sarcoplasmic and myofibrillar protein were taken and measured the protein content by Biuret method. Both sarcoplasmic and myofibrillar protein content showed an overall declining trend with a marked increase on 6th day. There was a slight declining trend from 25th to 30th day in the case of sarcoplasmic protein content. But myofibrillar protein content showed an increasing trend from 21st to 30th day. Sample preparation for SDS Page was carried out. For the LCMSMS analysis of biogenic amines extracts were collected at an interval of two days. Declining trend of both sarcoplasmic and myofibrillar protein content during iced storage of Pangasius fish with a marked increase on 6th day. Total volatile base nitrogen (4.2 mg% to 8.4mg %) and thiobarbituric acid value (0.062 to 0.99mg malonaldehyde/ kg) showed increasing trend during storage. Initial peroxide value of 2.5 increased to 27.03 meq of o2/kg during 15th day and further it was decreased. Similar trend also observed in free fatty acid content. Freshness quality was also evaluated by

determining K value. Initial K value of fish was 4.33% and it was slowly increased to 11.9% on day 3, 52.37% on day 19 and 86% on day 30.

A methodology has been standardized for preparing a value added product from tilapia meat and Jawla shrimp. Jawla extract was prepared from jawla shrimp using citrate buffer. The extract showed good sensory properties in terms of odour and taste of that of shrimp. Surimi was prepared from Tilapia mince using 2 washing steps in chilled water. The mince was manually pressed by using a muslin cloth and was ground with sucrose, salt, corn starch, jawla extract and oil in a grinder. The total grinding time given was 15 minutes. Temperature of the mixture was maintained below 10^0C during grinding. Different starch sources like potato, rice flour and corn flour were tried and corn starch was found to give the required texture. The finely ground paste was made into a layer of 1 cm thickness and was cooked at 90^0C for 30 min. a water bath. Addition of jawla extract imparted a light pink color to the product. The cooked product was cut into the shape of fingers and then battered, breaded and fried. Both the boiled and coated product imitated the flavour of shrimp. The coated fingers showed very good sensory acceptability by the sensory panel.

A cocktail preparation of 'Fish-n-vegetable' was developed using the blanched meat of rohu fish. Fish meat was blanched for 10 and 20 min, whereas a short term blanching for 3 min was given for vegetables. The products were further tray packed under normal air and vacuum atmospheres, and stored under chilled condition. The results indicated negligible difference in shelf life between the two samples. Both the packs were microbiologically stable for more than 30 days, with a maximum load of 4 log 10 cfu/g. Even though, vacuum packed samples showed better colour stability during extended chill storage, air packed samples excelled in overall appearance during initial period of storage.

Prepared combination sausages from the mince of Nemipterus and pangasius. A simple lattice mixture experimental design with six runs was planned for the development of sausages.The mince

combination of Nemipterus and Pangasius was optimized using mixture response surface methodology based on data generated from a simple lattice mixture experimental design on Bio-chemical responses of sausage. The maximum shelf life was found to be for sausages with higher quantity of pangasius mince. First order linear regression model fitted to the experimental data and the optimum combination of mince was found 40% Nemipterus and 60% Pangasius as well as 20% Nemipterus and 80% Pangasius for a best quality of sausage in terms of Bio-chemical responses. The microbiological evaluation has shown that TVC in all samples did not cross the acceptable limits during the storage period. S.aureus, E .coli & Streptococci were absent in all the samples. The rejection of samples was based on sensory evaluation. Sausages with 100% pangasius mince had a shelf life of 41 days in chilled condition followed by those with 60% pangasius mince (38 days), 80% pangasius mince (32 days), 60% nemipterus mince (29 days), 100% nemipterus mince (28days) & 80% nemipterus mince (27days).

5. Objective wise achievements

5.1 Preparation and process optimization of value added products from commercially important freshwater fishes and other emerging species.

- A study on the partial replacement of fish meat in fish cutlet by soy protein was carried out. It was observed that the product with a combination of 70% rohu meat and 30% soy had better acceptability, textural parameters and storage stability than the conventional fish cutlet.
- Fish rolls were prepared from the frame meat of Rohu (*L.rohita*).Flash fried rolls had a shelf life of 17 days in chilled condition.
- An intermediate moisture product from Pangasius (*Pangasionodon hypophthalmicus*) fillet prepared by a combination of pH modification (potassium sorbate and citric acid), controlled microwave heating and drying technique remained in acceptable condition for more than 45 days in chilled condition.
- Gelation characteristics of surimi from *Pangasionodon hypophthalmus* as affected by microwave heating were evaluated. The nature of the gel network formed during heating was evaluated based on

solubility profile of the heat induced gel in distilled water, high ionic strength buffer, TCA and SDS buffer. The results indicated significant reduction in solubility values of heat induced gel subjected for 60 and 90 sec durations, whereas the gel heated for 30 sec showed higher solubility values similar to unheated sol.

- Standardized the ingredients for the development of restructured products from pangasius fish mince. In order to find out the suitable concentration of starch, chitosan for the development of restructured product, various concentrations of corn starch (4-9.6%) and chitosan (0.75-1.81%) were incorporated with the pangasius fish mince based on statistical design. Sensory evaluation revealed that combination of 4% corn flour and 0.75% chitosan was the most acceptable one for the restructured product for pangasius mince.
- An instant fish gravy mix was developed and a patent has been filed. Shelf life evaluation of ready to constitute fish curry from instant fish gravy mix was carried out. The product had a shelf life of 30 days in chilled conditions whereas the control samples had 25 days of shelf life.
- A methodology has been standardized for preparing a value added product from tilapia meat and Jawla shrimp.
- Prepared combination sausages from the mince of Nemipterus and pangasius. The mince combination of Nemipterus and Pangasius was optimized using mixture response surface methodology based on data generated from a simple lattice mixture experimental design on Bio-chemical responses of sausage. Sausages made from combination mince of pangasius and nemipterus had better sensory qualities and shelf life than sausages made from single type of fish mince.

Fish Rolls ***Combination Sausages*** ***Instant Fish Gravy Mix***

5.2 Low temperature preservation characteristics of value added products with emphasis on quality and shelf life.

- The biochemical and sensory evaluation of microwave-blanched and vacuum-packed sutchi catfish fillets showed extended storage life of 21 days, compared with 12 days for unblanched vacuum-packed samples.
- Quality characteristics of Pabda (*Ompok pabda*) fish processed by sous vide technique indicated that both microwave and conventionally heated samples remained in acceptable condition for more than a month under chilled condition.
- Vacuum packing of gutted Pabda fish under iced condition was carried out. Results indicated that samples remained in acceptable condition till 24 days of storage in ice, whereas control samples packed in PE pouches gave less satisfactory results and were rejected after 18 days of storage in ice.
- Ice storage studies of Monosex tilapia was carried out. Whole cleaned samples can be kept under iced conditions for 27 days, steaks developed off flavour after 19 days and gutted & cleaned samples remained acceptable upto 23 days iced conditions.

Catfish fillets ***Gutted pabda fish***

5.3 Changes in the nutritional profile during handling and processing and nutritional labelling of the products.

- Commercial soy flour at a rate of 20 % is used for preparation of fish wafers with pangasius fish mince. Protein content of the soy flour incorporated wafers increased from 33% to 48.5 %.
- Rohu steaks and fillet portions dipped in the mint decoction for 15 minutes (0.5%, 1% and 1.5%) and quality was analysed under chilled condition. The study revealed that 1.5 % of mint decoction was effective in reducing the chemical and microbial spoilage indices.

5.4 Standardization and process optimization of thermal processed products.

- Flash fried Skinless boneless Pangasius fillets canned in TFS cans with refined oil had good textural properties and the water content was less than 10% which is a requirement for canned product.
- Rohu (*L.rohita*) steaks canned in TFS cans in instant curry medium had excellent quality attributes which was retained after six months of storage.

5.5 Modification of flavour/off-flavour of fresh/processed foods by way of treatment with specific flavour scavengers.

- The effect of washing with organic acids and banana leaf ash solution on the removal of muddy flavor of rohu fillets was evaluated based sensory and instrumental methods. There was a marked improvement in flavor and colour of fish treated fillets compared to controls

and the fillets treated with a combination of banana ash and organic acids were found to be more palatable. The colour was significantly improved by washing especially with higher concentration of banana leaf ash.

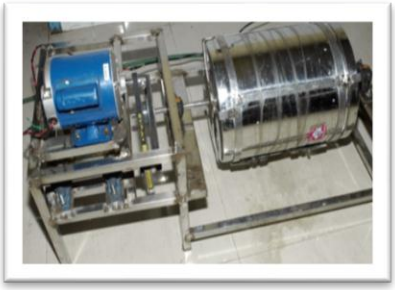
- The effect of spice extracts (Ginger, mint, chilli) on preservation of Pangasius (*Pangasionodon hypophthalmicus*) fillet during chilled storage was evaluated. Results showed that fillet treated with ginger and mint extract (20%) were found to be acceptable up to 15 days than the control for 9 days.
- Rohu steaks and fillet portions dipped in the mint decoction for 15 minutes (0.5%, 1% and 1.5%) and quality was analysed under chilled condition. The study revealed that 1.5 % of mint decoction was effective in reducing the chemical and microbial spoilage indices.
- The effect of spice extracts (Ginger, mint, chilli) on preservation of Pangasius fillet during chilled storage was evaluated. Results showed that fillet treated with ginger and mint extract (20%) were found to be acceptable up to 15 days than the control for 9 days.

5.6 Microbiological changes during preservation and standardisation of processing parameters of freshwater fish and fishery products.

- Studied the microbial profile of *Pangasianodon hypophthalmus* and *Ompok pabda* in chilled and frozen stored conditions and during preservation and processing.
- Studied the microbial profile of the products developed and its changes during preservation.

5.7 Design & development of equipment / machinery for fish processing and value addition

- A prototype of Bench top Fish de-scaling Machine was developed for descaling of fishes. For carps, the de-scaling process requires 10 min at 30 rpm and for tilapia it is 8 min at 25 rpm. A patent has been filed for the design and process.



Fish Descaler

6. Conclusion

Many technologies for value addition of freshwater fish were optimised and fine-tuned so as to make adoptable for a commercial production process. Consultancy offered for the establishment of freshwater fish processing unit in Harike, Punjab is an important outcome. Detailed studies were carried out on the quality, shelf life and value addition prospects of emerging species viz., *P.hypophthalmicus* and other commercially important freshwater species like *Ompok pabda*. This was effectively transferred to production units through brainstorming sessions Seminars, Symposia and Training programmes.

Cochin -29 **(George Ninan)**

30-6-2014 **Principal Investigator**

Annexure 1

Product/ Process/Technology/ IPR/New Models/ Methods/Databases/ Concept/ Tools/Technique /Commercial value of the technology developed

a) Product

Microwave treated catfish fillets.

Sous vide processed Pabda catfish.
Smoked and canned pangasius and rohu steaks.
Restructured products from the mince of pangasius.
Fish rolls
Instant Fish Gravy Mix.
Combination sausages
Fish descaler machine.

b) Process

Processes for production of:
Chilled products from Pangasius, *Ompok pabda*, Tilapia
Restructured products from freshwater fish mince
Canned products from freshwater fishes.

c) Technology

Technologies for:
Value addition of freshwater fish viz., mince based products, chilled products; sous vide products, thermal processed products and restructured products.

d) IPR

Patents filed for:
Instant Fish Gravy Mix
Fish Descaler Machine

e) Databases

Published Research Articles -08
Reports/Manuals - 15
Popular articles - 04
Book chapter - 01
Extension Bulletins - 03
Presentations in Seminars/Workshops/Symposia - 21

Cochin -29 **(George Ninan)**

30-6-2014 **Principal Investigator**

Annexure 2

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

CHECKLIST FOR SUBMISSION OF FINAL RESEARCH PROJECT REPORT (RPP-III)

1. Institute Project Code: **1000661028 [P-90/2011(3)]**
2. Investigators as approved in RPP-I, (If any change attach IRC proceedings):

Principal Investigator	**Co-PI**	**Remarks**
Dr.George Ninan Senior Scientist, FP Division. Stationed at CIFT Head Quarters, Cochin.	Sh.P.K Vijayan, Principal Scientist, FP Division	Stationed at CIFT Head Quarters, Cochin. Retired w.e.f August 2013.
	Dr.A.A Zynudheen, Senior Scientist, FP Division.	Stationed at CIFT Head Quarters, Cochin.
	Dr. J.Bindu, Senior Scientist, FP Division.	Stationed at CIFT Head Quarters, Cochin. Disassociated from project w.e.f April 2013 (Minutes of PME Committee meeting Ref No.F.PMC-MS/2013/EIS dated 19/11/13).
	Dr. Venkateswarlu Ronda, Scientist, FP Division.	Stationed at CIFT Head Quarters, Cochin. On study leave from February 2012 to July 2013.
	Dr. Binsi P.K, Scientist, FP Division.	Transferred to Mumbai Research Centre of CIFT w.e.f 2012 April.
	Ms. Tanuja S, Scientist, FP Division.	Transferred to DRWA, Bhubaneswar w.e.f September 2011.Disassociated from Project.
	Ms. Viji P, Scientist	Stationed at Mumbai Research Centre of CIFT. Associated with the project w.e.f December 2012 (Ref Note No.F.PMC-MS/2013/EIS dated 09/01/13)
	Dr. K.V Lalitha, Principal Scientist & Head, MFB Division	Stationed at CIFT Head Quarters, Cochin.
	Dr. Suseela Mathew, Principal Scientist ,B & N Division	Stationed at CIFT Head Quarters, Cochin. Disassociated from project (Ref Note No.F.PMC-MS/2012/EIS dated 21/9/12)
	Dr. Jeyakumari A, Scientist, FP Division.	Stationed at CIFT Head Quarters, Cochin. Associated with the project w.e.f September 2012 (Ref Note No.F.PMC-MS/2013/EIS dated 09/01/13)
	Sh.Joshy C.G, Scientist, FP Division.	Stationed at CIFT Head Quarters, Cochin. Associated with the project w.e.f September 2011.
	Smt. Parvathy U, Scientist, FP Division.	Stationed at CIFT Head Quarters, Cochin. Associated with the project w.e.f August 2013 (Minutes of PME Committee

		meeting Ref No.F.PMC-MS/2013/EIS dated 19/11/13)
	Smt.Laly S.J, Scientist, QAM Division.	Stationed at CIFT Head Quarters, Cochin. Associated with the project w.e.f August 2013(Minutes of PME Committee meeting Ref No.F.PMC-MS/2013/EIS dated 19/11/13)
	Sh.Ankur Nagori, Scientist, Engineering Division.	Stationed at CIFT Head Quarters, Cochin Associated with the project (Ref Note No.F.PMC-MS/2012/EIS dated 21/9/12)
	Dr.S. Vishnuvinayagam, Scientist	Stationed at Mumbai Research Centre of CIFT. Associated with the project w.e.f September 2012 (Ref Note No.F.PMC-MS/2013/EIS dated 09/01/13)

3. Any change in objectives and activities ~~Yes~~/**No**

(If yes, attach IRC proceedings)

4.	Date of Start & Date of Completion (Actual). If any extension granted enclose IRC proceedings		~~Yes~~	**No**
5.	Whether all objectives met		**Yes**	~~No~~
6.	All activities completed		**Yes**	~~No~~
7.	Salient achievements/major recommendations included		**Yes**	~~No~~
8.	Annual Progress Reports (RPP-II) submitted	1st Year √	**Yes**	~~No~~
		2nd Year √	**Yes**	~~No~~
		3rd Year	~~Yes~~	~~No~~
		nth year	~~Yes~~	~~No~~
9.	Reprint of each of publication attached		**Yes**	~~No~~
10.	Action for further pursuit of obtained results indicated		**Yes**	~~No~~
11.	Report presented in Divisional seminar (enclose proceedings & action taken report)		**Yes**	~~No~~
12.	Report presented in Institute seminar (enclose proceedings & action taken report)		**Yes**	~~No~~
13.	IRC number in which the project was adopted		IRC No: Note No.F. PAC-MS/2011/ EIS dated 28-2-2011	
14.	Any other Information			

15. **Signature**:

Dr.George Ninan (PI)

Sh.P.K Vijayan (Co PI)

Dr. A.A Zynudheen(Co PI)

Dr. J.Bindu (Co PI)

Dr.Venkateswarlu Ronda(Co PI)

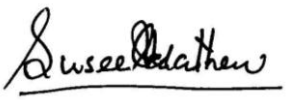
Dr. Binsi P.K (Co PI)

Dr. Jeyakumari A(Co PI)

Ms. Tanuja S (Co PI)

Ms. Viji P (Co PI)

Dr. K.V Lalitha(Co PI)

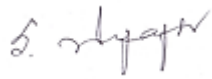


Dr. Suseela Mathew(Co PI)

Sh.Ankur Nagori(Co PI)

Sh.Joshy C.G (Co PI)

Smt. Parvathy U(Co PI)



Dr.S. Vishnuvinayagam(Co PI)

Smt.Laly S.J(Co PI)

HOD/PD/I/c.

Annexure 3

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

FINAL RESEARCH PROJECT REPORT (RPP- III)

PROJECT REPORT (RPP- III)

1. **Institute Project Code** : 1000661028 [P-90/2011(3)]
2. **Project Title:** *Species specific interventions in value addition of commercially important and emerging species of fresh water fish***.**
3. **Key Words**: *Freshwater fish, emerging species, process optimization, value addition***.**
4. (a) Name of the Lead Institute : Central Institute of Fisheries Technology , Cochin

   (b) Name of Division/ Regional Centre / Section: Fish Processing Division
5. (a) Name of the Collaborating Institute(s) NA

   (b) Name of Division/ Regional Centre / Section of Collaborating Institute(s)
6. **Project Team**(Name(s) and designation of PI, CC-PI and all project Co-PIs, with time spent)

S. No.	Name, designation and institute	Status in the project (PI/CC-PI/ Co-PI)	Time spent (%)	Work components assigned to individual scientist
01.	Dr.George Ninan, Senior scientist,CIFT	PI	50%	1.Preparation and process optimization of value added products from commercially important freshwater fishes and other emerging species. 2.Low temperature preservation characteristics of value added products with emphasis on quality and shelf life.
02.	Sh.P.K Vijayan	Co-PI	50%	1.Standardization and process optimization of thermal processed products.
03	Dr. A.A Zynudheen	Co-PI	25%	1.Preparation and process optimization of value added products from commercially important freshwater fishes and other emerging species. 2.Low temperature preservation characteristics of value added products with emphasis on quality and shelf life.
04	Dr. J.Bindu	Co-PI	25%	1.Standardization and process optimization of thermal processed products.
05	Dr. Venkateswarlu Ronda	Co-PI	25%	1.Changes in the nutritional profile during handling and processing and nutritional labelling of the products.

06	Dr. Binsi P.K	Co-PI	25%	1.Low temperature preservation characteristics of value added products with emphasis on quality and shelf life.
07	Ms. Tanuja S	Co-PI	25%	1.Preparation and process optimization of value added products from commercially important freshwater fishes and other emerging species. 2.Changes in the nutritional profile during handling and processing and nutritional labelling of the products.
08	Ms. Viji P	Co-PI	25%	1.Shelf life enhancement of products made from commercially important freshwater fish from Maharashtra region using natural preservatives.
09	Dr. K.V Lalitha	Co-PI	25%	1.Microbiological changes during preservation and standardisation of processing parameters of freshwater fish and fishery products.
10	Dr. Suseela Mathew	Co-PI	25%	Changes in the nutritional profile during handling and processing and nutritional labelling of the products.
11	Dr.. Jeyakumari A	Co-PI	25%	1.Preparation of restructured products using freshwater fish mince. 2.Evaluation of antioxidant properties of selected spices and its effect on preservation of freshwater fish production.
12	Sh.Joshy C.G	Co-PI	25%	1.Planning and execution of design of experiments and data analysis. 2.Product/Process parameter optimisation using Linear/ Non-linear modelling techniques.
13	Smt. Parvathy U,	Co-PI	25%	1.Low temperature preservation characteristics of value added products with emphasis on quality and shelf life.
14	Smt.Laly S.J	Co-PI	25%	1.Changes in the nutritional profile during handling and processing and nutritional labelling of the products.

15	Sh.Ankur Nagori	Co-PI	25%	1.Design & development of equipment / machinery for fish processing and value addition.
16	Dr.S. Vishnuvinayagam	Co-PI	25%	1.Microbiological changes during preservation and standardisation of processing parameters of freshwater fish from Maharashtra region.

7. Priority Area : Applied Research

8. Project Duration: Date of Start :01.4.2011 Date of Completion : 31.3.2014

9. a. *Objectives*

- Preparation and process optimization of value added products from commercially important freshwater fishes and other emerging species.
- Low temperature preservation characteristics of value added products with emphasis on quality and shelf life.
- Changes in the nutritional profile during handling and processing and nutritional labelling of the products.
- Standardization and process optimization of thermal processed products.
- Modification of flavour/off-flavour of fresh/processed fish products by way of treatment with specific flavour scavengers.
- Microbiological changes during preservation and standardisation of processing parameters of freshwater fish and fishery products.
- Design & development of equipment / machinery for fish processing and value addition

b. *Practical utility*

- Better utilization of fresh water fish
- Customized product development technologies
- Standardization of technologies for the production of value added safe products from freshwater fish.
- Better preservation technologies to minimize the quality loss during the movement of the fish and fishery products through the value chain.

10. Final Report on the Project (Materials and methods used, results and discussion, objective wise achievements and conclusions) : **Given as Annexure A**

11. Financial Implications (` in Lakhs)

11.1 Expenditure on		Rs. (in lakhs)
(a)	Manpower	117.91
(b)	Research/Recurring Contingencies	15.25
(c)	Non-Recurring Cost (Including cost of equipment)	145.00
(d)	Any Other Expenditure Incurred	--
11.2 Total Expenditure		**278.16**

12. Cumulative Output

a. Special attainments/innovations

1. A study on the partial replacement of fish meat in fish cutlet by soy protein was carried out. It was observed that the product with a combination of 70% rohu meat and 30% soy had better acceptability, textural parameters and storage stability than the conventional fish cutlet.
2. Fish rolls were prepared from the frame meat of Rohu (*L.rohita*).Flash fried rolls had a shelf life of 17 days in chilled condition.
3. An intermediate moisture product from Pangasius (*Pangasionodon hypophthalmicus*) fillet prepared by a combination of pH modification (potassium sorbate and citric acid), controlled microwave heating and drying technique remained in acceptable condition for more than 45 days in chilled condition.
4. The biochemical and sensory evaluation of microwave-blanched and vacuum-packed sutchi catfish fillets showed extended storage life of 21 days, compared with 12 days for unblanched vacuum-packed samples.
5. The effect of spice extracts (Ginger, mint, chilli) on preservation of Pangasius (*Pangasionodon hypophthalmicus*) fillet during chilled storage was evaluated. Results showed that fillet treated with ginger and mint extract (20%) were found to be acceptable up to 15 days than the control for 9 days.
6. Quality characteristics of Pabda (*Ompok pabda*) fish processed by sous vide technique indicated that both microwave and conventionally heated samples remained in acceptable condition for more than a month under chilled condition.
7. Vacuum packing of gutted Pabda fish under iced condition was carried out. Results indicated that samples remained in acceptable condition till 24 days of storage in ice, whereas control samples packed in PE pouches gave less satisfactory results and were rejected after 18 days of storage in ice.
8. Flash fried Skinless boneless Pangasius fillets canned in TFS cans with refined oil had good textural properties and the water content was less than 10% which is a requirement for canned product.
9. Rohu (*L.rohita*) steaks canned in TFS cans in instant curry medium had excellent quality attributes which was retained after six months of storage.
10. An instant fish gravy mix was developed and a patent has been filed. Shelf life evaluation of ready to constitute fish curry from instant fish gravy mix was carried out. The product had a shelf life of 30 days in chilled conditions whereas the control samples had 25 days of shelf life.
11. Commercial soy flour at a rate of 20 % is used for preparation of fish wafers with pangasius fish mince. Protein content of the soy flour incorporated wafers increased from 33% to 48.5 %.
12. Gelation characteristics of surimi from *Pangasionodon hypophthalmus* as affected by microwave heating were evaluated. The nature of the gel network formed during heating was evaluated based on solubility profile of the heat induced gel in distilled water, high ionic strength buffer, TCA and SDS buffer. The results indicated significant reduction in solubility values of heat induced gel subjected for 60 and 90 sec durations, whereas the gel heated for 30 sec showed higher solubility values similar to unheated sol.
13. Standardized the ingredients for the development of restructured products from pangasius fish mince. In order to find out the suitable concentration of starch, chitosan for the development of restructured product, various concentrations of corn starch (4-9.6%) and chitosan (0.75-1.81%) were incorporated with the pangasius fish mince based on statistical design. Sensory evaluation revealed that combination of 4% corn flour and 0.75% chitosan was the most acceptable one for the restructured product for pangasius mince.
14. Ice storage studies of Monosex tilapia was carried out. Whole cleaned samples can be kept under iced conditions for 27 days, steaks developed off flavour after 19 days and gutted & cleaned samples remained acceptable upto 23 days iced conditions.
15. Prepared combination sausages from the mince of Nemipterus and pangasius. The mince combination of Nemipterus and Pangasius was optimized using mixture response surface methodology based on data generated from a simple lattice mixture experimental design on Bio-chemical responses of sausage.

Sausages made from combination mince of pangasius and nemipterus had better sensory qualities and shelf life than sausages made from single type of fish mince.

16. A prototype of Bench top Fish de-scaling Machine was developed for descaling of fishes. For carps, the de-scaling process requires 10 min at 30 rpm and for tilapia it is 8 min at 25 rpm. A patent has been filed for the design and process.

b. List of Publications (one copy each to be submitted if not already submitted)

	Research papers
01	*Effect of chilling on microbiological, biochemical and sensory attributes of whole aquacultured rainbow trout* (*Oncorhynchus mykiss* Walbaum, 1792) (2011) Ninan G, Lalitha KV, Zynudheen A.A, Joseph J, Journal of Aquaculture Research Development S5:001. doi:10.4172/2155-9546.S5-001.
02	*Composition, Functional Properties and Antioxidative Activity of Hydrolysates Prepared from the Frame Meat of Striped Catfish (Pangasianodon hypophthalmus)* (2012) Tanuja, S, Viji, P, Zynudheen A.A & Joshy, C.G. Egyptian Journal of Biology, Vol. 14, pp 27-35.
03	*Microbiological and shelf life characteristics of eviscerated and vacuum packed freshwater catfish (Ompok pabda) during chill storage* (2013). Binsi, P. K. Viji, P. Visnuvinayagam, S. George Ninan, Sangeeta, G. Triveni A.& Ravishankar C. N. Journal of Food Science and Technology. DOI 10.1007/s13197-013-1165-x.
04	*Compositional and chill storage characteristics of microwave blanched sutchi catfish (Pangasianodon hypophthalmus) fillets* (2014). Binsi, P. K George Ninan, Zynudheen, A. A. Neethu, R. Ronda V. & Ravishankar C. N. International Journal of Food Science and Technology,49, pp 364-372.
05	*Composition, Textural Quality and Gel Strength of Surimi Prepared from Striped Cat Fish (Pangasianodon hypophthalmus, Souvage, 1878)***(**2014) Tanuja, S. Viji, P. Zynudheen, A. A. George Ninan & Joshy C. G. (2014).Fishery Technology, Vol. 51(2), April 2014.
06	*Biochemical, textural, microbiological and sensory attributes of gutted and ungutted sutchi catfish (Pangasianodon hypophthalmus) stored in ice* (2014) Viji, P. Tanuja, S. George Ninan, Lalitha, K. V. Zynudheen, A. A. Binsi P. K & Srinivasa Gopal T. K. Journal of Food Science and Technology. DOI 10.1007/s13197-014-1358-y.
07	*Quality Characteristics and Shelf Life of Sutchi Cat Fish (Pangasianodon hypophthalmus) Steaks During Refrigerated Storage* (2014) Viji, P. Tanuja, S. George Ninan, Zynudheen, A. A. Lalitha, K. V. International Journal of Agriculture and Food Science Technology. Vol592), pp. 105-116.
	Reports/Manuals
01.	*Fish descaling machine*. ICAR News. October – December 2012, p19.
02.	*Practical Manual – Coated products (BPVI-043)* for Diploma in Fish Products Technology (IGNOU) George Ninan. ISBN 978-81-266-5196-2, 74p.
03	*Practical Manual – Block 1 Battering & Breading – Coated products* (BPVI-043**)** for Diploma in Fish Products Technology (IGNOU) by George Ninan ISBN 978-81-266-4480-3, 49p.
04	*Microwave blanching and quick chilling of fish for shelf life extension***.**(2013) Binsi P.K, George Ninan, Vishnuvanayagam S, Viji,P & Chakrabarti R.(2013) Fish Technology Newsletter Vol XXIV(1), pp 04- 05.
05	*Preparation of restructured products from Pangasius hypophthalmus*.(2013) Jeyakumari A, George Ninan, Zynudheen A.A & Ravishankar C.N Fish Technology Newsletter Vol XXIV(2), pp 03- 04.
06	*Quality evaluation of Monosex tilapia during ice storage*. (2013) Parvathy U, George Ninan, Jeyakumari A, Zynudheen A. A. & Ravishankar C. N. Fish Technology Newsletter, Vol XXIV (4), pp 4-5.
07	*Jawala shrimp and tilapia: Potential candidates for seafood analogues*.2013) Viji P, Binsi P.K & George Ninan. Fish Technology Newsletter, Vol XXIV (4), pp 6-7.
08	*Value added fishery products* (2013) George Ninan .Manual on Collaborative training programme on value addition and secondary agriculture with special reference to fish & fishery products (21-24

	October 2013), CIFT, Cochin & MANGE Hyderabad. pp 45-54.
09	*Mince based products from fish* (2013). George Ninan. Manual on National training on Non thermal and non-chemical processing technologies: Application of High Pressure and Pulsed light technology for food processing (18-31 October 2013). CIFT, Cochin. pp 08-20.
10	*Detailed project Report on "Establishment of a Freshwater Fish Processing Unit at Harike, Punjab (2013).*
11.	*Detailed Project Report on Trout Processing Unit at Patlikuhal, Himachal Pradesh (2011).*
12.	*Technical Feasibility Project Report for Fish Processing and Fish Snack Bar for Poyya Eco - Fishing Village, ADAK, Thrissur, Kerala (2011).*
13.	*Detailed Project Report on Freshwater Fish Processing Plant, Feed mill and Silage unit at Lanja, Ratnagiri, Maharashtra (2012).*
14.	*Detailed Project Report on Production of fish based value added products, Jai Gayatri Exports, Veraval, Gujarat. (2013)*
15.	*Detailed Project Report on Assessment of technical feasibility of the project report of Fish & Prawn Processing Unit by M/s Real spice at A.P (2013).*
Popular articles	
01	*Value addition options for aquaculture species* (2012) Zynudheen, A. A and George Ninan Jaladhi, pp 17-25.
02	*Potential and Future Prospects for the Processing and Export of Major carps* (2012) Srinivasa Gopal T.K, Mohan C.O, George Ninan & Ravishankar C.N Fishing Chimes, 32(1) pp 60-65.
03	*Processing & value addition of P.hypophtalmichthys* (2012)George Ninan, Zynudheen A.A ,Viji P, Madhusoodana Rao V and Ravishankar C.N, Jaladhi , pp 59-65.
04	*Extrusion technology in developing ready to eat fish based snacks* (2013) Viji P, Binsi P.K. and Visnuvinayagam S. Beverages & Food world. 40 (11).
Books/Book Chapters	
01	*Coated Products Chapter 11 (2012)* George Ninan in Advances in Harvest and Post-Harvest Technology of Fish (Nambudiri D.D & Peter K.V Eds.), New India Publishing Agency, New Delhi, pp 265-305.
Extension Bulletins	
01	*Pangasius – an ideal candidate for value addition* (2012) George Ninan ,Zynudheen A.A, Viji P ,CIFT Publication (Booklet)
02	*Instant Fish Gravy Powder* (2013) Zynudheen A.A & George Ninan ,CIFT Publication (Booklet)
03	*Fish Descaling Machine* (2013) Zynudheen A.A & George Ninan ,CIFT Publication (Booklet)

c. Intellectual Property Generation

Patents filed	
01	*Design and process of a Fish de-scaling Machine* Zynudheen. A.A., C. R. Gokulan., George Ninan and C.N. Ravishankar (Reg.No.2828/CHE/2012) dt.12.07.12.
02	*Instant fish gravy powder*. Zynudheen. A.A., George Ninan and C.N. Ravishankar (Reg.No.2829/CHE/2012) dt. 12.07.12.

d. Presentation in Workshop/Seminars/Symposia/Conferences (Relevant to the project in which scientists have participated)

Presentations in Workshops /Conferences

1.	*Recent advances in in aquaculture product development and new value added products for domestic and International markets* –Chennai Aquaculture Technology Meet 2011 organized by TANUVAS at Chennai (17-11-2011). George Ninan - Invited paper
2.	*Simple and economic process technologies for value addition in Fisheries Sector- Food 360 ^{0}* - International Conference cum exhibition on Agribusiness & Food Processing at Hyderabad organized by FICCI & Government of Andhra Pradesh (22-11-2011). George Ninan - *Invited paper*
3.	*Small scale fish processing machinery for value added products* (2012). George Ninan, Zynudheen A.A, Ravishankar C.N & T.K.Srinivasa Gopal National Conference on research, production & marketing of value added fish products – present status and future direction at CFTRI Mysore.(Proceedings pp 92-97)
4.	*Role of Business Incubation in Entrepreneurship Development* (2012) Ravishankar C.N, Zynudheen A.A, George Ninan, & T.K.Srinivasa Gopal National Conference on research, production & marketing of value added fish products – present status and future direction at CFTRI Mysore, (Proceedings pp 75-79).
5.	*Advances in Aquaculture Product Development & Business Options for Small Scale Entrepreneurs*(2013) T.K.Srinivasa Gopal, George Ninan & C.N Ravishankar.PAF Congress on Public Private Partnership in Aquaculture and Culture based Fisheries at CIFRI, Barrackpore (09- 11 February).- *Invited paper.*
6.	*Post-harvest technologies for value addition in Aquaculture* (2013). George Ninan, Zynudheen A.A & C.N Ravishankar National Workshop on Business Opportunities in Freshwater Fisheries at Patna, Bihar (Proceedings pp 27-35.)
7.	*Options for utilization of freshwater fish processing waste* (2013). Zynudheen A.A, George Ninan & C.N Ravishankar National Workshop on Business Opportunities in Freshwater Fisheries at Patna, Bihar (Proceedings pp 36-41).
8.	*Biochemical and sensory evaluation of Rainbow Trout (O.mykiss Walbaum) in chilled and frozen storage conditions (*2012). George Ninan, Zynudheen A.A , Lalitha K.V, Ravishankar C.N, Srinivasa Gopal T.K., National Seminar on Mountain Fisheries at DCFR, Nainital, (5-6 November 2012).
9.	*Hygienic handling and value addition options for rainbow trout (O.mykiss Walbaum)* (2012). George Ninan, Zynudheen A.A, Vijayan P.K, Ravishankar C.N, Srinivasa Gopal T. K. National Seminar on Mountain Fisheries at DCFR, Nainital, (5-6 November 2012).
10.	*Quality evaluation of rainbow trout (O.mykiss Walbaum) in chilled storage* (2012). George Ninan, Lalitha K.V, Sankar T.V, Zynudheen A.A, Ravishankar C.N, Srinivasa Gopal T.K (2012) National Seminar on Mountain Fisheries at DCFR, Nainital, (5-6 November 2012).
11.	*Utilisation of Deccan Mahseer Tor khudree (Sykes) for development of convenience products* (2012).Bindu J. George Ninan, Dinesh, K, Ravishankar C.N., and Gopal T.K.S. National Seminar on Mountain Fisheries at DCFR, Nainital, (5-6 November 2012).
12.	*Facts and benefits behind washing fish with banana leaf ash: An Indigenous Practice of Indian households* (2012) P.K. Binsi, George Ninan, S.Visnuvinayagam and Zynudheen A.A. National Seminar on Traditional Knowledge & Management Systems in Fisheries at CIFT, Cochin (30-31 October 2012)
13.	*Effect of turmeric and cold smoking on the biochemical, textural and sensory attributes of sutchi catfish fillet during chill storage* (2013) Viji, P., Tanuja, S. George Ninan, Binsi, P. K .Zynudheen, A.A. and Sreenivasa Gopal, T.K. international Symposium on Greening Fisheries – Towards Green Technologies in Fisheries (21-23 May 2013)
14.	*Standardisation and quality evaluation of fish roll prepared from frame meat of rohu (L.rohita) stored under chilled conditions* (2013) Zynudheen A.A., George Ninan, Sumayya Kalam, Joshy C.G and Ravishankar C.N international Symposium on Greening Fisheries – Towards Green Technologies in Fisheries (21-23 May 2013)
15.	*Effect of turmeric and cold smoking on the biochemical , textural and sensory attributes of striped catfish fillet during chill storage* (2013) Viji P, Tanuja S, George Ninan, Binsi P.K and Zynudheen A.A. international Symposium on Greening Fisheries – Towards Green Technologies in Fisheries (21-23 May 2013).
16.	*Development and quality evaluation of a canned product from rohu (L.rohita) steaks in instant curry medium* (2013) Vijayan P.K, Bibin K, George Ninan and Zynudheen A.A. international Symposium on Greening Fisheries – Towards Green Technologies in Fisheries (21-23 May 2013).

17.	*Development striped catfish steaks canned in oil medium* (2013) Nimisha V.Satheesh, Stepahnie Listel, Vijayan P.K, and George Ninan. International Symposium on Greening Fisheries – Towards Green Technologies in Fisheries (21-23 May 2013).
18.	*Effect of chitosan on the quality of restructured products from pangasius fish mince during chilled storage* (2013) A.Jeyakumari, George Ninan, A.A.Zynudheen, K.V.Lalitha and C.N.Ravishankar, 2013. National Seminar on Therapeutics of marine bioactive compounds held on 9-10 December 2013, Gandhigram Rural Institute, Dindigul. Abstracts p-37.
19.	*Processing &value addition of fish* (2014) – *Lead paper* presented by Dr. George Ninan at the First national Student Conference on food Technology organized by Indian Institute of Crop processing Technology, Thanjavur (7-8 February 2014).
20.	*Advances in chilled/frozen and value added fish products* (2014) *Invited talk* by Dr.George Ninan at VALUE FISH 2014 ,the National Conference on Emerging Safety & technological issues in Seafood industry jointly organized by CIFT, CFTRI and NFDB at Veraval, Gujarat (14-15 March 2014)
21.	*Quality Characteristics and Shelf Life of Sutchi Cat Fish (Pangasianodon hypophthalmus) Steaks During Refrigerated Storage* (2014) Viji, P. Tanuja, S. George Ninan, Zynudheen, A. A. Lalitha, K. V. International congress on "Agriculture, Food Engineering and Environmental Sciences- Sustainable Approaches-AFEESSA-2014, New Delhi (29-30th march 2014).

e. ***Details of technology developed***

Consultancy

1. Freshwater fish processing unit at Harike, Punjab.
2. Trout Processing Unit at Patlikuhal, Himachal Pradesh.
3. Production of fish based value added products, Jai Gayatri Exports, Veraval, Gujarat.
4. Freshwater Fish Processing Plant, Feed mill and Silage unit at Lanja, Ratnagiri, Maharashtra. - Assessment of technical feasibility of the project report of Fish & Prawn Processing Unit by M/s Real spice, A.P.

f. ***Trainings/demonstrations organized***

1. Training on preparation of fresh fish products-Preparation of dressed fish, fish steaks, fish fillets and marinated fish products' to 10 trainees from KITCO, Cochin (09-05-2011).
2. A demonstration was given (04-02-12) on the production of value added products from Giant fresh water prawn to the farmers under NFDB training programme organized by KUFOS.
3. Conducted training programmes on the production of value added products from freshwater fish from 22-24 March at Uchiwa tribal village, Imphal West district and from 26-28 March at Sekmaijin village, Thoubal district, Manipur.
4. Organized training programme on 'Production of value added fishery products from fresh water fish for employment and income generation' for two batches of entrepreneurs during 26-29, March, 2012 at Dimapur, Nagaland.
5. Organized a training programme on Post-harvest utilization & value addition fresh water fish at Barpetta district, Assam during 27-29 September, 2012.
6. Organized a training programme on Post-harvest utilization & value addition of trout & Carps at DCFR research centre , Chamapawat, Uttarakhand State (8-10 September 2012)
7. Organised two training programmes in Arunachal Pradesh on value added freshwater fish products and fish canning (1-6 November 2012)
8. Organised National Workshop on "Business Opportunities in Freshwater Fisheries at Patna, Bihar (23 March 2013).
9. Conducted a training programme on batter preparation and breading for the production managers from M/s Abad Fisheries (4-5 February 2014).
10. Conducted training programme on "Production of value added fishery products" to ST Fisher folk at Meenkara reservoir site in Palakkad district, Kerala during 28-29th March, 2014.

g. ***Training received***

Dr. Binsi P.K

- Attended a 15 days short training course on 'Synthesis and characterization of nanomaterials and their applications in Agriculture' from 16th to 29th Nov, 2011 at CIRCOT, Mumbai.

Shri Joshy C.G

- Attended one day workshop on 'Internet protocol V6- IPV-6) on 27th February 2014 at NAS Complex New Delhi.

Dr. Jeyakumari A

- Attended 21 days CAFT training programme on Responsible Harvest and Quality Standards for seafood export at CIFE, Mumbai from 09-01-2013 to 29-01-2013
- Attended short course on "Thermal processing of ready to eat meat products" from 09-07-13 to 18-07-13 at NRC on Meat, Hyderabad.
- Attended the training programme on "Data analysis using SAS" from 1-7th February, 2014 at CIFT, Cochin.
- Attended the "Food safety for entrepreneurs awareness and implementation" programme held at CIFT, Cochin during 13-14th February, 2014.
- Attended National training on "Application of high pressure and pulsed light technology for food processing" from 18-31 October, 2013 at CIFT, Cochin.

Smt. Laly S.J

- Attended a workshop on 'Scientific writing' conducted by MBAI (Marine Biological Association of India) and BOBLME (Bay of Bengal Large Marine Ecosystem) project at hotel Travancore court, Cochin (14th to 17th October 2013)
- Attended the training programme on 'HACCP concepts' at CIFT, Cochin (21st to 25th October)
- Attended 'AgrIP 2013', National workshop on ' Role of Intellectual Property rights in the modern era' conducted by ZTM – BPD unit, CIFT, Cochin (15th to 16th November 2013)
- Attended a workshop on 'Scientific Presentation' conducted by Marine Biological Association of India and Bay of Bengal Large Marine Ecosystem project at Beaumont Fern hotel, Cochin (18th to 21st November 2013).

Smt. Parvathy U

- Attended National training on 'Non-thermal and non-chemical processing technologies - Application of high pressure and pulsed light technology for food processing' at CIFT, Cochin from 18th -31st October, 2013.

h. ***Any other relevant information***

13. (a) Extent of achievement of objectives and outputs earmarked as per RPP-I

Objective wise	Activity	Envisaged output of monitorable target(s)	Output achieved	Extent of Achievement (%)
Preparation and process optimization of value added products from commercially important freshwater fishes and other emerging species.	A study on the partial replacement of fish meat in fish cutlet by soy protein was carried out. Fish rolls were prepared from the frame meat of Rohu (*L.rohita*) and shelf life was evaluated. Prepared combination sausages from the mince of Nemipterus and pangasius. The mince combination of Nemipterus and Pangasius was optimized using mixture response surface methodology. Development and standardisation of instant fish gravy mix. A comparative evaluation was carried out on the quality characteristics of *Ompok pabda* processed by sous vide technique employing two different modes of heating. An intermediate moisture containing product from Pangasius catfish fillet was prepared by a combination of pH modification, controlled microwave heating and drying technique. Gelation characteristics of surimi from *Pangasionodon hypophthalmus* affected by microwave heating was evaluated.	Coated products with freshwater fish mince and combination products with cheap alternatives. Standard process for an instant fish gravy mix suitable for local preparations. Product development from less utilised freshwater species.	Fish cutlet with a combination of 70% rohu meat and 30% soy had better acceptability, textural parameters and storage stability than the conventional fish cutlet. Flash fried rolls had a shelf life of 17 days in chilled condition. Sausages made from combination mince of pangasius and nemipterus had better sensory qualities and shelf life than sausages made from single type of fish mince. An instant fish gravy mix was developed and a patent has been filed. The product had a shelf life of 30 days in chilled conditions. Microwave and conventionally heated samples of *Ompok pabda* remained in acceptable condition for more than a month under chilled condition. The biochemical and sensory evaluation of microwave-blanched and vacuum-packed sutchi catfish fillets showed extended storage life of 21 days in chilled condition	100

	Standardized the ingredients for the development of restructured products from pangasius fish mince.	Development of restructured products based on freshwater fish mince	. Combination of 4% corn flour and 0.75% chitosan was the most acceptable one for the restructured product for pangasius mince.	
Low temperature preservation characteristics of value added products with emphasis on quality and shelf life.	Vacuum packaging studies of gutted pabda fish (*Ompok pabda*) under iced condition Studies on the effect of spice extracts on preservation of Pangasius fillet and rohu steaks during chilled storage Ice storage studies of Monosex tilapia.	Protocols for low temperature preservation for freshwater fish based products	Gutted pabda fish remained in acceptable condition till 24 days of storage in ice Pangasius fillets treated with ginger and mint extract (20%) were found to be acceptable up to 15 days in chilled conditions. Mint decoction was found to be effective in reducing the spoilage indices in fillet portions and steaks of rohu Whole cleaned tilapia samples can be kept under iced conditions for 27 days, steaks developed off flavour after 19 days and gutted & cleaned samples remained acceptable upto 23 days iced conditions.	100

Changes in the nutritional profile during handling and processing and nutritional labelling of the products.	Protein enrichment of Pangasius wafers with soy flour. Studies on the nutritional composition of Pangasius products.	Nutritional enrichment and labelling of freshwater fish products	Commercial soy flour at a rate of 20 % is used for preparation of fish wafers with pangasius fish mince. Protein content of the soy flour incorporated wafers increased from 33% to 48.5 %. Studies on Enrichment of Pangasius fish wafers with Sardine oil was carried out. Wafers with 1.5 % oil were found to be acceptable. EPA + DHA content increased from 5 % to 8.5 % by incorporating sardine oil at 1.5 % level.	100
Standardization and process optimization of thermal processed products.	Developing standard protocols for thermal processed products from freshwater fish	Thermal processed products from freshwater fish.	Protocols were developed for canned products viz., a.Pangasius fillets in oil. b.Rohu steaks in instant curry medium. c.Trout steaks in oil.	95
Modification of flavour/off-flavour of fresh/processed foods by way of treatment with specific flavour scavengers.	Process formulation to remove muddy flavour of freshwater fish products.	Freshwater fish products with improved flavour.	Addition of essential oils of clove and curry leaf improved the flavor and extended the shelf life of rohu mince compared to that of control in chilled conditions. Treatment with potassium sorbate & essential oils from clove and curry leaf improved the quality and extended the shelf life of fresh *P. hypophthalmicus* fillets in chilled conditions. The effect of washing with organic acids and banana leaf ash solution on the removal of muddy flavor of rohu fillets was evaluated based sensory and instrumental methods. There was a marked improvement in flavor and colour of fish treated fillets and the fillets treated with a combination of banana ash and organic acids were found to be more palatable. The colour was significantly improved by washing	95

			especially with higher concentration of banana leaf ash.	
Microbiological changes during preservation and standardisation of processing parameters of freshwater fish and fishery products.	Study of the bacterial population in freshwater fish and its changes during processing and preservation.	Microbiology of freshwater fish during preservation and processing for standardisation of process parameters.	Microbial profile studies were carried out on: *P. hypophthalmus* treated plant extracts. Marinated *P. hypophthalmus in* chill storage under air and vacuum packs. Microwave treated P. *hypophthalmus in* chill storage. Monosex tilapia products under chill stored conditions. Chill and frozen stored products of *Ompok pabda* Sterility studies of canned freshwater fishery products. Combination sausages. Restructured fish mince products.	100
Design & development of equipment / machinery for fish processing and value addition	Design & development of Fish de-scaling Machine. Design & development of processing machine for cutting frozen fish mince block/fresh fish	Indigenous, low cost fish processing machinery.	A prototype of Bench top Fish de-scaling Machine was developed for descaling of fishes. A patent has been filed for the design and process. Fabricated a fish block cutting machine.	95

(b) Reasons of shortfall, if any: NIL

14. Efforts made for commercialization/technology transfer

1. The technology of Instant Fish Gravy Mix is commercialised and presently marketed under the name "Swadish".
2. The technology for processing and value addition of freshwater fish has been transferred as consultancy to five entrepreneurs.
3. Patents have been filed for Instant Fish Gravy Mix and Fish Descaling Machine.
4. Training programmes & Business meets have been carried out in various parts of the Country on freshwater fish processing and value addition.
5. Many technologies for value addition of freshwater fish were optimised and fine-tuned so as to make adoptable for a commercial production process. Consultancy offered for the establishment of freshwater fish processing unit in Harike, Punjab is an important outcome.

6. Detailed studies were carried out on the quality, shelf life and value addition prospects of emerging species viz., *P.hypophthalmicus* and other commercially important freshwater species like Ompok pabda. This was effectively transferred to production units through brainstorming sessions and training programmes.

15. (a)How the output is proposed to be utilized?

The output of the Project viz., technologies and processes for better utilisation and value addition of freshwater fish will be utilised for the development of inland fish sector in India, particularly in the field of aquaculture for diversification and value addition.

(b) How it will help in knowledge creation?

The project output has created knowledge inputs in the form of:

- Standard technologies for the production of safe value added and convenience products from freshwater fish.
- Nutritional labelling of value added products.
- Suitable packaging technologies for better preservation and extended shelf life.
- Species specific value added products from freshwater fish catering to different market segments.
- Process patents for value addition technologies.
- Publications viz., Research papers in peer reviewed journals, technical and popular articles, Detailed Project Reports, Seminar / Symposia proceedings etc.
- Training programmes in different parts of India on value addition and better utilisation of freshwater fish.

16. Expected benefits and economic impact(if any)

- Better utilization of fresh water fish.
- Customized product development technologies.
- Standardization of technologies for the production of value added safe products from freshwater fish.
- Better preservation technologies to minimize the quality loss during the movement of the fish and fishery products through the value chain.
- Optimized process technologies for the production of value added products from freshwater fish which can be adopted for domestic and export value chains.
- Better management of the freshwater fishery resources by total utilization.
- Diversification of the fish processing industry.

17. Specify whether the project requires submission of RPP-IV for up scaling of research output.

Yes

18. Future line of research work/other identifiable problems

Future line of research work should be addressing the following problems.

- Value addition technologies for new species introduced in aquaculture.
- Process technologies for development of novel products from aquatic resources.
- Developing predictive models for shelf life evaluation in cold chain systems.
- Optimising energy use in fish post-harvest operations to attain cost effectiveness and reduce carbon footprints.
- Adoption of indigenous fish processing machinery in Fish processing operations.

19. Details on the research data (registers and records) generated out of the project deposited with the institute for future use

Research data generated are consolidated and deposited in the Institute as Consolidated Quarterly Reports. There are twelve consolidated quarterly reports.

20. Signature of PI, CC-PI(s), all Co-PIs

Dr.George Ninan (PI)

Sh.P.K Vijayan (Co PI)

Dr. A.A Zynudheen(Co PI)

Dr. J.Bindu (Co PI)

Dr.Venkateswarlu Ronda(Co PI)

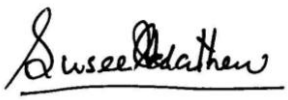
Dr. Binsi P.K (Co PI)

Dr. Jeyakumari A(Co PI)

Ms. Tanuja S (Co PI)

Ms. Viji P (Co PI)

Dr. K.V Lalitha(Co PI)

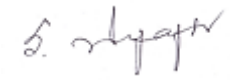


Dr. Suseela Mathew(Co PI)

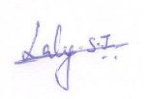
Sh.Ankur Nagori(Co PI)

Sh.Joshy C.G (Co PI)

Smt. Parvathy U(Co PI)



Dr.S. Vishnuvinayagam(Co PI)



Smt.Laly S.J(Co PI)

21. Signature of Head of Division

22. Observations of PME Cell based on Evaluation of Research Project after Completion

23. Signature (with comments if any along with rating of the project in the scale of 1 to 10 on the overall quality of the work) of JD (R)/ Director

Annexure 4

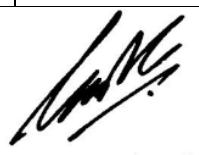
INDIAN COUNCIL OF AGRICULTURAL RESEARCH

PROFORMA FOR RESEARCH PERFORMANCE EVALUATION OF INDIVIDUAL SCIENTIST

1. Institute Project Code ***1000661028 [P-90/2011(3)]**

2. Evaluation by PI on the contribution of the team in the project including self

S. No.	Name	Status in the project (PI/CC-PI/Co-PI)	*Rating in the scale of 1 to 10
01	Dr.George Ninan	PI	8.5
02	Sh.P.K Vijayan	Co-PI	8.5
03	Dr. A.A Zynudheen	Co-PI	8.5
04	Dr. J.Bindu	Co-PI	8.5
05	Dr.Venkateswarlu Ronda	Co-PI	8.5
06	Dr. Binsi P.K	Co-PI	8.5
07	Dr. Jeyakumari A	Co-PI	8.5
08	Ms. Tanuja S	Co-PI	8.5
09	Ms. Viji P	Co-PI	8.5
10	Dr. K.V Lalitha	Co-PI	8.5
11	Dr. Suseela Mathew	Co-PI	8.5
12	Sh.Ankur Nagori	Co-PI	8.5
13	Sh.Joshy C.G	Co-PI	8.5
14	Smt. Parvathy U	Co-PI	8.5
15	Dr.S. Vishnuvinayagam	Co-PI	8.5
16	Smt.Laly S.J	Co-PI	8.5



3. Signature of PI

Annexure 5

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

PROFORMA FOR EVALUATION OF A RESEARCH PROJECT AFTER COMPLETION BY PI

1. Institute Project Code: **1000661028 [P-90/2011(3)]**

2. Evaluation research project after completion by PI

S. No.	Criteria	Methodology	Marks (output)	Self Evaluation by PI
1.	Achievements Against approved and stipulated outputs under project	**Qualitative and quantitative assessment of objectives and stipulated outputs under the project will be carried out** a) Activity Input /Projected Output/ Output Achieved b) Extent to which standard design methodology, experimental designs, test procedures, analytical methods followed c) Does the data justify the conclusions? d) Innovativeness and creating of new knowledge e) Additional outputs over those stipulated under the project f) Creation of linkages for commercialization of technology developed under the project g) Is scientific input commensurate to output (manpower, financial input and time duration)?	**75** 35 10 05 10 05 05 05	 **30** **07** **05** **07** **04** **05** **05**
2.	Publication/ awards	Assessment will be done in respect of: Research papers; Reports/Manuals; Working and Concept Papers; Books/Book Chapters/Bulletins. Quality of publication (s) and Awards /Scientific recognitions received	**10**	**08**
3.	Additional facilities created	Facilities created in terms of laboratory. Research set-up, instrumentation, software, hardware etc. during the project.	**05**	**02**
4.	Human Resource Development (Scientific and Technical)	Scientist trained in different areas	**05**	**02**
5.	Revenue generated under the project/ avenues created for revenue generation	Resources and revenues generated	**05**	**03**
6.	Product/ Process/Technology/ IPR/New	Details to be provided on (**Annexure B**) a) Product b) Process c) Technology	**10**	**07**

	Models/ Methods/Databases/ Concept/ Tools/Technique /commercial value of the technology developed	d) IPR e) Registration of the varieties f) New Models g) Methods h) Tools i) Databases j) Concepts k) Techniques		
7.	Quality of available documents of the project duly authenticated	Research Project Files, Data, Reports etc.	**05**	**05**
Total Marks			**115**	
8.	Timelines of execution of the project	Marks will be deducted if extension sought over the approved project duration beyond recorded and officially granted extension with recorded reasons	Marks to be deducted	
		Up to 5%	01	
		Up to 10%	02	
		Up to 30 %	03	
		Beyond 30 %	05	
Net Score: Score obtained to be counted out of 100 to compensate for activities not relevant to the project			**100**	**90**

3. Signature of PI

Annexure 6

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

PROFORMA FOR EVALUATION OF A RESEARCH PROJECT AFTER COMPLETION BY EVALUATION COMMITTEE

1. Institute Project Code: **1000661028 [P-90/2011(3)]**

2. Evaluation research project after completion by Evaluation Committee

S. No.	Criteria	Methodology	Marks (output)	Evaluation by Evaluation Committee
1.	Achievements Against approved and stipulated outputs under project	**Qualitative and quantitative assessment of objectives and stipulated outputs under the project will be carried out** a) Activity Input /Projected Output/ Output Achieved b) Extent to which standard design methodology, experimental designs, test procedures, analytical methods followed c) Does the data justify the conclusions? d) Innovativeness and creating of new knowledge e) Additional outputs over those stipulated under the project f) Creation of linkages for commercialization of technology developed under the project g) Is scientific input commensurate to output (manpower, Financial input and time duration)?	**75** 35 10 05 10 05 05 05	
2.	Publication/ awards	Assessment will be done in respect of: Research papers; Reports/Manuals; Working and Concept Papers; Books/Book Chapters/Bulletins. Quality of publication (s) and Awards /Scientific recognitions received	**10**	
3.	Additional facilities created	Facilities created in terms of laboratory. Research set-up, instrumentation, software, hardware etc. during the project.	**05**	
4.	Human Resource Development (Scientific and Technical)	Scientist trained in different areas	**05**	
5.	Revenue generated under the project/ avenues created for revenue generation	Resources and revenues generated	**05**	
6.	Product/ Process/Technology/ IPR/New Models/	Details to be provided on a) Product b) Process c) Technology	**10**	

<table>
<tr><td></td><td>Methods/Databases/ / Concept/ Tools/Technique /commercial value of the technology developed</td><td>d) IPR
e) Registration of the varieties
f) New Models
g) Methods
h) Tools
i) Databases
j) Concepts
k) Techniques</td><td></td><td></td></tr>
<tr><td>7.</td><td>Quality of available documents of the project duly authenticated</td><td>Research Project Files, Data, Reports etc.</td><td>05</td><td></td></tr>
<tr><td colspan="3">Total Marks</td><td>115</td><td></td></tr>
<tr><td>8.</td><td>Timelines of execution of the project</td><td><table><tr><td>Marks will be deducted if extension sought over the approved project duration beyond recorded and officially granted extension with recorded reasons</td><td>Marks to be deducted</td></tr><tr><td>Up to 5%</td><td>01</td></tr><tr><td>Up to 10%</td><td>02</td></tr><tr><td>Up to 30 %</td><td>03</td></tr><tr><td>Beyond 30 %</td><td>05</td></tr></table></td><td></td><td></td></tr>
<tr><td colspan="3">Net Score: Score obtained to be counted out of 100 to compensate for activities not relevant to the project</td><td>100</td><td></td></tr>
</table>

4. Signature of Evaluation Committee

Annexure 7

GUIDELINES FOR FILLING - CHECKLIST FOR SUBMISSION OF FINAL RESEARCH PROJECT REPORT- (RPP-III)

1. Institute Project Code: **1000661028 [P-90/2011(3)]**
2. Investigators as approved in RPP-I, If any change attach IRC proceedings: (Self Explanatory)

Name	Status in the project (PI/CC-PI/Co-PI)	Name	Status in the project (PI/CC-PI/Co-PI)
Dr.George Ninan	PI	Sh.P.K Vijayan	Co-PI
Dr. A.A Zynudheen	Co-PI	Dr. J.Bindu	Co-PI
Dr.Venkateswarlu Ronda	Co-PI	Dr. Jeyakumari A	Co-PI
Dr. Binsi P.K	Co-PI	Ms. Tanuja S	Co-PI
Ms. Viji P	Co-PI	Dr. K.V Lalitha	Co-PI
Dr. Suseela Mathew	Co-PI	Sh.Ankur Nagori	Co-PI
Sh.Joshy C.G	Co-PI	Smt. Parvathy U	Co-PI
Dr.S. Vishnuvinayagam	Co-PI	Smt.Laly S.J	Co-PI

3. Any change in objectives and activities ~~Yes~~/**No**
(If yes, attach IRC proceedings) (Self Explanatory)

1.	Date of Start & Date of Completion (Actual). If any extension granted enclose IRC proceedings		~~Yes~~	No
2.	Whether all objectives met		**Yes**	~~No~~
3.	All activities completed		**Yes**	~~No~~
4.	Salient achievements/major recommendations included		**Yes**	~~No~~
5.	Annual Progress Reports (RPP-II) submitted	1st Year	**Yes**	~~No~~
		2nd Year	**Yes**	~~No~~
		3rd Year	~~Yes~~	~~No~~
		nth year	~~Yes~~	~~No~~
6.	Reprint of each of publication attached		**Yes**	~~No~~
7.	Action for further pursuit of obtained results indicated		**Yes**	~~No~~
8.	Report presented in Divisional seminar (enclose proceedings & action taken report)		~~Yes~~	No

9.	Report presented in Institute seminar (enclose proceedings & action taken report)	Yes	~~No~~
10.	IRC number in which the project was adopted	IRC No:	
11.	Any other Information		

4. Signature

Dr.George Ninan (PI)

Sh.P.K Vijayan (Co PI)

Dr. A.A Zynudheen(Co PI)

Dr. J.Bindu (Co PI)

Dr.Venkateswarlu Ronda(Co PI)

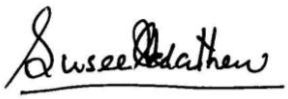
Dr. Binsi P.K (Co PI)

Dr. Jeyakumari A(Co PI)

Ms. Tanuja S (Co PI)

Ms. Viji P (Co PI)

Dr. K.V Lalitha(Co PI)

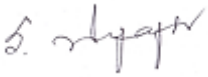


Dr. Suseela Mathew(Co PI)

Sh.Ankur Nagori(Co PI)

Sh.Joshy C.G (Co PI)

Smt. Parvathy U(Co PI)



Dr.S. Vishnuvinayagam(Co PI)

Smt.Laly S.J(Co PI)

HOD/PD/I/c.

Annexure 8 - Publications

Published Research Articles - Abstracts

Reports / Manuals

Popular articles

Book chapter

Extension bulletins

Seminars /Symposia/Workshops -Abstracts

ISSN: 2155-9546. J Aquac Res Development 2011, S5 http://dx.doi.org/10.4172/2155-9546.S5-001

Effect of Chilling on Microbiological, Biochemical and Sensory Attributes of Whole Aquacultured Rainbow Trout (*Oncorhynchus mykiss* Walbaum, 1792)

George Ninan*, Lalitha K.V, Zynudheen A.A and Jose Joseph
Central Institute of Fisheries Technology (ICAR), Kochi 682 029, India

Abstract

The effect of chilling (0-2ºC) on the quality deterioration of whole ungutted aquacultured rainbow trout (*Oncorhynchus mykiss*, Walbaum,1792) was studied by integrated evaluations of microbiological, biochemical, and sensory attributes. The counts of aerobic mesophilic, psychrotrophic bacteria and *Pseudomonas* increased exponentially. An initial lag phase was noticed for H2S producing bacteria, *Aeromonas* and Enterobacteriaceae. Presence of pathogens such as *Aeromonas hydrophila* and *A. sobria* are of concern in the case of delay in icing or temperature abuse during storage. The pH values increased from an initial value of 6.74 to 7.13. PV showed fluctuations. Of the chemical indicators of spoilage, Thiobarbituric acid (TBA) values increased very slowly reaching final value of 16.56 µg MA g-1. Total Volatile Base Nitrogen (TVB-N) values exceeded 27. 87 mg N 100 g-1 on day 14 when the psychrotrophic counts exceeded 107 cfu g-1 indicating that this value may be useful as a measure of degree of freshness for whole ungutted rainbow trout. Based on the TVB-N and microbiological limits, the shelf life of trout at 0-2˚C was 9-12 days.

Keywords: Rainbow trout; Chilled storage; Spoilage bacteria, H2S producing bacteria; Volatile bases; Quality; Shelf life

*Corresponding author: George Ninan, Senior Scientist, Fish Processing Division, Central Institute of Fisheries Technology (ICAR), Kochi 682 029, India, E-mail: george66jiji@rediffmail.com
Received June 24, 2011; Accepted October 18, 2011; Published November 08, 2011

Citation: Ninan G, Lalitha KV, Zynudheen AA, Joseph J (2011) Effect of Chilling on Microbiological, Biochemical and Sensory Attributes of Whole Aquacultured Rainbow Trout (*Oncorhynchus mykiss* Walbaum, 1792). J Aquac Res Development S5:001. doi:10.4172/2155-9546.S5-001

Egyptian Journal of Biology, 2012, Vol. 14, pp 27-35
© Printed in Egypt.
http://dx.doi.org/10.4314/ejb.v14i1.3
Egyptian British Biological Society (EBB Soc)

Composition, functional properties and antioxidative activity of hydrolysates prepared from the frame meat of Striped catfish (*Pangasianodon hypophthalmus*)

*S. Tanuja [*1,2], P. Viji [1], A.A. Zynudheen [1] & C.G. Joshy [1]*

1 *Fish Processing Division, Central Institute of Fisheries Technology, Matsyapuri P.O, Willington Island, Cochin, India 682029.*
2 *Directorate of Research on Women in Agriculture, Bharatpur Square, Nandan Kanan Khandagiri Road, Baramunda, Bhubaneswar, India 751003*

Abstract

The Striped catfish *Pangasianodon hypophthalmus* has increasing importance as a candidate for aquaculture in India. It is an abundant and underutilized resource that can be used as a unique protein source to make Fish Protein Hydrolysates. The objective of the present study was to prepare protein hydrolysates from its frame meat using the neutral proteases Papain and Bromelain at 0.5% (w/w) concentration to compare the composition, functional and antioxidative properties. The yield and degree of hydrolysis did not differ significantly between the two proteases. Hydrolysate prepared with papain had a higher crude protein and ash content. They differed significantly in foaming, emulsification and peptide solubility, with papain better in foaming capacity and peptide solubility, and bromelain better in emulsification capacity. Both exhibited almost 90% radical scavenging capacity, and differed significantly in reducing capacity. Thus hydrolysates produced with these proteases vary in their nutritional, functional and antioxidant characteristics.

Keywords: degree of hydrolysis, DPPH radical-scavenging capacity, reducing capacity, metal-chelating capacity, foaming capacity, emulsifying capacity, oil-binding capacity.

Revised: 28 March 2014 /Accepted: 7 April 2014

Abstract:
Pangasianodon hypophthalmus (sutchi catfish) is a fresh water catfish extensively being cultured in the South East Asian countries in the recent years. The present study provides the first report on the effects of gutting on the quality characteristics of aquacultured sutchi catfish stored in ice. pH of whole ungutted and gutted catfish didn't show significant difference ($p>0.05$) during ice storage period. Total Volatile Base Nitrogen (TVB-N), Alpha Amino Nitrogen (AAN), Free Fatty Acids (FFA) and Thio Barbituric Acid Reactive Substance (TBARS) were lower in gutted fish compared to whole ungutted fish at any particular day during ice storage. However, gutted fish expressed higher rate of primary lipid oxidation than ungutted fish. Textural degradation of the fish muscle as indicated by hardness, cohesiveness, springiness and chewiness was lower in gutted fish. Results of sensory evaluation revealed that gutting has significantly improved the sensory quality of the fish. However, microbiological analysis revealed higher Total Plate Count (TPC) and Enterobactereaceae count in gutted fish. The shelf life of gutted and whole ungutted sutchi cat fish as determined by microbiological analysis was 16–18 days and 18–20 days respectively while storage in ice.

Keywords: Sutchi catfish, Gutting. Ice storage, Biochemical and microbial quality.

International Journal of Agriculture and Food Science Technology.
ISSN 2249-3050 Volume 5, Number 2 (2014), pp. 105-116

http://www.ripublication.com

Quality Characteristics and Shelf Life of Sutchi Cat Fish (*Pangasianodon Hypophthalmus*) Steaks During Refrigerated Storage

Viji P[1]., Tanuja S[2]*., George Ninan[3]-Zynudheen A.A[4],and Lalitha, K.V.[5]

[1,3,4,5]Fish Processing Division, Central Institute of Fisheries Technology, Matsyapuri P.O, Willington Island, Cochin, India
[2]Directorate of Research on Women in Agriculture, Opp Kalinga studio, Baramunda Post, Bhubaneswar, India 751003,*

Abstract

Fish is more vulnerable to deterioration than chicken and red meat as it contains relatively larger amounts of free amino acids, a higher water activity and a higher final pH, limiting the shelf life of the product. Hygienic handling practices can control the deterioration of fish quality during storage and distribution. The quality changes and shelf life of iced (0^0C) and chill (4^0C) stored sutchi catfish (*Pangasianodon hypophthalmus)* steaks was assessed by evaluating the changes in biochemical, textural, microbiological and sensory attributes during storage. The study revealed that all the biochemical quality indices studied like pH, TVBN, TBA and PV were within the acceptable range for both the treatments throughout the storage period. However, the chill stored steaks showed higher degree of textural deterioration than the ice stored steaks. Total mesophilic and Enterobactereaceae counts were lower in ice stored steaks compared to chill stored steaks. Based on the sensory and microbiological analysis, the shelf life of chilled and ice stored sutchi catfish steaks is determined as 14 and 17 days, respectively, during storage.

Keywords: Sutchi catfish, refrigerated storage, quality, shelf life, steaks

International Journal of Food Science & Technology

Original article

Compositional and chill storage characteristics of microwave-blanched sutchi catfish (*Pangasianodon hypophthalmus*) fillets

Puthenpurakkal Kizhakkethil Binsi,[1]* George Ninan,[2] Abubacker Aliyamveetil Zynudheen,[2] Ravikumar Neethu,[2] Venkateswarulu Ronda[2] & Chandragiri Nagarajarao Ravishankar[2]

1 Mumbai Research Centre of Central Institute of Fisheries Technology, Vashi, Navi Mumbai 400 703, India
2 Central Institute of Fisheries Technology, Matsyapuri Willington Island, Cochin 682 029, India

(Received 14 May 2013; Accepted in revised form 24 July 2013)

Summary The effect of microwave blanching on quality characteristics of vacuum and conventional polyethylene-packed sutchi catfish fillets was evaluated under chilled condition. Emphasis has been given to retain the sensory characteristics such as colour and textural properties, which is a major problem in sutchi catfish fillets during extended chill storage. In general, microwave blanching imposed minimum changes on fatty acid and mineral composition of fish meat. A marginal increase in fat content was recorded after microwave heating of fish fillets. The microwave-blanched fillets showed minimum cooking loss of 3.2 mL per 100 g meat. A slower increase in spoilage parameters was obtained with microwave-blanched samples compared with unblanched samples, demonstrating the higher storage stability of the sample under chilled conditions. Microwave heating of fish fillets coupled with quick-chilling and packing under vacuum improved the colour and texture stability of sutchi catfish fillets to a considerable extent. Microwave blanching increased the hardness and chewiness values and decreased the stiffness values of fish fillets. The biochemical and sensory evaluation of microwave-blanched and vacuum-packed sutchi catfish fillets showed extended storage life of 21 days, compared with 12 days for unblanched vacuum-packed samples.

Keywords Microwave blanching, quick-chilling, sutchi catfish, texture profile, vacuum packaging.

Introduction

Minimally processed convenience foods with characteristics closer to that of the fresh products are gaining importance in recent years and have led to interventions in fish-processing sector for extending the shelf life with minimal use of preservatives or severe heating procedures. Cook-chill technology, which allows minimal heating followed by quick-chilling, has been conveniently used for this purpose which preserves freshness characteristics and offers extended shelf life to the product. In cook-chill process, the temperature and duration of heating and method of heating play an important role in retention of freshness and sensory properties of fish fillets. Cooking at elevated temperature for a long period ensures microbial safety to some extent, but quite often deteriorates the sensory characteristics of fish meat. Mild blanching for short period retains the freshness characteristics and results in texture softening and liberation of flavour compounds. Also, the blanched fish meat can be used for the preparation of value-added products, as it retains the taste and textural profiles closer to that of fresh fish meat. However, the shelf life of cook-chilled products falls in a wide range of 6–42 days, depending on the heat treatment (González-Fandos *et al.*, 2005). Hence, the method and severity of the treatment need to be standardised based on the intended end use.

Currently, microwave heating is being investigated to improve, replace or complement conventional processing technology for pasteurising or sterilising food products as well as to meet the demands of on-the-go consumers who want quick food preparation and superior taste and texture (Ahmed & Ramaswamy, 2007). Domestic microwave ovens are conveniently used to heat foods as they do it faster than conventional methods. The sensory properties of muscle foods, such as texture and colour primarily depend on the time–temperature history of the product. Compared to conventional heating methods, microwave energy has the potential to provide more uniform and

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doi:10.1111/ijfs.12308

Fishery Technology 51 (2014) : 106 - 111

Composition, Textural Quality and Gel Strength of Surimi Prepared from Striped Catfish (*Pangasianodon hypophthalmus*, Souvage, 1878)

S. Tanuja[1]*, P. Viji[2], A. A. Zynudheen[2], George Ninan[2] and C. G. Joshy[2]

[1] *Directorate of Research on Women in Agriculture, Nandan Kanan Khandagiri Road, Baramunda, Bhubaneswar - 751 003, India*

[2] *Central Institute of Fisheries Technology, P. O. Mastyapuri, Cochin - 682 029, India*

Abstract

Surimi was prepared from the meat of striped catfish *Pangasianodon hypophthalmus* using single wash and double wash method and the composition, gel strength and textural properties were compared. Crude protein and fat content of double wash surimi was significantly low ($p<0.05$). Both single wash and double wash surimi gels exhibited high expressible drip and low water holding capacity with double wash surimi gel showing significantly higher values ($p<0.05$). The gel strength, and textural parameter like hardness, and stiffness were significantly ($p<0.05$) higher for single wash surimi. The additional washing resulted in a significant decrease ($p<0.05$) in total pigment content of the surimi.

Keywords: Myofibrillar proteins, rheological property, total pigment, expressible drip, water holding capacity

Received 02 June 2012; Revised 17 February 2014; Accepted 03 March 2014

* *E-mail: tanujasomarajan@gmail.com*

Introduction

Surimi is the wet concentrate of the myofibrillar proteins of fish muscle (Okada, 1992). It is defined as a refined fish protein product prepared by washing mechanically deboned fish to remove blood, lipids, enzymes and sarcoplasmic proteins and minced and washed fish flesh that has been stabilized by cryoprotectants (Vilhelmsson, 1997). Surimi is light in color, bland in odor, low in fat and high in myofibrillar protein. It is extremely functional due to the unique gelling properties of the myofibrillar proteins. Hence surimi is an ideal ingredient for making imitation and analogue products (Lanier, 2000). The washing procedure is of great importance for surimi quality, not only for removing fat and undesirable materials, such as blood, pigments and odorous substances but, more importantly, for increasing the concentration of myofibrillar protein, thereby improving gel-forming ability (Lanier & Lee, 1992).

The suitability of freshwater species, particularly major carps for the preparation of mince and surimi have been reported by Sankar & Ramachandran (1998; 2002). Luo et al. (2001) reported that the surimi from freshwater fish species is inferior in gel properties than from marine species. However Nousad et al. (1999) has observed that surimi from tropical freshwater fish species *viz*., snakehead, wild mullet and Nile tilapia showed good gel setting ability. The surimi from Black tilapia had significantly higher gel strength than that from the Indian major carps (Ninan et al., 2004). Chang et al. (1998) has observed that the gel forming ability of surimi from the freshwater fishes such as carps and rainbow trout was low but suitable for the preparation of kamaboko and comparable with sardine surimi. Although surimi from freshwater fish has moderate gel forming ability, it can be utilised by adapting the parameters of gelation process (Ganesh et al., 2006). Additives such as chitosan was found to improve the textural and sensory properties, prevent lipid oxidation and inhibits microbial growth in freshwater fish surimi (Hajidoun & Jafarpour, 2013; Amiza & Kang, 2013)

Revised: 24 August 2013 /Accepted: 29 August 2013

Abstract:

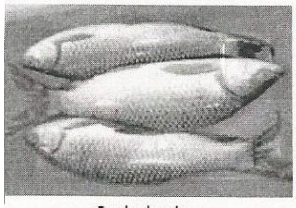
The effect of vacuum packaging technique on the shelflife of eviscerated pabda catfish (*Ompok pabda*) during chill storage at 4±2 °C was studied. The shelflife of pabda fish was predicted based on the cumulative observations of biochemical, microbiological and sensory parameters. There was no significant difference in the lipid quality parameters studied between the samples during the chill storage period, whereas, vacuum packaging significantly improved the sensory and microbiological quality. Based on microbiological parameters such as Total Viable Count, Enterobacteriaceae, Escherichia coli, Salmonella Spp, total Vibrios, Listeria monocytogenes, Staphylococcus aureus, faecal Streptococcus and anaerobic sulphite reducers, the shelflife of chilled gutted pabda catfish was estimated to be 14–16 and 18–20 days for air packed and vacuum packed samples, respectively. The sensory parameters showed extended shelflife by four more days for both the samples.
Keywords: Vacuum packaging. Pabda catfish, Evisceration, Chill storage

Reports /Manuals

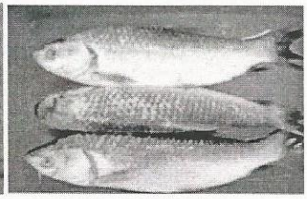
Fish descaling machine

A fish-descaling machine has been designed and developed. This can be used for removal of scales from all types of marine as well as freshwater fishes. It is equipped with a perforated rotating drum and an induction motor of variable frequency drives. The drum has a capacity to load 10-kg fish at a time. The time of operation and rpm of the drum has been standardized for each species under different size categories for efficient removal of scales. The rpm of the drum can be adjusted at a minimum of 2 rotations to a maximum of 80 rotations per minute. Trials conducted have shown that 98% of the scales could be removed using descaling machine. For sardine, the process requires 5 minutes at 20 rpm, for rohu, it is 10 minutes at 30 rpm and for tilapia, it is 8 minutes at 25 rpm.

The material can be loaded and unloaded and operated easily by a single person; thereby it is a useful tool to overcome the shortage of skilled manpower in the fish-processing industry. Mechanization of descaling activity can significantly reduce handling time, thus shortening pre-processing period also. This in turn will reduce overhead cost and also enhance quality of the final product.



Scaled rohu



Descaled rohu

Central Institute of Fisheries Technology
Willington Island, Matsyapuri PO
Kochi (Kerala) 692 029

Published by Dr Rameshwar Singh, Project Director, Directorate of Knowledge Management in Agriculture, Indian Council of Agricultural Research, New Delhi 110 012. *Phone:* 011-25842787; *Fax:* 011-25843285; *e-mail:* pddkma@icar.org.in. Lasertypeset by M/s Print-O-World, Shadipur, New Delhi 110 008, and printed in India at M/s Royal Offset Printers, A-89/1, Naraina Industrial Area, Phase I, New Delhi 110 028.

Editing : **Dr R.P. Sharma and Shashi A. Verma** ***Design & Production :*** **Dr V.K. Bharti and Punit Bhasin**

ICAR NEWS Volume 18 No.4 October –December 2012

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Indira Gandhi National Open University
School of Agriculture

BPVI- 043
COATED PRODUCTS

Diploma in Fish Products Technology (DFPT)

Practical Manual

February, 2011

ISBN 978-81-266-5196-2

Printed and published on behalf of Indira Gandhi National Open University by the Director, School of Agriculture.

Laser Composed by: Tessa Media & Computers, C-206, A.I.E.-II, Okhla, New Delhi-110025

Printed at : Vijayalakshmi Printing Works Pvt. Ltd., B-117, Sector-5, Noida-201301

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THE PEOPLE'S UNIVERSITY

Indira Gandhi National Open University
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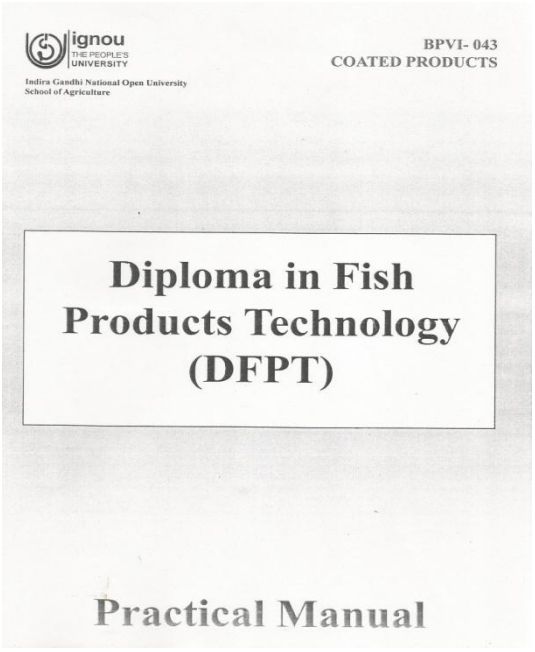
BPVI- 043
Coated Products

PRACTICAL MANUAL

Indira Gandhi National Open University
School of Agriculture

BPVI - 043
COATED PRODUCTS

Battering and Breading 1



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Battering and Breading

1

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Block

1

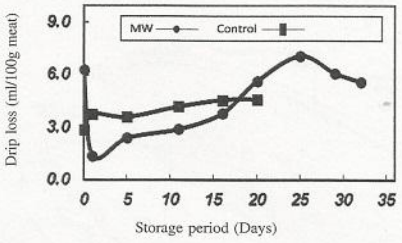
BATTERING AND BREADING

Microwave Blanching and Quick Chilling of Fish for Shelf-life Extension

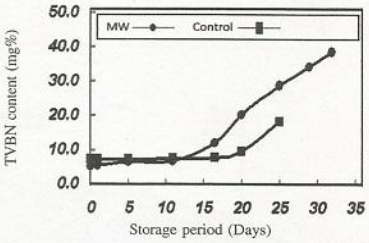
With the changing life styles, the use of microwave ovens is becoming more popular in developing countries like India as the equipment has become affordable in the recent years. Domestic microwave ovens are conveniently

used to heat foods as they do it faster than conventional methods. A short processing time is highly desirable in food industry in terms of less nutritive and sensory loss. In addition, mild heating using microwave oven followed by quick chilling improves the texture of fresh fish as it softens the connective tissue proteins, at the same time maintaining the functionalities of myofibrillar proteins. Recently, CIFT has initiated work on microwave processing of fish incorporating the hurdle concept for shelf life extension of fresh fish.

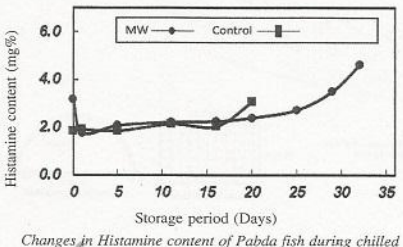
Microwave blanching of *Ompok pabda* gutted fish was carried out in combination with quick chilling and vacuum packaging techniques. Blanching of gutted Pabda fish was achieved using a home model microwave oven at a core temperature of 70 °C for 1 min. The fish samples were vacuum packed before heating and separate control samples were maintained for comparison. After heating, the samples were quick chilled using crushed ice and were further stored at -4 °C. The microbiological parameters were analyzed at regular intervals for total mesophilic, psychrophilic and thermophilic count, enterobacteriaceae in addition to common pathogenic/spoilage organisms like *E. coli, Streptococcus, Vibrio parahaemolyticus, Salmonella, Listeria* and *Staphylococcus*. The biochemical parameters analyzed included TVBN, NPN, alpha amino Nitrogen, FFA, PV, TBA, *Drip loss* and pH and Histamine. Results indicated that microwave blanched samples remained in acceptable condition for more than a month. On the other hand, control vacuum packed samples were to be rejected after 20 days of storage under chilled condition.



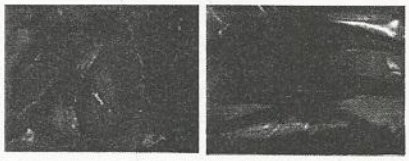
Changes in Drip loss of Pabda fish during chilled storage



Changes in Total Volatile Base Nitrogen of Pabda fish during chilled storage



Changes in Histamine content of Pabda fish during chilled storage



Microwave blanched Pabda gutted fish *Control vacuum packed Pabda gutted fish*

Dr. P.K. Binsi, Dr. George Ninan*, Dr. S. Visnuvinayagam, P. Viji and Dr. R. Chakrabarti

Mumbai Research Centre of CIFT

*Fish Processing Division, CIFT, Cochin

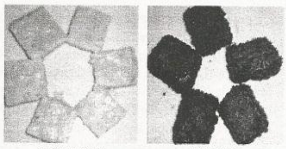
Preparation of Restructured Products from *Pangasius hypophthalmus*

Aquaculture contributes more than 50% of the total inland fish production. One of the fastest growing freshwater fish species suitable for aquaculture all over the world is Pangasius or Basa catfish. *Pangasius hypophthalmus*, has proven particularly adaptable for intensive production. The aquaculture potential of this species in tropical regions of the world outside of Southeast Asia appear to be excellent and it has become an economically valuable freshwater fish. Being influenced by international market, large numbers of farmers in India got fascinated to culture *P. hypophthalmus*. On an average, India imports over 5,000 tonnes of Basa every month. Also, a large number of super markets in major cities are selling sliced and packed Basa. Recently, farmers in Andhra Pradesh started farming Basa on a large scale. The productivity in Andhra is 50 tonnes/ hectare. It is a promising rate compared to the rate of other items like Scampi and Black Tiger shrimp. It is mostly marketed in fresh and frozen or as thawed fillet in seafood markets. Quality and hygiene of any seafood product is dependent on the production chain, the quality of the water where the fish are raised, fish handling during filleting and freezing. Until now little or few efforts have been made to produce value added products from Pangasius. Restructured fishery products are products made from minced and/or chopped muscle and which, with or without other ingredients, are used to make other products with a new appearance and texture.

Based on this background, an attempt was made to prepare the restructured products from *Pangassius* sp. using chitosan as functional ingredient. Frozen Pangassius fillets were purchased from M/s. Prime Exports, Chertala and brought to the laboratory in insulated boxes. Fillets were thawed and minces were prepared by using a meat mincer. The homogenized mince was used to prepare restructured products. Various ingredients for the products were selected based on sensory evaluation. Composition included mince (100g), chitosan (0.75%), sodium tri polyphosphate (0.25%), Sodium chloride (1%) and starch (4%). In order to find out a suitable starch for the product preparation, different starch were used which includes wheat flour, maida flour, tapioca flour and corn flour. The ingredients were added one by one to the mince in the order: sodium chloride, sodium tri polyphosphate (0.25%), chitosan (0.75%) and starch (4%) and mixed well. The mix was kept at refrigerated condition for 30 min. Then it was spread in an oil smeared stainless steel plate and cooked at 90-100 °C for 30 min. After cooking, the plates were immediately removed, and cooled. After cooling the gels were cut in to required shape and removed from the plate and their quality were analyzed. Moisture, protein, fat, ash, sodium, potassium and calcium were determined by the method of AOAC (2006).

Biochemical composition of restructured products is given in the Table. Product contained moisture of 76.86-78.30%, protein content of 11.88-1.99%, fat content of 5.06-5.27% and ash content of 2.15-2.29%. Sodium, potassium and calcium were found to be 2.66-3.20g%, 0.68-0.72%, 0.29-0.34g% respectively.

For sensory evaluation, the products were battered and breaded and then fried in oil till both sides turn in to light brown colour. Sensory evaluation was done by using 10 point hedonic scale. The overall acceptability scores for all the products were between 8 and 9 indicating that in general all the products were good. However the products incorporated with corn flour scored highest in over all acceptability. Application of Pangasius minces for the development of restructured products offer new opportunities to develop novel healthy and convenience food for the modern market. Additionally inclusion of chitosan to the fish mince provides possibility of developing functional food with beneficial effects. However, the effect of incorporation of chitosan in extending the shelf life of the products needs further investigations.



Before cooking *After cooking*

Restructured products

Biochemical composition of restructured products

Sample/ parameter	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Sodium (g%)	Potassium (g%)	Calcium (%)
WF	77.16	11.99	5.06	2.27	2.66	0.69	0.30
MF	76.98	11.95	5.11	2.29	2.64	0.68	0.29
TF	76.86	11.88	5.24	2.22	3.24	0.78	0.34
CF	78.30	11.99	5.27	2.15	2.91	0.72	0.30

WF - Product containing wheat flour; MF - Product containing Maida flour; TF - Product containing Tapioca flour; CF - Product containing corn flour

Sensory evaluation of restructured products

Sample/ parameter	Appearance	Flavour	Taste	Texture	Over all acceptability
WF	8.8	8.3	8.3	8.0	8.2
MF	8.8	8.6	8.6	8.5	8.6
TF	8.8	8.3	8.3	8.0	8.0
CF	8.8	9.0	9.0	8.5	9.0

WF - Product containing wheat flour; MF - Product containing Maida flour; TF - Product containing Tapioca flour; CF - Product containing corn flour

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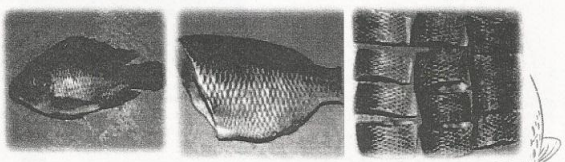
Quality evaluation of monosex tilapia during ice storage

Tilapia species is currently one of the most popular cultivated freshwater fish in the world, to such an extent that they have been called the fish of the future. The most important producers of tilapia today are China, Egypt, Indonesia and Philippines. The advantages of tilapia are its rapid growth, resistance to various diseases and stress, tolerance to changing environmental conditions, and willingness to spawn in captivity. Very few studies have been conducted on the quality and shelf life of freshwater fish during ice storage conditions in contrast to the information available for marine species.

The common tilapia is normally highly prolific. As a result, space and food become limited resources leading to a reduced growth rate or even stunting. Batches of young monosex tilapia can be obtained from tilapia breeders by utilizing techniques such as hybridization and hormones. When certain species or strains of tilapia breed with each other, the resulting batch of hybrids consist of a very low number of females or no females at all. Breeding of female *Oreochromis nilotica* (Nile tilapia) or *Oreochromis mossambicus* (Mozambique tilapia) with male *Oreochromis aurea* (Blue tilapia) or *Oreochromis hornorum* (Zanzibar tilapia) will result in all male tilapia offsprings. Such monosex tilapia will have comparatively better growth than common tilapia.



Whole cleaned tilapia *Gutted and cleaned tilapia* *Tilapia Steaks*

The purpose of this study was to evaluate the quality and shelf life of monosex tilapia during ice storage. Monosex tilapia having an average length and weight of about 22 cm and 266 g respectively was procured from a local culture pond. The sample was further made into three lots *viz.*, whole cleaned (Sample A), gutted and cleaned (Sample B) and steaks (Sample C). All the samples were packed in polythene bags and kept in insulated boxes in iced condition. Ice was changed periodically throughout the sampling period and sampling was done at two days interval.

The proximate composition of tilapia was analyzed (Table 1). The fatty acid composition study indicated that oleic acid (33.28%) and palmitic acid (24.70%) were found in higher levels whereas caprylic acid (0.028%) was the most limiting one. The major class fatty acids in tilapia were the mono-unsaturated fatty acids (42.36%), which is mostly on account of the high content of oleic acid. It was also found that omega-3 fatty acid present in the sample was 7.15%. The amino acid analysis indicated higher levels of aspartic acid (16.15%), glutamic acid (22.52%), lysine (15.64%) and alanine (15.74%), whereas tryptophan (0.03%) was the most limiting amino acid. Proline (1.05%), tyrosine (1.69%) and methionine (1.86%) were also found in low levels.

Table 1. Proximate composition of monosex tilapia

Parameter	Composition (%)
Moisture	73.44 ± 0.24
Protein	17.11 ± 0.16
Fat	6.75 ± 0.04
Ash	1.18 ± 0.01

Quality parameters *viz.*, pH, TBA, PV, FFA, TMA and TVBN as well as colour and texture were analyzed during the storage period. The moisture content of all the samples remained steady throughout the storage period whereas in all the samples there was a slight increase in pH values which may be on account of the bacterial action on fish during ice storage.

The TBA values showed an increasing trend during the storage. TBA increase was less in Sample A compared to Sample B and C. PV and FFA also showed increasing trend for all the samples indicating that oxidation of fish lipids is taking place during the storage.

Sensory evaluation was conducted based on the quality attributes like appearance, flavour, odour, texture and over all acceptability. The present study showed that whole cleaned samples (Sample A) had a higher shelf life of 27 day and Sample C had a marked off-taste towards the 19th day whereas Sample B was rejected on the 23rd day under iced conditions. The results indicated a gradual reduction in the quality during ice storage.

Monosex tilapia is getting popular and has high potential in the future market. Hence more studies need to be conducted on the quality and processing aspects of the species.

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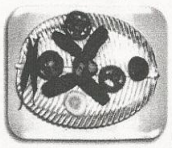
Jawala shrimp and tilapia: Potential candidates for seafood analogues

Jawala shrimp (*Acetes* sp.) is one of the major non-penaeid species harvested in huge quantities along Maharashtra coast. The utilization or processing of this species is a major concern as it is very small in size and is very difficult to peel. Hence, majority of the catch is either discarded or sundried in a traditional way. As the shrimp is having the texture and flavour of that from the penaied groups such as *Peneaeus* or *Metapenaeus* spp., there is a scope for utilization of this species for the development of value added products. Similarly, tilapia is a widely cultured freshwater fish species in India. The meat of tilapia is boneless and white in colour and hence, it is suitable for developing mince based products.

Presently, several value added seafood products are being developed to meet the demand of working population all over the world. Surimi-based analogues or surimi

Jawala shrimp

Cooked shrimp analogue before battering and breading



Battered and breaded shrimp analogue

seafood is considered as a low cost alternative to shrimp/ lobster and has great prospects for earning foreign exchange. Seafood analogue is one such product prepared out of surimi. Analogues are also called imitation products as it imitates the colour, flavour and appearance of the authentic products. An imitation product with a very specific texture is generated by the gelling of proteins and the gelatinization of starch.

Table 1. Sensory score for the boiled and coated shrimp analogue

Attribute	Average Score*	
	Without coating	Coated
Colour	8.2	8.55
Appearance	7.95	8.50
Odour	8.25	8.45
Texture	7.85	8.65
Flavour	7.85	8.55
Over all acceptability	8.05	8.54

*based on 9 point hedonic scale

Mumbai Research Centre of CIFT has standardized a method to develop an analogue product based on tilapia surimi and Jawala extract. Jawala extract was prepared from Jawala shrimp using a suitable buffer. The whole Jawala shrimp is homogenized and extracted with the buffer at room temperature. The extract showed good sensory properties in terms of odour and taste of that of shrimp. For the preparation of analogue product, surimi was prepared from tilapia mince using two washing steps in chilled water. The mince was manually pressed by using a muslin cloth and was ground with sucrose, salt, corn starch, Jawala extract and oil in a grinder. The total grinding time given was 15 minutes. Temperature of the mixture was maintained at 4 °C during grinding. The finely ground paste was made into a layer of 1 cm thickness and was cooked at 90 °C for 30 min. in a water bath.

Addition of Jawala extract imparted a light pink colour to the product. The cooked product was cut into the shape of fingers and then battered, breaded and fried. Both the boiled and coated product imitated the flavour of shrimp. The texture of the product was assessed by folding test and graded as 'A'. The coated fingers showed satisfactory sensory acceptability by the sensory panel. The overall sensory acceptability of the product is given in Table 1. The boiled product can also be used as a base material for seafood salads. The analogue product can be stored in chilled or frozen condition.

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DETAILED PROJECT REPORT

FOR

A FRESHWATER FISH PROCESSING PLANT, SILAGE AND FEED MILL UNIT

AT

LANJA, RATNAGIRI DISTRICT, MAHARASHTRA

Prepared by

Dr.George Ninan

Senior Scientist

Fish Processing Division

Central Institute of Fisheries Technology (ICAR)

(20-12-2011)

FISH PROCESSING DIVISION
CENTRAL INSTITUTE OF FISHERIES TECHNOLOGY (ICAR)
MATSYAPURI (P.O.), CIFT JUNCTION,
COCHIN – 29

Establishment of a Freshwater Fish Processing Unit at Harike, Punjab

DETAILED PROJECT REPORT

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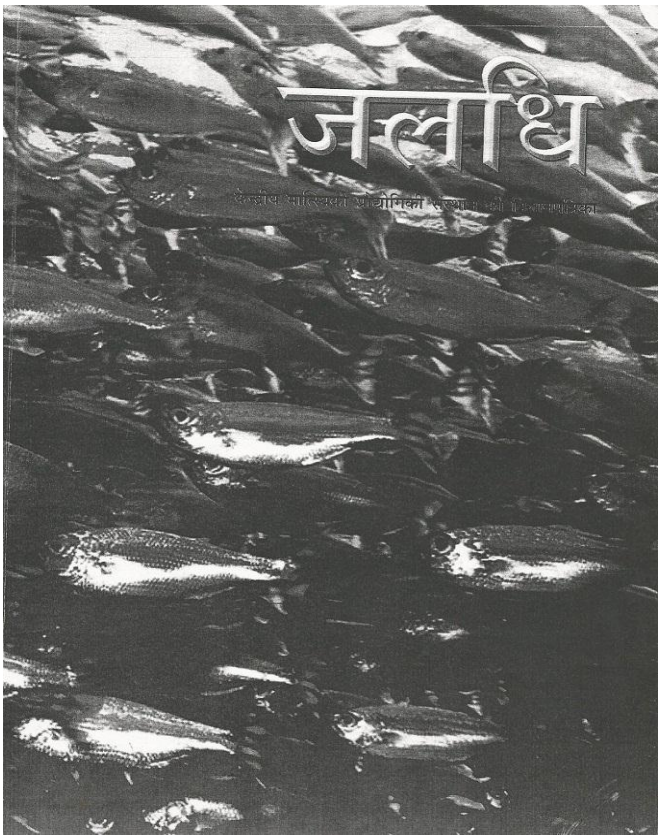


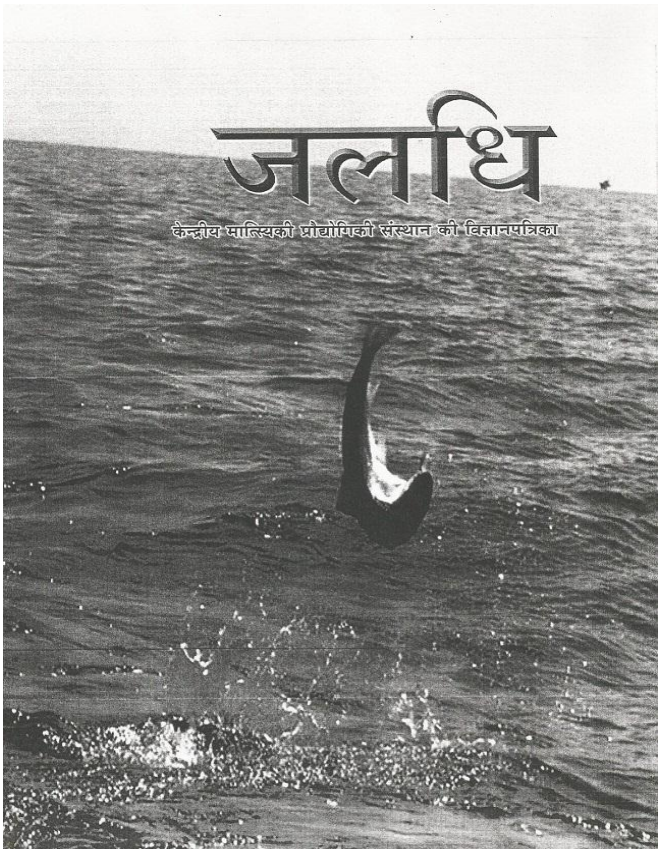
विविध जलकृषि उत्पादों को व्यवहृत करने के लिए उन्नत प्रौद्योगिकियाँ

जैनुद्दीन ए. एवं जार्ज नैनान

भारत दुनिया में मत्स्य उत्पादित करनेवाले देशें में दूसरे स्थान पर है। जंगली और जलकृषि स्रोतों से 6.1 मिलियन टन मत्स्य की पैदावार होती है। पिछले एक दशक में हमारे देश में मूल्य-जोड़ समुद्री उत्पादों के निर्यात की वृद्धि तेजी से हो रही है। 1996-97 में भारत में 31,322 मेट्रिक टन मूल्य जोड़ मात्स्यकी उत्पादों का निर्यात किया जो कि 455.03 करोड़ रुपयों का था। एक कृल समुद्री आहार उत्पाद में आयातन में 8.28% और मूल्य में 11.04% है 2005-06 के आँकडे है, 106879 मेट्रिक टन (17.72%) और 1979.53 करोड रुपया (23.85%) हालांकि देश में नियोजित ज्यादातर मात्स्यिकी उत्पादों पारंपरिक ब्लोक हिमीकरण आधार पर है जिससे मूल्य जोड़ कम मात्रा में ही है। भिन्न आयातित राज्यों में मूल्य जोड़ समुद्री उत्पादों की मांग उत्पादों के हिसाब से बदलती है। उदाहरण के लिए जापान में झींगा आधारित उत्पाद का बहुत मांग है, खासकर नोबाशी, शुशि, इंजी पील, छीला हुआ पूँछ, निकाला गया नस और ब्रेडेड झींगा के लिए हालंकि भारत में इन चीजों का उत्पाद किया जा सकता है, लेकिन भारत इन उत्पादों के लिए कच्चे माल का स्रोत है, जो कि कहीं और संसाधित किया जाता है और जापान में निर्यातित किया जाता है।

हालांकि उपभोक्ता बाजार में खाने में आसान पकाने में आसान उत्पादों की बड़ी जरूरत है, भारत मूल्यजोड़ समुद्री आहार के निर्यात में सारभूत सहयोग नहीं दे पाया है, भारत से निर्यातित मुख्य मूल्य जोड़ चीज़ों इस प्रकार है: मत्स्य फिलेट, मत्स्य स्टीक्रस पूरा पकाया गया हिमीकृत लाबस्टर, हिमीकृत झींगा, फटल मत्स्य फिलेट, रिंग, IQF

स्क्रविड फिलेट IQF रिंग, टेंटेकलस, हिमीकृत केकड़ा सूरिमि और समुदी आहार मिक्स
भारत से 2006 में निर्यात मुख्य मूल्य जोड मात्स्य उत्पादों के आकड़े



पन्गेशियनोडोन हैइपोपथालमस के लिए संसाधन विकल्प

जोर्ज नैनान, जैनुद्दीन, ए.ए. विजि पी.वी. मधुसूदन राव,
रविशंकर सी.एन.

पन्गेसियस या इन्डीसन्ट शार्क के नाम पर ज्ञात प.है का विस्तृत संवर्धन भारत के देशी मत्स्य संवर्धन क्षेत्र पर खासकर अरुणाचल प्रदेश राज्य पर है और मूल्य जोड के लिए एक नए अवसर प्रदान करता है। 'बसा' नाम पर मशहूर हिमीकृत कैट मत्स्य फिलेटें वियटनाम से यू एस और यूरोप के मात्स्यिकी उत्पन्नों के निर्यात का मुख्य सहारा है। वर्तमान काल में 19 से अधिक पन्गेसियस संसाधन और निर्यात कपनियाँ है और वियटनाम के मेकान्ग डेल्टा में मात्स्यिकी क्रियाकलापों में कार्यरत है। इसका प्रारंभ भारत में 1995 को है और तकरीबन 4 मिल्यम लोग कार्यरत है। वर्ष 2000 के दौरान जातियों का प्रारंभ आन्ध्रा प्रदेश में हुआ और आजकल तकरीबन 32,000 हेक्टर के अधीन पन्गेसियस संवर्धन कृष्णा, पश्चिम गोदावरी, पूर्वी गोदावरी, गुन्टूर और निल्लूर आदि मुख्य जिलों में होता है। पन्गेसियस को श्रेष्ठवान बढ़ती दर (90 दिनों पर अधिकांश एक की ग्रा) जो उसे संवर्धन के लिए वरीयता प्राप्त बनाया है। आन्ध्रा प्रदेश में पन्गेसियस का वार्षिक उत्पादन की बढती होकर 2010 में 5,40,000 टन पहुँच गए।

Potential and Future Prospects for the Processing and Export of Major Carps

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Focal Points at a Glance

Marine aqua species and their processed products are known to be part of India exports. In this context, there is a measure of baffling among industrial circles as to why there is no significant initiative at exporting freshwaters fishes and their products. Small quantities of freshwater species are exported based on special requests received but not in a general way. In this background, the authors explain the reasons for this special situations.

Globally, the demand for fish products is on the rise due to their high protein content. Fish farming is the most likely answer to meet the ever increasing demand for fish products as fish has highest food conversion rate (FCR) compared to other land based farmed animals and also the environmental impact of aquaculture is lower than raising cattle, pigs or poultry. With stagnating global capture fish production and an increasing human population, aquaculture is perceived as having the greatest potential to produce more of fish in the future to meet the growing demand for safe and quality aquatic food. World aquaculture has grown significantly during the past five decades. The contribution of aquaculture to global fish supply continues to grow, increasing from merely 3.9% of total production by weight in 1970 to 38% in 2009. Global fish production from aquaculture was less than one million tonnes in the early 1950s which increased to 57.2 million tonnes in 2010. Of the 15 major aquaculture producing countries, 11 are in the Asia-Pacific region accounting for nearly 89% of global production. Asia dominates world in aquaculture production with over 88% of global aquaculture production by quantity and nearly 78% by value in 2008. The major cultivable species are carps, shrimps, catfishes, tilapia, salmon and trout. Of these different groups, carps form one of the major cultivable fish species in terms of quantity.

Carps are species of freshwater fish of the family Cyprinidae, native to Asia and Europe. Of the total world carp production, Asia alone contributes to over 90%. China, India, Bangladesh and Thailand contribute nearly 80, 12, 3 and 1% of carp production in the world, respectively. Nearly 20 native species of carps have been reported in this region. Carps have been the mainstay of culture practices in India and it is the three Indian major carps viz., Catla, Rohu and Mrigal together with three exotic carps viz., silver carp, grass carp and common carp contribute over 85% of the aquaculture production of the country. The production levels in ponds and tanks have increased from about 600 kg/ha to over 2,000 kg/ha due to technological interventions during last three decades. Higher production levels of 6-8 tonnes/ha/year are being achieved by several farmers and entrepreneurs in States like Andhra Pradesh, West Bengal, Punjab and Haryana. Several combinations of culture practices have been evolved in the country to suit the fish species, water resources, availability of fertiliser, feed resources, etc. and also the investment potentials of the farmers. Carp culture is shown to be highly compatible with other farming practices. With the availability of vast freshwater resources in India in the form of rivers, canals, reservoirs, tanks and ponds, flood plains, lakes, derelict water bodies and brackish waters (Table 1), there is a great potential to expand the fish production to greater levels in the near future. Tanks and ponds are small water bodies which are commonly used for aquaculture purpose as they are easily manageable. Aquaculture is amongst the fastest growing industries in India. Between 1990 and 2010, Indian fish capture harvest doubled, while aquaculture harvest tripled. In India, the growth in aquaculture section has increased at an average of 7.1% between 1980 and 2009 (Fig.1). In 2008, India was the world's

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ready for consumption without the need for separation.

Fish mince

Fish mince is prepared by concentrating only on edible muscle part, removing all the other parts like scale, skin, gut and bones. The minced fish technology offers a great possibility for the processing of bony fishes, particularly IMCs which possess intramuscular bones. Fish mince acts as base material for majority of the value-added products. It is prepared by split opening the fish ventrally and passing through the meat bone separator. Larger bones are normally removed manually and fine pin bones are then separated by passing the mince through a pin bone remover, so that the bone content in the final mince should not exceed 2% as it affects the quality of mince. Normally, fish mince is stored under frozen condition. Fish mince is used for the preparation of surimi, fish balls, fish finger and other specialty products.

Fish finger

Fish fingers are regular rectangular sized fish portions made from either frozen fish fillets or fish mince. Skinless and boneless fillets are partially frozen to get the correct shape of the finger. For ease of cutting operation, frozen slabs of 1.5cm thickness are used. The frozen slabs are passed through a motor operated band saw to cut into suitable size. A typical British fish finger weighs around one ounce (28g) and in Asian countries it varies from 20 – 25g each. They are battered and breaded before freezing or cooking. They are normally frozen stored and consumed as snack food after frying in vegetable oil.

Fish balls

Fish balls are a restructured convenient product which is believed to have originally come from China. These are similar to the products like Kofta of India, Polpette of Italy, Koningsberger Klopse of Germany, Swedish meat balls, Koefte of Turkey, and Nunh Hoa of Vietnam. It is prepared from a mixture of fish, fat particles, water, carbohydrate, ginger, garlic, pepper and salt. During the processing, meat is mixed with the ingredients and carbohydrate source, which will bind the particles directly or indirectly. The mixture is then formed to the desired shape and this shape is retained after freezing or cooking. Minced meat of IMCs can be utilised for preparation of fish balls and they are normally battered and breaded before freezing or cooking like other specialty products and are frozen stored.

Fish cutlet

Cutlet is a spicy snack food popular in many Asian, European and South American countries. However, the spiciness will be more in Asian countries than in other countries. Fish cutlets are prepared by mixing the cooked fish meat with the cooked potato and fried onion, chilly, ginger, garlic, pepper, turmeric, coriander, oil, salt and other ingredients based on the consumer taste. After proper mixing, they are shaped desirably and battered and breaded. Cutlet can also be prepared from cooked meat, from skeletal frame remaining after filleting the fish. Frozen storage is the normal practice and the product is consumed after frying in oil.

Fish burgers (Fish patties)

Burgers are similar to cutlets except the spiciness, which is less in burgers. In the preparation, fish meat or mince is cooked and mixed with cooked potato, fried onion, carbohydrate source, spices, herbs and salt and formed into desired shape. It is normally frozen stored and whenever required it is thawed, heated and eaten as sandwiches with fresh vegetables, leaves and plain buns.

Apart from developing processing and preservation methodologies, utilisation of waste derived from IMCs processing is important as it improves the economy of processing and minimises the negative impact on environment. Like any other fish processing, waste generated from processing of IMCs are rich in nutrients, which can be utilised for the production of fishmeal or fish silage for feeding animals or high value fish species. The scales, skin and bones can be utilised for the production of collagen, and skin for gelatin production. Another important by-product, particularly in IMCs processing is the pituitary gland that can be collected from the fish head. The IMCs waste, mainly head, tails and fins can be collected and used for the production of soup. The fins and skin can be dried and used as a crispy ingredient in soup.

Sultan Singh's Fresh water Fish Processing Unit in Haryana-India's first integrated- zero waste agri-business venture

India's first integrated- zero waste agri-business venture was established at Bhutana, District of Karnal, Haryana by Mr. Sultan Singh, a progressive fish farmer-cum-entrepreneur. He is the man behind the establishment of the 'Sultan Singh's Fish Seed Farm', 'Sultan Singh's Food Court' and the Processing Unit for the production of value-added products from fish.

Mr. Sultan Singh is a registered incubatee under the Zonal Technology Management – Business Planning and Development Unit, South Zone, an agricultural business incubation initiative of ICAR at CIFT, Cochin. The processing unit at Karnal was set up in technical collaboration with the Fish Processing and Quality Assurance & Management division at CIFT, Cochin.

Mr. Sultan Singh has been working in this field for the past 27 years. The certified farm and processing unit are spread over sprawling 27 acres of land with a capacity to process one tonne of fish per day. The plant is expected to improve the economic status of hundreds of the families engaged in fish farming in the village ponds, and other entrepreneurs. The products like fish nuggets, burger, fingers, balls etc are being prepared and marketed through retail kiosks under the brand name 'Fish Bite'. The processing unit is designed in such a way that even the waste from fish processing would be converted into fish feed, thereby setting a fine example of zero waste agriculture. The fish and fish products from the farm are of superior quality. The project is expected to open a new gateway to the entrepreneurs of Haryana, to market their produce. With the vision of establishing more successful ventures in this field, the Unit is also acting as a training center for progressive farmers and scientists.

In conclusion, it has to be mentioned that there is a great potential and opportunity for the expansion of IMCs industry in India, if the processing methodologies mentioned are adopted. It is anticipated that the production of IMCs would continue to increase in the future. Therefore, continued efforts are needed to develop better processing and preservation methods. There is also greater scope for fish processing industry in India to adopt these processing technologies for their better future and to reduce the stress on marine environment.

Book Chapter

Extension bulletins

Advances in Harvest and Post Harvest Technology of Fish

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2012

New India Publishing Agency
Pitam Pura, New Delhi-110 088

Published by
Sumit Pal Jain *for*
New India Publishing Agency
101, Vikas Surya Plaza, CU Block, L.S.C. Mkt.,
Pitam Pura, New Delhi- 110 088, (India)
Phone: 011-27341717, Fax: 011-27341618
E-mail: info@nipabooks.com
Web: www.nipabooks.com

ISBN : 978-93-81450-09-3

Typeset at: Harminder for Typographiya
Printed at: Jai Bharat Printing Press, Delhi

Advances in Harvest and Post Harvest Technology of Fish, 2012
© Prof. D.D. Nambudiri and Prof. K.V. Peter (eds.), pp. 265-305
New India Publishing Agency, New Delhi (India)
e-mail : info@nipabooks.com; website : www.nipabooks.com

CHAPTER **11**

Coated Products

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1. Introduction

Coated food industry particularly based on fish is highly sophisticated so as to produce convenience foods such as ready to eat or ready to use products meeting international quality standards. Coated products *viz.*, fish fingers, squid rings, cuttlefish balls, fish balls and prawn burgers form one of the major fish and shellfish based items of trade by the ASEAN countries (Chang *et al.*, 1996). A coated food product, also known as enrobed product, is one, which is coated with another foodstuff. Two types of coatings are in common use, the batter and, the crumb or the breading. A batter may be defined as a liquid mixture composed of water, flour, starch and seasonings in to which food products are dipped prior to breading or frying. The breading is normally a bread-based crumb, but other coatings like crumbled potato chips or puffed and coarsely powdered rice grain are also popular. Several varieties of batters and breading in different colours and mesh size are available and are being used in the industry. The coating will impart the desired characteristics to the product when fried and offered for consumption.

The demand for 'ready to eat' or 'ready to use' products has led to the development of several products diverse in taste, texture and appearance based on fish. A major group among them commanding high consumer appeal is the battered and breaded products commonly known as coated or enrobed

Modified starches with a high amylose content have good film forming properties which, alone or in combination with other ingredients such as rice flour or flour from other cereals help to reduce oil absorption by creating an effective barrier against oil in fried, battered products. These starches normally have a higher gelatinization temperature (Van Beirendonck, 1998; Higgins *et al.*, 1999; Bertram, 2001).

The gelling ability of hydrocolloids, together with their usual hydrophilic nature makes them suitable for reducing oil uptake during frying in battered products (Annapure *et al.*, 1999). The hydrocolloids most commonly used as a barrier are methylcellulose (MC) and hydroxypropyl methylcellulose (HPMC) (Lee and Han, 1988; Ang, 1989; Stypula, and Buckholz, 1989; Meyers and Conklin, 1990). Guar gum based batter showed superior functional properties when compared to batters based on other hydrocolloids viz. carboxy methyl cellulose and carboxy methyl chitosan (Abbas *et al.*, 2009).

Egg albumen is useful in binding the batter to the product; the lecithin in the yolk can act as an emulsifier, which contributes to its stability (Loewe, 1993). The use of dextrins in batter formulations is associated with an improvement in the crispness of the fried product (Shinsato *et al.*, 1999).

2.2.3 Batter preparation

It may be noted that no exact recipes exist for the batter system. Depending on the food substrate and the desired coating appearance, formulae can be extremely flexible to allow for maximum adaptability in the development of coated products. However batter ingredients can be classified as critical and optional ingredients based on the functions (Table 2). The addition ranges cited in the table are relatively wide, which gives a flexible formulation to suit the final product.

2.2.4 Critical quality factors of batter

Viscosity is the most important rheological property in batter formulations since batter is to be coated over the product in a liquid form and is recognized as one of the most important factors in determining its performance during frying (Shih and Daigle, 1999). The viscosity affects the pick up and quality of the adhering batter, handling properties of the batter, its appearance and the final texture. While reconstituting the batter with water care should be taken to incorporate the correct quantity of water. Too much water can produce thin batter. Thin batter during frying release a large quantity of water and produce a porous coating that absorbs a lot of oil during frying. Insufficient water can result in a thick batter. A thick batter layer can lead to an incompletely cooked final product, lack of crispness, and a generally hard lumpy appearance. It has an adverse influence on oil uptake during flash frying.

Extension bulletins

Extension bulletins

Nuggets

Nuggets are another form of breaded and battered product. These are prepared from fish fillets. Fish fillets were washed and cut into square shape pieces of 2-3 cm size. It was then dipped in 1% salt solution for 10 minutes. The pieces were then drained, battered and breaded followed by flash frying for 30 seconds. Fried nuggets were stored in chill room. The product has shown a shelf life of 11 days in chilled storage.

Fish pickle

Fish meat is cut in to small pieces and mixed with 3% salt and sun dried for two hours. The semidried meat pieces are then deep fried in gingelly oil and mixed with other fried ingredients. After cooling, sufficient quantity of vinegar is added, salt adjusted and kept at least for two days for proper mixing of ingredients and adjustment of pH. The pickle is then packed in airtight containers / stand-in pouches for consumer use.

Besides the above mentioned products, a variety of other value added items can be prepared from the species viz., ready to eat products like fish curry in retort pouches, canned products, frozen curry in tray packs etc. For products like cutlets and wafers, the meat attached to the filleting frames can be separated after cooking and can be utilised.

For the complete utilisation of the species, it is necessary to utilize the by products and wastes like skin, air bladder, bones, fins and viscera generated during processing. The technology for production of silage, feed etc, from the waste are available with CIFT

Among the culturable freshwater fish species, Pangasius has high potential to become one of most sought after species for value addition. However, the prospects for value addition and successful marketing of pangasius products depend on consumer acceptance, processing infrastructure and cold chain facilities for distribution.

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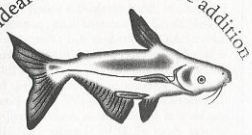
Pangasius

An ideal candidate for value addition



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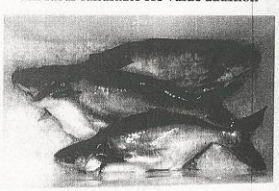
Pangasius - An ideal candidate for value addition



Pangasianodon hypophthalmus, commonly known as Pangasius or iridescent shark is widely cultured in the inland fish culture sector of India , particularly in the state of Andhra Pradesh and offers new scope for value addition. Frozen catfish fillets popularly known as "Basa" form the mainstay of export of fishery products from Vietnam to U.S and Europe. It was first introduced in India during 1995. In the year 2000, the species was introduced in Andhra Pradesh and at present about 32,000ha is under Pangasius culture mainly in the districts of Krishna, West Godavari, East Godavari, Guntur and Nellore. Pangasius has a remarkable growth rate (almost one Kg in 90 days) which makes it a preferred candidate for culture. The annual production of Pangasius cultured in Andhra Pradesh increased phenomenally and reached 5,40,000 tonnes in 2010.

Pangasius meat has high nutritional qualities and excellent sensory properties. The fish can easily be filleted due to the absence of intramuscular pin bones.

Proximate Composition of Pangasius Meat

- Moisture : 78%
- Protein : 18%
- Fat : 2%
- Ash : 2%

Pangasius fillets are preferred choice for a wide range of products due to:

- Tender flesh
- Sweet taste
- Absence of fishy odour
- No spines
- No small bones
- No skin
- Delicate flavour
- Firm texture when cooked

With a view to promote the avenues for value addition of Pangasius, the Central Institute of Fisheries Technology (ICAR) has carried out detailed studies on the post harvest aspects of this species. The studies included development of value added products, quality assessment and shelf life evaluation.

Post-harvest handling

The shelf life of Pangasius is influenced by preservation and handling practices. To reduce the bacterial spoilage, fish should be washed and iced immediately after harvesting. The bigger sized samples (5Kg up) contain significant quantity of subcutaneous fat and high collagen content in the meat. Medium sized specimens (2Kg) are found to be suitable for product development. For better preservation, the fish should be gutted; gills removed, washed thoroughly and packed in ice. It has been observed that bleeding the fish immediately after the catch significantly improved the quality and colur of meat. The yield at different stages of processing of Pangasius is given below.

Stages of processing	Yield
Gutting	76%
Steaks	37%
Filleting (Skin on)	28-32%
Mince	22%

Value added products from Pangasius

Gutted fish

Shelf life of the fish can be extended by gutting and evisceration. Care has to be taken to avoid cut or bruises on the surface of fish during handling. Studies conducted at CIFT have shown that gutted fish remained in acceptable condition up to 24 days in ice. Sensory evaluation revealed that gutted fish retained high quality compared to whole fish at the same conditions of storage.

Steaks and Fillets

TThe most common form of ready to cook product of fish is steaks and fillets. The whole fish has to be gutted and the gutted fish can be cut into steaks of 1-2 cm thickness. Fillets are prepared as skin on and skinless from the whole fish. Studies carried out in CIFT have shown that Pangasius steaks had a shelf life of 14 – 17 days in chilled conditions.

Smoked portions

The whole fish was filleted and cut into pieces which were then cold blanched in 10% brine followed by 2% w/w turmeric for 15 minutes each. It was then hot smoked at 60° C for two hrs. Chilled storage studies showed that the product had a shelf life of 4 weeks.

Fish fingers

Fish fingers from pangasius are prepared from the skinless fillets / portions of meat. The meat cut in the size of 8 X 2 X ¾ cm are cold blanched in 2% salt solution for 10 minutes, drained and coated with batter and breadcrumbs. The coated fingers are then flash fried for 30 seconds and stored in frozen condition.

Fish Balls

Battered and breaded fish balls were prepared using fish mince from pangasius. Fish mince was thoroughly mixed with salt, corn starch and spices. Then it was made into balls of 2-3 cm in diameter and cooked in boiling water for 5-10 minutes. The cooked balls after cooling were battered and then breaded. After flash frying in hot oil, the balls were kept in chill store. Biochemical and sensory evaluation had shown that the fish balls were acceptable up to 15 days in chilled storage below 4 ° C.

INSTANT FISH GRAVY POWDER

The instant fish gravy powder is a ready–to-prepare form in sachets. This is a new product developed by employing a standardized process with optimum combination of ingredients to get the desired flavour. The ingredient composition of the product was optimized by trials and sensory evaluation studies. This product has to be mixed with required quantity of water and boiled with fish steaks. The gravy powder in metallised polyester pouches can be stored in good condition for more than six months at ambient temperature. This product does not contain any preservatives and additives. The sachet contain the required quantity of gravy powder for the preparation of 500g fish curry sufficient for one serving for a four member family. A patent has been filed for this product.

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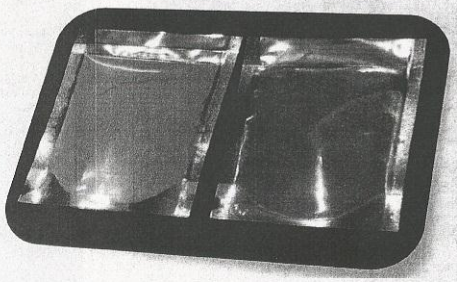
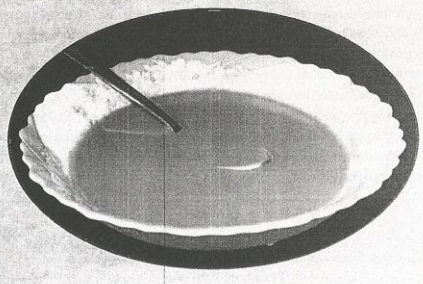
Ready –to- cook foods are categorized as convenience foods which are designed to save consumers time, reduce wastage from spoilage and reduce costs. Ready –to- eat fish curry in retortable pouch is available in the market which is very handy for the homemaker and save much time and avoids drudgery in the preparation of these products at home. Preparation of fish based dishes at home require a lot of ingredients other than fish which are to be cleaned, mixed, fried and boiled to make a gravy before the addition of fish or prawn to form the dish. Ready –to-cook instant fish gravy powder developed can be added to the fish at required quantity and boiled to prepare the dish within minutes.

Instant fish gravy powder

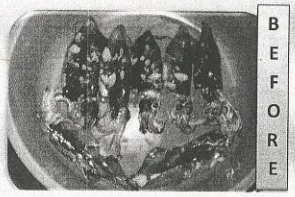


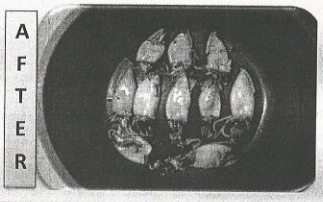
Instant fish gravy



Conventional fish gravy has a very short shelf life of 24 hours under normal conditions without addition of preservatives. At refrigerated temperatures (2 to 3°C) the shelf life can be extended to about 72 hours. By dehydrating the shelf life of the gravy mix can be enhanced to six months at ambient conditions with suitable packaging. The gravy powder is very convenient to be packed sachets of required quantity, easily transported and can be bulk stored with minimum facilities. To prepare 500g fish curry, 50g gravy powder will be required. The powder has to be dispersed in water and boiled with 200g cleaned fish steaks for 10 minutes.

Squid Peeling





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Fish De-Scaling Machine

Removing the scales of fishes is a tedious as well as time consuming job in the fish processing industry. Manual descaling not only involves labor and prolonged icing but also results in quality loss due to storage for overcoming the delay of processing. A Fish De-scaling Machine is designed and developed by Central Institute of Fisheries Technology in order to solve the problem of manual de-scaling of small sized fishes. The operation of the machine can be extended for removal of scales from all types of marine as well as fresh water fishes in batches. The machine is equipped with a perforated drum, an induction motor and variable frequency drive. Variable frequency drive is incorporated to standardise the operation of the machine for the efficient removal of scales by varying the rpm of the drum with respect to different size categories and species.

The complete body parts of the machine are made of SS 304. The drum of the de-scaling machine has a capacity to load 10 kg fish in a batch. The rpm of the drum can be adjusted at minimum of 2 rotations to a maximum of 80 rotations per minute.

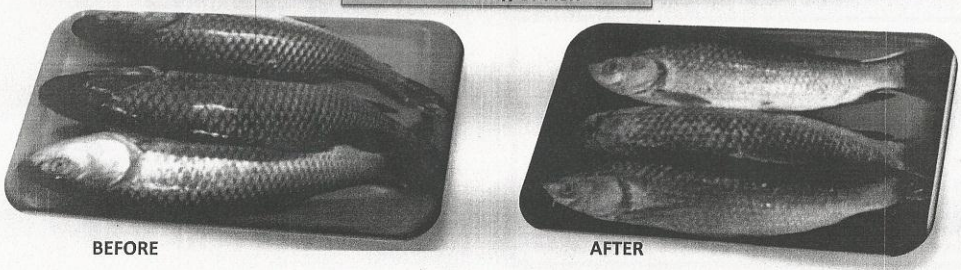
An RPM meter with electro-magnetic sensor is also attached to the De-scaling machine which gives the digital display of the rpm of the drum in the LCD display.Trials conducted have shown that 98% of the scales can be removed using de-scaling machine. For sardine, the de-scaling process requires 5 minutes at 20 rpm, for Rohu it is 10 minutes at 30 rpm and for tilapia it is 8 minutes at 25 rpm.

This is a batch process and the material can be loaded and unloaded easily and only one person is required to operate the machine. Water inlet and outlet facilities are provided to clean the machine easily.

Mechanization of de-scaling activity can significantly reduce the handling time thereby shortening the pre-processing period. This in turn reduces the overhead costs and also enhances the quality of the final product.

The process results in collection of entire scales which can be used for the manufacture of other high value products.

De-Scaling of Fish



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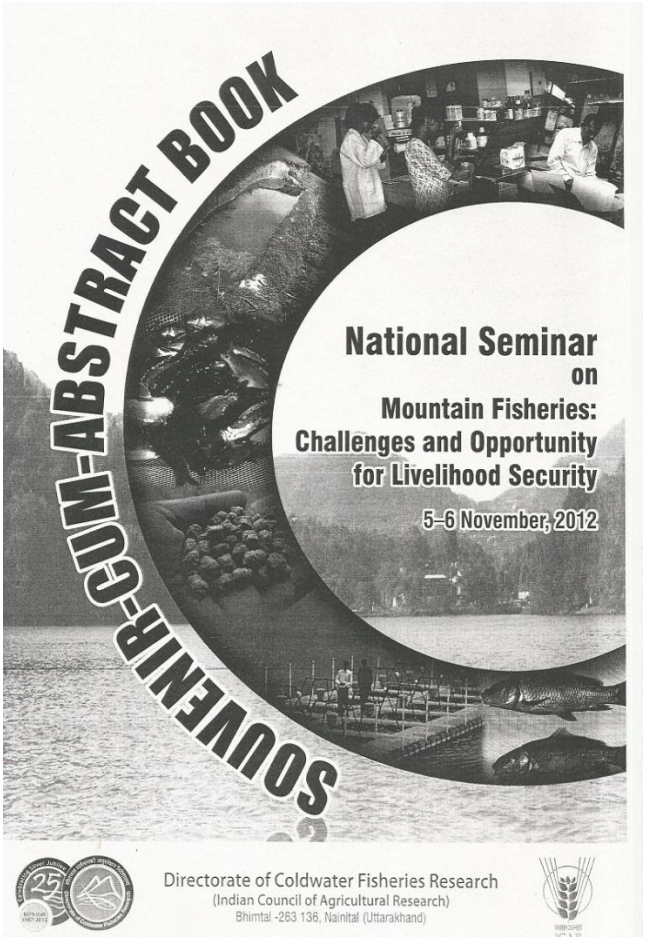

BH-2

Studies on the status of lipids, lipid peroxides and antioxidants with dietary supplementation of water-soluble chitosan during aging in young and adult rats

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Aging is a post-maturational process with progressive decrease in physiological capacity and the reduced ability to respond to stress leading to increased susceptibility and vulnerability to diseases. Advancement of age increases the risks related to various pathological conditions associated with cholesterol. In the present study the beneficial properties of dietary supplementation of water- soluble chitosan at 2% and 4% level in young and adult rats is envisaged.In aged animals total cholesterol, triglycerides, phospholipids, free fatty acids and lipid peroxidation were considerably high whereas antioxidants, superoxide dismutase, catalase, glutathione peroxidase and glutathione were low in the liver tissue. Dietary supplementation of water soluble chitosan reverted these age-associated differences to the status comparable to young rats. The results of this study conclude that dietary supplementation of water- soluble chitosan can improve liver function during aging and minimize the age- related disorders.

Key words: Aging, lipids, lipid peroxidation, anti-oxidants. water-soluble chitosan

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BH-3

Biochemical and sensory evaluation of Rainbow Trout *(Oncorhynchus mykiss Walbaum)* in chilled and frozen storage conditions

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This paper discusses the results of biochemical and sensory evaluation of chill and frozen stored rainbow trout (*Oncorhynchus mykiss* Walbaum). In this study the peroxide value showed fluctuations during the chilled storage, but the values were very low to cause rancidity or off flavour at any point of time during the study. Thiobarbituric acid values for whole ungutted trout samples remained low but increased steadily and reached a value of 14.1 µg MA/g on 9th day of chilled storage. Significant increase in TVBN values ($p < 0.05$) was observed from the 9th day and reached 31.25 mg N $100g^{-1}$ by the 14th day of chilled storage. During frozen storage at -20 0 C, peroxide values were relatively low and stable till 8 months after which there was significant increase reaching 6.89meq O_2 / Kg of oil. Free fatty acids showed the same pattern in frozen storage.Significant increase in pH was observed by the 10th month of frozen storage which corresponded to the spoilage of samples.Sensory evaluation indicated that the fish samples were spoiled after 14th day in chilled storage and the frozen samples were fit for consumption upto 10 months after which they were considered to be spoilt.

Keywords: Rainbow trout, chilled storage, frozen storage, Peroxide value, Total volatile nitrogen bases, sensory evaluation

BH-4

Hygienic handling and value addition options for rainbow trout (*Oncorhynchus mykiss* Walbaum)

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This study deals with the hygienic handling and processing of rainbow trout for better utilisation and value realisation. The methods for the preparation and process yield of various value added products viz., smoked trout, smoked & canned trout steaks, coated fillets are discussed in detail. Whole farmed rainbow trout stored in ice in chilled conditions can retain its saleable quality upto 14 days. The fish remained in excellent condition upto six days and can retain high quality upto nine days. Vacuum packed smoked trout had a shelf life of 4 weeks in chilled conditions compared to air packed samples which retained the quality upto one week. Coated trout fillets retained good sensory qualities for twelve months in frozen storage at -20° C. Smoked and canned trout steaks had good texture and flavour. This product had a salt content of 2.61% and the pH of the meat was 6.02.

Keywords: Rainbow trout, handling, process yield, value added products, chilled trout, smoked trout, canned trout steaks, coated trout fillets

BH-5

Quality evaluation of rainbow trout (*Oncorhynchus mykiss* (Walbaum, 1792) in chilled storage

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The shelf life and quality of farmed rainbow trout from India (*O .mykiss*) stored in ice and kept at chilled conditions (0-2° C) was evaluated based on chemical (Thiobarbituric acid (TBA), Total Volatile Base Nitrogen (TVBN), Peroxide Value (PV) , Free Fatty Acid (FFA), & pH) microbiological (Total viable aerobic bacterial count (TVC) Enterobacteriaceae& Coliform count) and sensory methods. Oxidative rancidity indices viz., PV and TBA were found to be poor indicators of quality. A two log reduction ($P < 0.05$) was noticed in the Enterobacteriaceae count the end of storage on day 15 while there was an increase in TVC over the same period (10^7cfu g^{-1}). The faecal coliforms and *E. coli* population in trout decreased during ice storage The TVB-N content ranged from 14.53 to 31.32 mg TVB -N/100 g flesh for whole trout samples, during the 15 day period of storage in ice. Significant reduction in NPN value was observed by the end of chill storage period, indicating the loss of flavour as well as commencement of spoilage of the samples. There was a sharp decline in protein extractability by the end of chill storage. The study shows that whole ungutted rainbow trout stored in chilled conditions can retain its saleable quality upto 14 days. The fish will be in excellent condition upto six days and can retain high quality upto nine days. Detailed sensory evaluation is the effective and practical method to assess the freshness of chill stored whole ungutted rainbow trout.

Key words: Shelf life, Quality, Rainbow trout, chilled storage, sensory evaluation

BH-13

Utilisation of Deccan Mahseer, *Tor khudree* (Sykes) for development of convenience products

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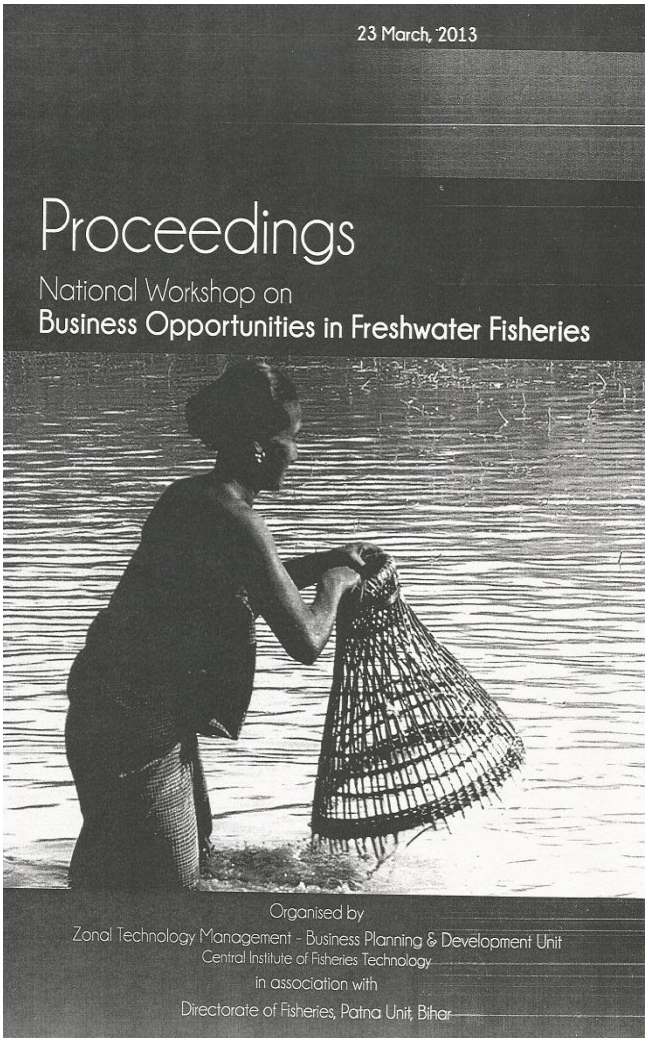
Tor khudree or Deccan Mahseer is unique to the peninsular region of India. The fish is highly priced for food and sport due to its large size, durability and taste. Deccan Mahseer is a source of livelihood and food security for the local fishermen and tribal population inhabiting the Chalakudy high ranges in Kerala. Limited quantities of fishes are caught and sold in nearby markets in the fresh and dried forms. This paper describes different types of convenience products that have been developed from Mahseer. They include ready to eat products like Mughalai UP curry and Punjabi curry in retortable pouches which can be stored for a period of one year at ambient temperature (28±2°C). Smoked skinless fillets had a shelf life of 2 months at 2-3 °C when packed in polyester polythene laminate pouches. Cutlets from the mincemeat of Mahseer have also been successfully prepared and stored for 12 months at -18°C. The meat of Mahseer is comparable to any other fresh water fishes like carps and can be effectively utilized for the development of different types of convenience products.

Keywords: Deccan Mahseer, Chalakudy, Smoked



CHAPTER 3

Post-harvest Technologies for Value Addition in Aquaculture

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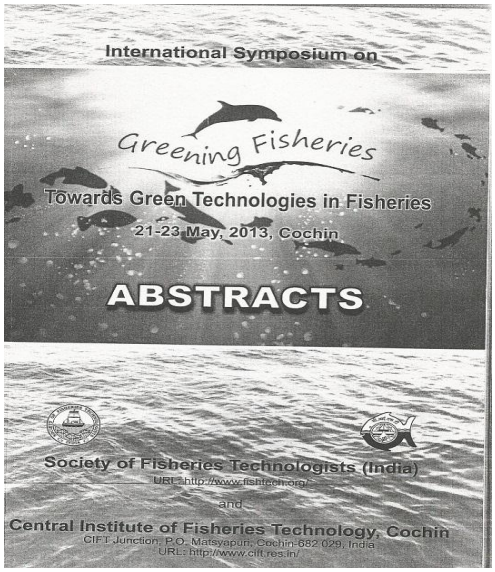
Among the various fresh water fishes supporting the Indian fresh water fishery, carps are the most important species contributing about 67.7% of the total inland fish production. The bony fishes including Indian major carps (*Labeo rohita, Catla catla, and Cirrihnus mrigala*) and Chinese carps (*Cyprinus carpio, Ctenopharyngodon idella, and Hyophthalmicthys molitrix*) form a major component of Indian aquaculture, as they can be easily cultured in low-input technology systems due to their herbivorous feeding habit. However, to ensure the continued expansion of fish culture, there must be a market for these species. Although the production of carps has gone up significantly, their market value has come down during the recent years. The reasons for the low market price are the low consumer preference and limitations in value addition due to problems of "muddy flavour" and presence of pin bones. However, these quality problems are minimum in cultured Indian Major Carps and they have white coloured meat and low fat content. Thus, there is a great potential for the development of some convenience products based on fillets and mince from these species to enhance their consumer acceptability.

Although there are wide variations in carp production technologies and consumer customs throughout the world, carp is perceived as a basic food that has a low /medium price and that has been sold predominantly live. It is true that carp can be produced at relatively low cost, but it does not mean that carp flesh has a low value. The edible parts of carp including gonads constitute 60-70% of the total live weight. The flesh of carps contains on average 69-80% water, 16-20% protein, 3-12% fat, and l.l-1.3% ash depending on the culture conditions. It contains most of the amino acids essential in human nutrition. The proportion of unsaturated fatty acids is 80%, with high levels of linoleic, linolenic and arachidonic acids. The flesh has a good texture and characteristic flavour. However the presence of pin bones and the muddy flavour are two major factors that adversely affect the consumer acceptance of carps.

Presence of intramuscular bones (Pin bones)

Although bones are a major attribute of almost all fish species, intramuscular bones represent a specific problem in freshwater fishes, particularly carps. There are 43 intramuscular bones on each side of the fish, 26 above the lateral line (20 of them have a typical Y-shape) and 17 below the lateral line. These bones can be found in the flesh approximately l/3 of the depth below the body surface. Pin bones from catla and Rohu



SSO-4

Effect of turmeric and cold smoking on the biochemical, textural and sensory attributes of striped catfish fillet during chill storage

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Effects of turmeric treatment as well as smoking duration on shelf life characteristics of striped catfish (*Pangasianodon hypophthalmus*) fillets during chill storage were evaluated. Fillets were given a dip treatment in 2% (w/v) turmeric solution for different smoking duration *viz*., 1 h and 2 h at 60°C. Biochemical analysis revealed a significant reduction in the free fatty acid (FFA), peroxide value (PV) and thiobarbituric acid reactive substances (TBARS) values in samples treated with turmeric for 1 h (T1) and 2 h (T2) compared to their respective control samples without turmeric treatment (C1 and C2) during storage at 4°C. The C2 samples recorded highest values for TBARS throughout the storage period. There was no significant change in pH within the samples over the storage period. Highest total volatile basic nitrogen (TVBN) content was observed in C1, followed by C2 samples. The textural parameters like hardness, springiness, chewiness and cohesiveness showed a decreasing trend in all the samples over the storage period. Higher hardness values were observed in C2 and T2 samples compared to C1 and T1 samples. The sensory

SSO-35

Standardization and quality evaluation of fish roll prepared from frame meat of rohu (*Labeo rohita*) stored under chilled conditions

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The recipe for fish rolls prepared from the frame meat of rohu (*Labeo rohita*) was standardised. Flash fried and control samples of fish rolls were made in the selected combination, packed in HIPP trays and kept under chilled condition. The samples were periodically evaluated for biochemical and sensory changes. Total volatile base nitrogen showed an increasing trend from 3.45 to 14.09 mg/100g in control samples where as in flash fried samples, the initial value of 3.45 has increased to 8.79 mg/100g during 17 days of storage. The TBA value also progressed during the course of storage in both samples. From the initial value of 0.3 it rose to 0.59 on flash fried samples whereas the change was rapid in control samples. Even though, the biochemical parameters were within the acceptable limits during the period of storage, the raw sample lost its appearance within 9 days while the flash fried samples remained acceptable for a period of 17 days.

Keywords: Frame meat, rolls, chilled storage, quality evaluation, rohu, *Labeo rohita*

SSP-68

Development and quality evaluation of a canned product from rohu (*Labeo rohita*) steaks in instant curry medium

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Freshwater fish, rohu (*Labeo rohita*) was canned in an instant curry medium. The fish steaks were subjected to flash frying at 170°C for different periods of time such as 30, 45 and 60 seconds. The flash fried fish steaks were packed in polyester-coated tin free steel (TFS) cans in 60:40 ratio (fish:curry) and heat processed in retort to an Fo value of 8.0. Physical tests of the can such as double seam efficiency, lacquer integrity, resistance to sulphur staining and food contact application showed that polyester-coated TFS cans are suitable for canning rohu. When flash fried and canned in curry medium there was an increase in the time required to provide the set Fo value (8) for 45 and 60 seconds flash fried samples, respectively. Sterility studies at 37°C and 55°C showed that all the canned samples including control were sterile. Sensory evaluation of the canned rohu in curry medium showed that 60 seconds flash fried product was rated as the best one while 45 and 30 seconds flash fried products were rated second and third, respectively. The products showed excellent quality attributes when tested after three months of storage. Textural attributes such as hardness, chewiness, springiness and cohesiveness did not show marked variation in the samples stored at room temperature during this period.

Keywords: Canned product, quality evaluation, rohu steaks in instant curry medium, *Labeo rohita*.

SSP-71

Development of striped catfish steaks canned in oil medium

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A process for developing striped catfish steaks canned in oil has been investigated in this study. Fish steaks of size suitable for packing in TFS cans were cut from skinless boneless fillets striped catfish (*Pangasianodon hypophthalmus*). The steaks were blanched in a solution containing 10% salt and 0.5% citric acid, followed by flash frying at 170°C. Flash frying for 1, 2 and 3 min were tried to find out the optimum frying time. The steaks were packed in TFS cans, followed by filling with hot refined ground nut oil. The filled cans were exhausted, seamed and heat processed in an overhead pressure autoclave at 121.1°C for Fo 8, 9, and 10. The cans were cooled to room temperature and taken for quality evaluation. Proximate composition of the fish meat, spoilage parameters, texture profile parameters, bacterial quality of the fish, sensory evaluation of the canned fish, can seam efficiency tests, thermal process validation parameters were carried out. Fo 8 was found to provide sufficient sterility. TPA analysis showed that the fish meat was soft in texture. Three min flash fried steaks showed better texture. The initial biochemical and sensory evaluation also has shown that the 3 min flash fried canned product has excellent characteristics. Water content in oil medium was also within the acceptable level in 3 min flash fried sample, as per BIS specifications.

Keywords: Fish steaks, flash frying, canning, striped catfish, *Pangasianodon hypophthalmus*.