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COCHIN



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From the Editorial Board.....

"Best Wishes for a Happy and Prosperous New Year 2017"

Fisheries is a dynamic sector and the growth and potential of aquatic fisheries resources is fluctuating, causing concerns throughout the world. However, the sector has been rightly identified as a sunrise sector due to its recent resurgence and multi-dimensional growth potential. India exhibited a tremendous growth over the years and the export figure in recent times is quite impressive with over 1 million tons worth over 33000 crore Indian rupees.

The R&D effort in the area is significant and scientific contributions often take the country forward directly or indirectly. The post harvest sector has flourished from simple chilling to sophisticated technologies and the products are available for consumers to relish. In this small pursuit, small ideas, concepts or work by the active researchers are compiled and presented for enlightening the interested in this area.

This issue of the publication covers 16 articles in the area of fishing technology, fish processing, quality assurance, biochemistry and microbiology. Contribution of motorized fishery to climate change and seasonal *Acetes* sp. fishery are highlighted as articles from fishing technology theme. The extension of shelf life of fish and fishery products and new innovative products from fish are the main articles from processing sector, while a few articles focus on the quality and quality improvements in fish and fishery products.

The editorial board invites more focused articles highlighting importance of different fisheries, novel or innovative products from the resources, glimpses on technologies and such related subjects, for the benefit of readers.

Motorized fishing contributions to climate change

Leela Edwin and Dhiju Das P.H.

ICAR-Central Institute of Fisheries Technology, Cochin

Until three decades ago small pelagic fish stocks of the south west Indian coast were exploited mainly by artisanal fishermen employing traditional gears such as the boat seine, shore seine, gillnets and other gears operated from plank-built canoes. To counter the sidelining of the traditional fisheries sector by the strongly emergent mechanized sector, the early eighties witnessed the introduction of the mini purse seine (ring seine) in the artisanal fisheries sector (Panicker, 1985). Subsequently, it became the most popular gear among traditional fishermen. At present, ring seiners of Kerala can be classified into motorized (using outboard motor, OBM) ring seiner and mechanized (using inboard motor, IBM) ring seiner. The mechanized ring seiners are mainly targeting species like mackerel, sardine, prawns, pomfret, etc. and motorized ring seiners target sardine, anchovy, prawns etc. In Kerala, nearly 80% of fish are landed by trawls and ring seines (ICAR-CMFRI, 2016).

The introduction of a lightly constructed purse seine (ring seine) by the ICAR-Central Institute of Fisheries Technology (ICAR-CIFT) for the traditional plank-built canoes by the artisanal fishermen, has now become a landmark event in the history of Indian fisheries. Though 300 ring seines were recommended for use by ICAR-CIFT in 1985 (Panicker, 1985), there were 2277 units in Kerala, providing work for more than half of Kerala's active fishermen by 1998 (SIFFS, 1999). The ring seines dominated the fishery and caused major setback to the non-motorized traditional boat seine operations. This system of fishing was so successful that it is now the dominant technique in the state of Kerala and has spread along parts of the west and east coasts of the country.

At the time of introduction, ring seines were operated from small canoes with very low power engines. Presently ring seines are operated from

high powered motorized and mechanized vessels. Recent studies reveal that in the past 30 years the size of the ring seines have grown at least three to four times in proportion to the extent of about 800 to 1500 m ring seine operated from 20-24 m wooden/ steel/ Fiberglass Reinforced Plastic (FRP) fishing vessels with 350-440 hp engines for mechanized ring seine operation and 500 to 650 m ring seine operated from 7-16 m FRP or wooden vessels with one or two 9.9/ 25 and/or 40hp engines for motorized ring seine operation (Edwin and Das, 2015). The ring seine operation uses small motorized vessel propelled by OBMs as skiff for assistance in fishing operation and transfer of catch to the landing centre.

The larger unit size increased the operational expenses for fuel, labour, daily operational allowance to the fishing crew, transportation, maintenance and repair. The high cost of fuel accounts for the high operational expenditure. OBM ring seiners which depend on petrol for starting the engine and kerosene for running, faced an increase of 800% cost for petrol and 2100% for kerosene since 1986. Diesel prices increased by 1500% since 1986. It is estimated that 62 - 66% of the total operational cost in OBM operated vessels is spent on fuel and 70 - 80% in IBM craft. While a motorized ring seine unit would use 150 liters of kerosene for production of one tonne of oil sardine landing, the fuel consumption would be 112 liters per ton of fish landed in a mechanized vessel.

One tonne of oil sardine - one of the most sought after fish variety in Kerala - when fished and brought to shore in a kerosene-fueled motorized vessel, would release 402 kg Carbon dioxide into the atmosphere. Carbon emissions would be lower (300 kg of carbon dioxide for every tonne of sardine) for a mechanized vessel which uses diesel engine for the catch.

So far in India, fishing impacts were

calculated through the direct effect towards the fishing area and to the targeted species. Apart from the targeted species, the impact of fishing methods go well beyond to the environmental burdens. In this scenario ICAR-CIFT, Cochin conducted software-based energy analysis in relation to fisheries Life Cycle Assessment (LCA) and carbon foot print studies to quantify the scale and importance of emissions in fisheries sector.

An LCA methodology is used to analyze the environmental burdens associated with mechanized and motorized ring seine fishing systems. This analysis encompassed operational inputs to fishing activities, inputs to fishing craft and gear construction, maintenance and service life of fishing system. This is done using material-wise analysis for ring seine fishing systems in detail and it is the first of that kind in Indian fisheries sector. During the LCA analysis for individual fishing unit including vessel and gear, the energy, raw material and ancillary inputs, other physical inputs, products, co-products and waste generated from the construction of the vessel to the landing of the catch were evaluated. The quantity of materials like steel used in hull, engine, propeller and shaft of the vessels, welding rod, electricity for welding and grinding, powering lamps, plywood for deck, wooden material, use of alloy for propeller, fiber glass mat, resin, other ingredients like paint primer, paint and antifouling paint were also taken into account. Studies in this regard show that in ring seine landing, fuel used for fishing contributed more than half of

the total impacts in eight out of the ten impact categories analyzed. Motorized ring seine fleet is having higher impact when compared to mechanized ring seine fleet except for Abiotic depletion potential elements (ADP elements) and Stratospheric ozone depletion potential (ODP), due to the high use of lead weight and polyamide webbing in mechanized fleets (Fig. 1a & b). Impact of motorized fleet Abiotic depletion potential fossil (ADP fossil), Acidification potential (AP), Eutrophication potential (EP), Global warming potential (GWP), Human toxicity potentials (HTP) and Photo-oxidant formation potential (POFP) shows more than 20% impact than mechanized fleet with a higher value of 24% in GWP.

The higher environmental impact of the motorized fleets are mainly due to the operational issues like the intensive use of kerosene as fuel by inefficient outboard engines, whereas mechanized ring seiners are propelled by inboard engines run by diesel. A similar study conducted in Norwegian fleet shows that 90 kg fuel was consumed per tonne of mackerel landed (Ramos *et al.*, 2011). Another in Galicia on the horse mackerel fishery reports that 176 kg of fuel has been used for the production of one tonne of fish. Studies on Spanish tuna fishery shows 420 kg of fuel usage per ton of production (Vázquez-Rowe *et al.*, 2010). There are no reported environmental impact studies based on CO₂ emission for any type of fishing method prevalent in the country.

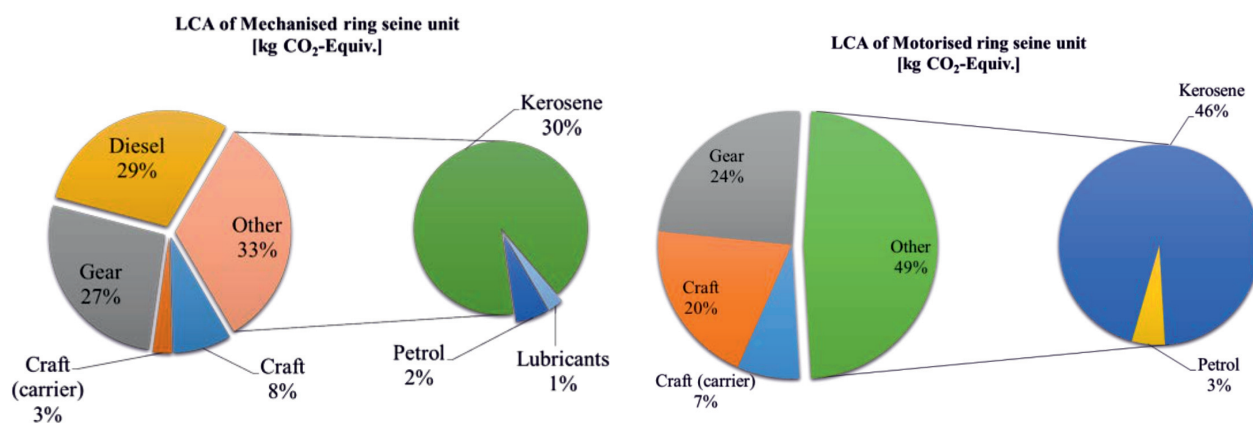


Fig. 1. Percentage contribution of a (a) mechanized and (b) motorized ring seine fishing system in operation to carbon emission

Through this study some important interventions can be proposed for the improved efficiency of this fishery like fishing vessel hull optimization, reduction of engine rpm, periodic maintenance of hull and replacement of two stroke petrol engine to inboard diesel engine in order to reduce environmental impact related to fishing operation and knowledge about pelagic fish spatial distribution to reduce the environmental impact by reduced shoal searching time. Use of high durability alternative webbing materials and appropriate use of lead sinkers will increase the life of gear and reduce the environmental impact.

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Seasonal fishery of *Acetes* sp. off Veraval

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¹ICAR- Central Institute of Fisheries Technology, Cochin

Acetes sp. are non-penaeid and epipelagic planktonic shrimp (Fig. 1). *Acetes indicus* and *Acetes japonicus* are the two species contributing to the *Acetes* fishery. They are called 'Paste shrimp' in English, and locally they are called 'Jawala' in fresh and 'Kolim' in dried form, in Marathi and Gujarati. Almost all species are occurring in flocks and exhibit spatio-temporal migration patterns. *Acetes* sp. is caught from 0.5 m to 150 m depth range depending on geographic location. In India they are mainly distributed in the coasts of Gujarat, Maharashtra, West Bengal, Andhra Pradesh, Kerala, and coast of Andaman and Nicobar Islands (Deshmukh, 2002).

A seasonal fishery of *Acetes* sp. exists in Saurashtra coast. In Veraval, fishery of *Acetes* sp. commences by January and end up by April and its peak season is February (Fig. 2). Wooden trawlers with length range of 35 - 45 ft and width range 13 - 16 ft and trawl nets with very small codend mesh size of about 13 - 25 mm are used for fishery. Average daily catch during the fishing season is 350 - 1000 kg/boat. About 90% of the catch constitutes *Acetes* sp. and the remaining 10% is contributed by other species like ribbon-fish, squid, squilla, crocker, small shrimps, octopus, sepia etc. (Fig. 3.) From a field survey it was assessed that the landing of *Acetes* sp. during January to April 2016 was 1932 t. The catch is



Fig. 1. *Acetes* sp.



Fig. 2. Freshly landed *Acetes* sp. off Veraval coast



A



B



C



D

Fig. 3. Landing of *Acetes* sp. in Veraval hoarbour (A,B,C) and dried *Acetes* sp. and other fishes from local fish market (D)

mainly sold to fish meal plants for meager amount and is sold in local market as dried *Acetes* sp. It is also sold to fish plants at ₹ 5-6 per kg.

Acetes sp. is also known to play an important role in the ocean food web. They are being important for transmittance of energy from one trophic level to next higher trophic level. *Acetes* sp. is preferred as food for many commercially important fishes like threadfin bream, catfish, ribbonfish, mackerel, lizard fish, crocker, Bombay duck, bull's eye etc. (Jaiswar and Chakraborty, 2005). Over-exploitation of *Acetes* sp. will lead to insufficiency of preferred food of many fish species and this may contribute to migration of

species in search of food, further causing depletion of the species from that location. Bombay duck is reported to resort to cannibalism in the absence of *Acetes* sp. which forms ideal food affecting the Bombay duck fishery as such by reducing the stock.

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Extension of shelf life of marinated Tilapia (*Oreochromis mossambicus*) fillets during chilled storage: Effect of high pressure and vacuum packaging

Bindu J., Tinu Thomas, Sarika K. and Panda S.K.

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Demand for fresh, additive-free and safe seafood products have stimulated efforts to discover novel processing methods to extend the shelf life of fresh products with minimum quality loss. The quality and safety of food products are the two factors that influence the choices of today's increasingly demanding consumers. Often, marination of fresh fish is employed to improve flavour and tenderness of the product. Conventional food sterilization and preservation methods often result in a number of undesired changes in foods, such as loss of smell, colour, flavour, texture, and nutritional value of the final product. High pressure (HP) processing, or High hydrostatic pressure (HHP) processing, or Ultra high pressure (UHP) processing is a relatively non-thermal food processing method that subjects liquid or solid foods, to a pressure between 100 to 1000 MPa (Hogan *et al.*, 2005). Extensive investigations have revealed the potential benefits of high pressure processing as an alternative to heat treatment. These benefits are apparent in various areas of fish processing, such as the inactivation of microorganisms and enzymes, denaturation and alteration of the functionality of proteins and structural changes to the materials. Tilapia is currently one of the most popular cultivated fresh-water fish in the world, to such an extent that it has been called the fish of the future (www.delishably.com). In the present study, high pressure processing was investigated for its effects on quality and shelf life of fresh tilapia fillets in combination with vacuum packaging, which is a popular method of extending the shelf life of food products.

Fresh farmed tilapia each weighing 100 g were divided into six batches. One batch was kept as control air packed without marination. The other five batches were marinated with spice condiments and kept for 30 min. One batch of marinated sample was air packed, the 2nd was vacuum packed and the 3rd was subjected to vacuum marination for 10 min. To compare the effect of vacuum impregnation of condiments into the fillets. All the

above four lots were packed in polyeter/polythene laminated films. The remaining two marinated samples were subjected to pressure processing in High pressure equipment (Model No: FPG7100:9/2C, Stansted Fluid Power Ltd., Essex, UK) at pressure levels of 200 MPa and 400 MPa with a ramp rate of 600 MPa and a holding time of 5 min. (Figs. 1-3).



Fig. 1. Raw tilapia fillets

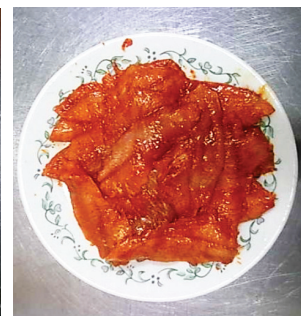


Fig. 2. Marinated tilapia fillets

Hardness of tilapia fillets (25 mm x 25 mm x 10 mm) measured using a Universal Texture Testing machine (Lloyd Model LRX, Fareham Hand, UK) were found to be decreasing in all the samples during chilled storage. The decreasing trend was less pronounced in pressure treated samples, with a least reduction in 400 MPa treated samples. Chemical analysis did not show significant difference in pH values between pressure treated samples at 200 MPa and 400 MPa, but the treatments showed an increasing trend during storage.

An increase in Total Volatile Base Nitrogen (TVB-N) values was found in all the samples, during storage with higher values in non-marinated AP control (25.12 mg N₂/100 gm) than marinated samples. The pressure treatment at 200 MPa and 400 MPa showed highest impact in reducing the TVB-N values, perhaps due to partial inhibition of bacterial growth. The oxidation indices values also increased during storage in all the treatments, but the effect of high pressure had a strong influence in reducing the PV, FFA and TBA values. Even though a marginal increase in oxidation rate



Fig. 3. Tilapia fillets with different treatments (A - Marinated air packed, B - Non-marinated, C - Vacuum packed, D - Double vacuum packed, E - 400 MPa treated, F - 200 MPa treated)

of high pressure processed samples in the initial phase was observed, pressure level of 400 MPa was optimal in controlling proteolysis, and TVB-N formation.

The average aerobic mesophilic count indicated that vacuum marinated-pressure processed (200 and 400 MPa) samples had a shelf life of more than 27 days, whereas marinated air and vacuum packed samples were rejected before 27 days. The control samples without marination had only 11 days of shelf life. Maximum shelf life was indicated by marinated tilapia processed under 400 MPa pressure, with more than 30 days of storage. The inactivation of vegetative microorganisms during pressure treatment may be due to changes in the permeability of the cell membrane resulting in improper transport mechanism, finally leading to lack of nutrients and cell death.

Application of high pressure improved the shelf life of marinated tilapia compared to conventional method of packing. The pressure level of 400 MPa was found to be optimal and most effective in prolonging the storage period to more than 30 days in chilled condition. The results of present study suggests that HPP as a commercially feasible processing solution over traditional processing methods for production of shelf-stable high value fisheries products.

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[http://delishably.com/food-industry/Why Tilapia is the fish of the future](http://delishably.com/food-industry/Why_Tilapia_is_the_fish_of_the_future)

Improving the quality of whole frozen Bombay duck (*Harpodon nehereus*)

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Drying is the only processing method adopted since long time by processors and fishermen to preserve the fish on commercial scale. Freezing is one of the best methods of preserving the fish for maintaining quality and its natural delicate attributes (Boonsumrej *et al.*, 2007). The quality changes in frozen samples can be minimized to a

greater extent by adopting additional treatments like glazing, packaging, pre-treatments like salt dip etc. Bombay duck being a moisture-rich species, has a delicate jelly texture and the texture may get affected on freezing and further storage. Hence, an attempt was carried out to derive the best freezing and dip treatment

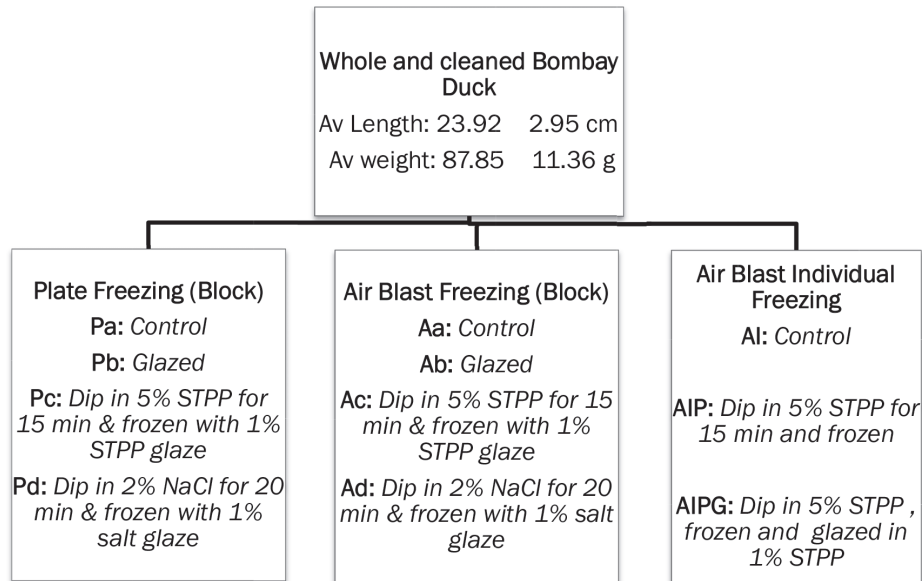


Fig. 1. Different freezing methods and treatments adopted for Bombay duck

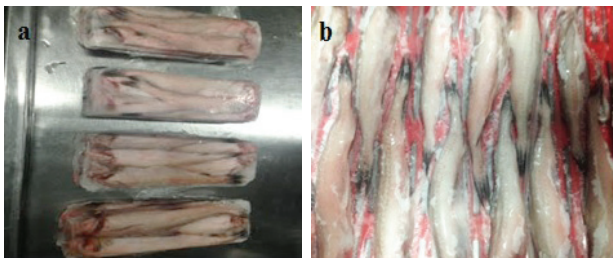


Fig. 2. a - Plate frozen Bombay duck, b - Air blast individually frozen Bombay duck

combinations that can be adopted to retain its prime quality during subsequent storage (Fig. 1 and 2).

Frozen samples were further stored at -20 °C

and were subjected to physical, sensory, biochemical and microbiological evaluation every month for a period up to six months.

Salt content (NaCl) of fresh sample was 0.47% which increased to 0.52% after dip treatment with 2% NaCl solution. The salt content in the samples registered a lower value of 0.48% on 6th month of frozen storage. Similarly the phosphate content of fresh sample was 0.22% which increased to 0.34% on subjecting it to 5% STPP dip. The value further decreased to 0.32% towards the final month of storage. Initial TPC of Bombay duck was observed to be 3 log₁₀ which on frozen storage for six months got increased by one log cycle in plate

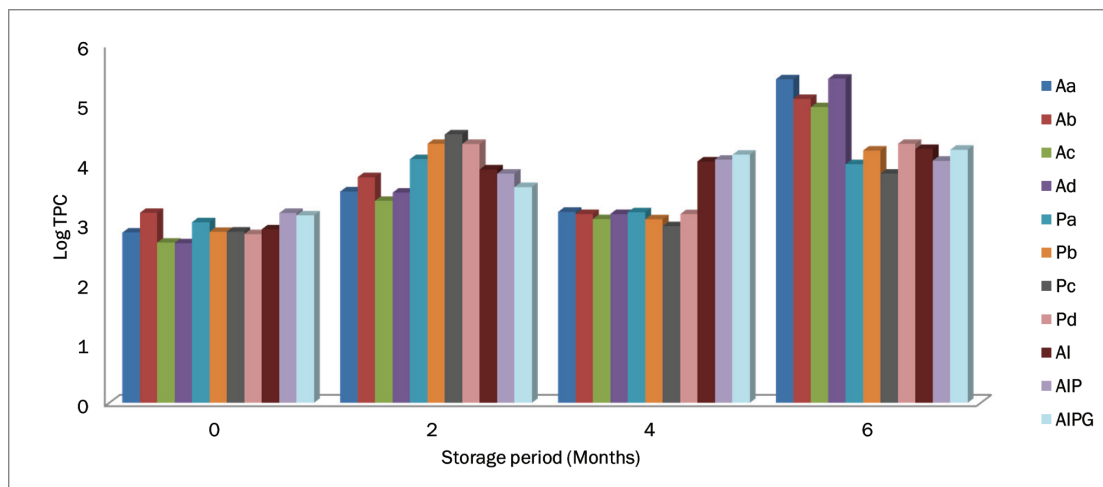


Fig. 3. Variations in TPC of frozen whole Bombay duck samples stored at -20 °C

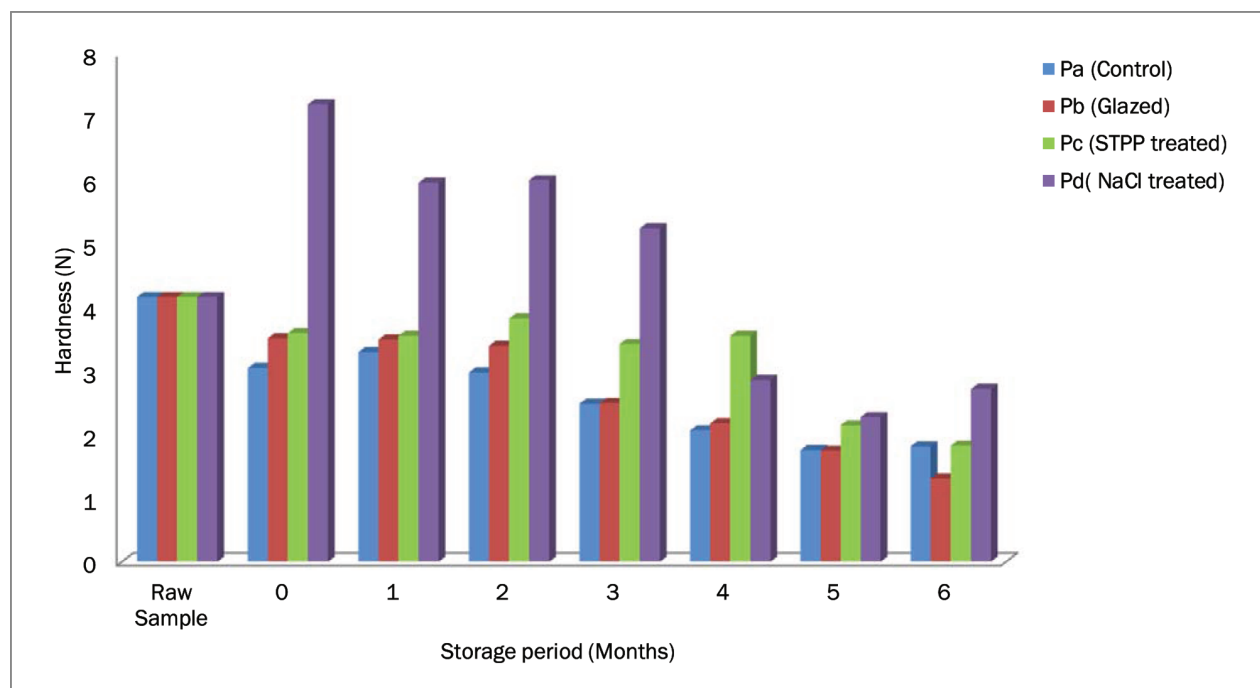


Fig. 4. Variations in hardness of plate frozen whole Bombay duck samples stored at -20 °C

frozen and air blast individually frozen samples and two log cycles in air blast block frozen samples (Fig. 3).

Texture of Bombay duck, as indicated by hardness value was found to be better in plate frozen samples compared to air blasted ones. It decreased from 4.17 N in raw Bombay duck samples to an average value of 1.21, 1.23 and 1.82 N in air blast block frozen, air blast individual frozen and plate frozen samples, respectively towards the end of storage period. Radhakrishnan *et al.* (1973) reported a loss of textural characteristics in block frozen dressed Bombay duck samples after three months of frozen storage. Additional treatments like glazing and salt treatments was observed to have a positive effect on the texture of the sample. Additionally, it was noted that NaCl treated samples exhibited a hardened texture compared to raw sample (Fig. 4).

Free drip and expressible moisture content were higher for individually frozen air blast samples compared to air blast block frozen and plate frozen samples. Salt treatment as well as glazing of samples showed comparatively lower free drip and expressible moisture contents compared to their respective controls. Similar observations of reduced drip loss were reported

by Goncalves *et al.* (2008) in phosphate treated pink cuskeel and searobin fillets. Biochemical, textural and microbiological analysis inferred plate freezing as better method for freezing of whole Bombay duck and additional treatments like glazing and salt dip enhanced the quality of the samples.

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Omega-3 fortified fish based granola bar as high value snack food

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Food fortification is a convenient and efficient means for enriching foods with different micro and macro nutrients. The changing lifestyle adds to the requirement of nutritious energy supplements along with a pleasing food portability method. Fortification of fish protein offers high quality digestible protein with fewer calories than similar sized portion of meat (Shaviklo *et al.*, 2011). Fish protein having a high biological value can balance the low lysine and sulphur-containing amino acids (methionine and cysteine) in cereals-based diet. Fish oil, an excellent dietary source of polyunsaturated fatty acids, Eicosa pentaenoic acid (EPA) and Docosa hexaenoic acid (DHA) has been encapsulated before incorporation in the food system in order to avoid oxidation (Kolanowski *et al.*, 2007; Santhanam *et al.*, 2015). The food bars are ready to eat snacks of good sensory and nutritional characteristics due to their high carbohydrate, proteins, lipid and mineral content (Izzo and Niness, 2001). In the present study, fish granola bars fortified with omega-3 fatty acids, which also contained fish protein and various sources of carbohydrates, minerals and vitamins, was developed (Fig 1). Further, the stability of the formulated bar was evaluated under ambient, elevated (37 °C) and sub-zero (-18 °C) temperatures.



Fig. 1. Omega-3 enriched fish-based granola bar

The granola bars are snack foods consisting of oats, wheat, puffed rice, corn, nuts and almonds usually baked until crisp, followed by heating the mixture, with continuous stirring to maintain a loose but cereal type consistency. Fish oil was added as a source of omega-3 fatty acids and fish protein powder as protein supplement. Accordingly, fish oil to a maximum level of 2% and fish protein powder at 5% level was found to be sensorily more acceptable. Ingredients composition and process optimization were done based on the physical and sensory evaluation of the formulated bar. The bars were packed in Paper-Aluminium Foil Polyethylene laminate (PFP) and stored under various storage conditions. The stored bars were analyzed for their nutritional composition, sensory, physico-chemical and microbial parameters at frequent intervals (Fig. 2 and 3).

The developed bars provide high calorific value of 395 kcal/100g. On an average each bar weighing 25 g contributes about 30 mg EPA + DHA to contribute to the daily requirements of 250 mg EPA + DHA. The storage analysis under ambient, elevated and extreme low temperature indicated low water activity (below 0.5) throughout the storage period, which is congenial for the low micro-

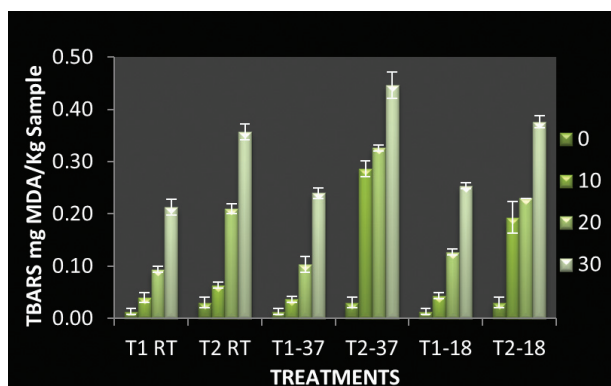


Fig. 2. Changes in TBARS value at different temperature of storages

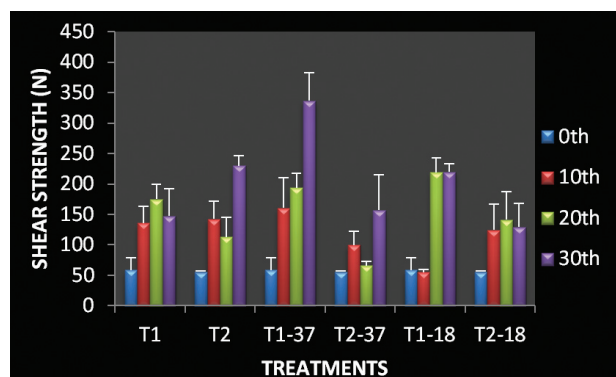


Fig .3. Changes in shear strength values at different temperature of storages

bial proliferation of the product during storage. The oxidative indices slightly increased during storage in the fortified bars, especially in those samples stored at 37 °C. The decrease in L* and increase in a* and b* values observed in 37 °C stored samples indicated the occurrence of Maillard reaction. Sensory scores indicated a similar consumer acceptance for all the three bars. The study indicated that fish-based bars were physico-chemically and microbiologically safe and shelf stable at room temperature, elevated and

sub-zero temperature and can be a good snack food for consumers.

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Natural pigments add consumer appeal of fishery products

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The demand for natural colours in food is set to increase due to consumer awareness on the deleterious effects of synthetic colours. Fortifying fishery products with natural colours from fruits and vegetables not only improves the aesthetic value of food, but also provide health benefits. Carrot and beetroot are rich source of pigments which are known for their antioxidant, anticancer, anti-atherogenic, anti-inflammatory and antimicrobial properties (Stintzing and Carle, 2004; Koley *et al.*, 2014). In the present study, fishery products namely battered and breaded stretched shrimp and fish wafers were fortified with beetroot and carrot pigments to enhance consumer appeal for the products.

Extraction of natural pigments: Natural pigments were extracted from beetroot (*Beta vulgaris*) and carrot (*Daucus carota*; orange cultivar) using a screw presser. The yields of pigment-laden liquid from beetroot and carrot were 73% (v/w) and 62% (v/w), respectively.

Battered and breaded shrimp fortified with natural pigments: *Litopenaeus vannamei* shrimp (mean weight 14.5g) were stretched using the CIFT-shrimp stretching mould. The extension in length ranged between 2 and 2.5 cm. Battered and breaded stretched *L. vannamei* was prepared by pre-dusting the stretched shrimp with dry batter and later coating the pre-dusted shrimp



Fig 1. Stretched shrimp coated with vegetable pigments and stretched shrimp dipped directly in undiluted beetroot pigment-laden liquid

with an adhesive type quick setting batter (finely ground wheat flour maida 2000g, corn flour 200g, Bengal gram 200g, salt 30g, guar gum 5g, turmeric powder 5g and sodium tri polyphosphate 10g) formulated at ICAR-CIFT, Cochin. Control shrimp were breaded using commercially available bread crumbs. Beetroot and carrot pigment-laden liquids were sprayed on commercial bread crumbs at different concentrations (1, 2, 4 and 8% v/w) to impart colour to the stretched shrimp (Fig 1). In another batch, stretched *L. vannamei* shrimp were directly dipped in the undiluted colour-laden liquid (separately in beetroot and carrot pigment-laden liquids) and later breaded with commercially available bread crumbs (Fig. 1).

The L^* (lightness), a^* (positive value-red; negative value-green), b^* (positive value-yellow, negative value-blue) values of control and pigment-fortified breaded shrimp was measured using Hunter's colorimeter (ColorFlex EZ, Hunter Lab) immediately after preparation. Beetroot pigment-fortified breaded shrimp had higher a^* value (10.7) whereas carrot pigment-fortified breaded shrimp had higher b^* (20.7) value (Fig 2). Stretched shrimp dipped directly in beetroot pigment laden liquid (undiluted) imparted a deep pink colour to the shrimps and after frying the outer layer of the shrimp had distinct pink colour (Fig 1b). However, based on taste, the bread crumbs coated with beetroot were preferred to direct dipping of the shrimp in beetroot-laden liquid and the results based on organoleptic

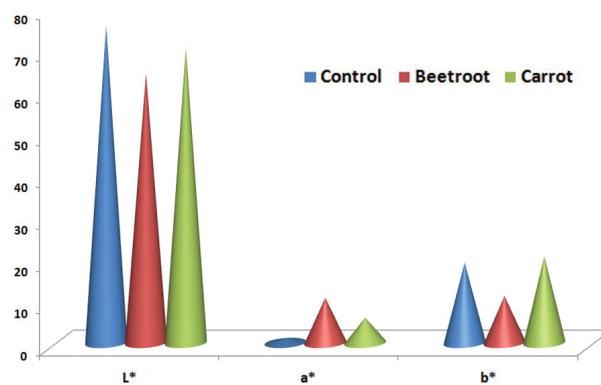


Fig. 2. Colour and lightness value of vegetable pigment fortified *L. vannamei* shrimp

evaluation (colour and taste) showed that beetroot pigment at 4% v/w and carrot pigment at 8% v/w had better acceptability.

Fish wafers fortified with natural pigments: Fish wafers were prepared using croaker (*Nibea maculata*) fish meat. Coloured wafers were prepared by mixing the ingredients in natural pigment-laden liquid extracted from beetroot and carrot. The ingredients for the preparation of wafers are given in Table 1. Wafers were prepared as per ICAR-CIFT standardized process. However, beetroot-fish wafers and carrot-fish wafers were prepared by substituting water with the pigment-laden liquid. The fish wafers were stored in sealed polythene pouches and stored at ambient temperature in a dry place.

The control wafers appeared off white, beetroot-fish wafer as dark pink and carrot-fish

Table 1. Ingredients for the preparation of control and coloured fish wafers

Ingredients	Control-fish wafer (%)	Beetroot-fish wafer (%)	Carrot-fish wafer (%)
Fish mince	23.0	23.0	23.0
Starch	23.0	23.0	23.0
Corn flour	11.5	11.5	11.5
Salt	0.5	0.5	0.5
Water	42.0	0	0
Pigment-laden liquid extracted from beetroot	0	42.0	0
Pigment-laden liquid extracted from carrot	0	0	42.0

wafers as bright orange in raw form/before frying, to the naked eye (Fig. 3a). However, on frying there was a distinct change in the colour of the fish wafers. Control fish wafers appeared light yellowish brown; beetroot-fish wafers as light pink and carrot-fish wafers as dark brown colour (Fig. 3b).

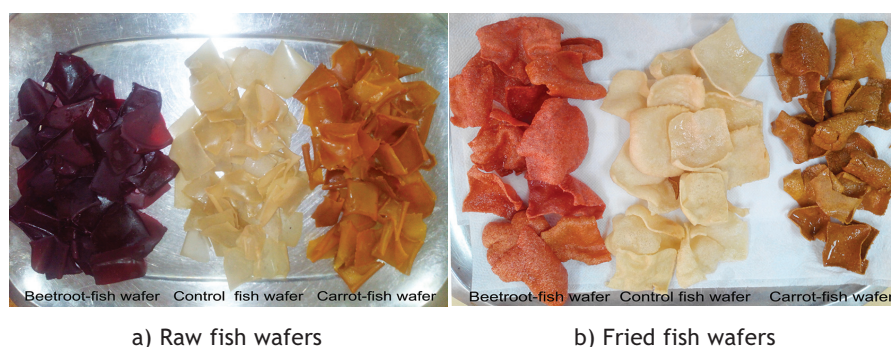


Fig. 3. Appearance of raw and fried fish wafers

The L^* value of raw wafers was distinctly higher for control fish wafer (51.55 ± 2.3) compared to carrot-fish wafer (35.95 ± 1.9) and

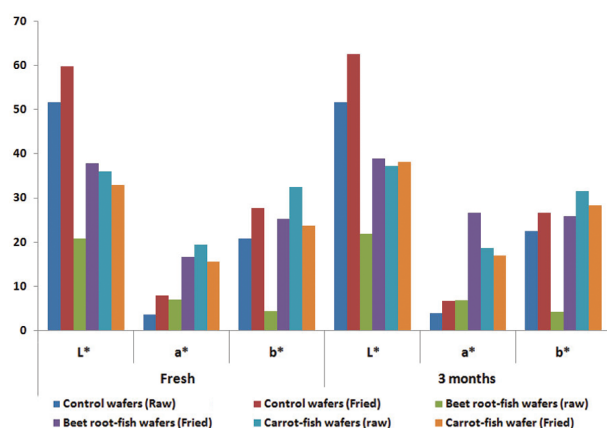


Fig. 4. L^* , a^* and b^* values of raw and fried fish wafers (Fresh and after three months storage at ambient temperature)

beetroot-fish wafer (20.7 ± 1 whereas a^* value and b^* value were higher for raw carrot-fish wafer (19.4 ± 1.8) (Fig. 4). Frying increased the L^* , a^* , b^* values of control fish wafers and beetroot-fish wafers but the increase in these values was relatively higher for beetroot-fish wafers. L^* value

of beetroot-fish wafers increased from 20.7 to 37.8; a^* increased from 6.9 to 16.6 and b^* value increased from 4.3 to 25.2. During storage at ambient temperature, there was a slight change in the L^* , a^* and b^* values of all the different fish wafers but the trend remained similar to that of raw fish wafers.

The texture of the fried control fish wafers and beetroot-fish wafer was puffy but carrot-fish wafer was crispy.

Battered and breaded shrimp and fish wafers fortified with beetroot and carrot pigments were simple to prepare, increased the sensory appeal and have the potential to enhance consumer appeal. The results indicate that beetroot was relatively better compared to carrot as a colour imparting natural agent.

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Collagen peptide fortified biscuits: Recent addition to geriatric diet

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Importance of functional foods, nutraceuticals and other health products has been well recognized in connection with health promotion, disease risk reduction and decrease in health care costs. Collagen peptide may be considered as a functional ingredient for its health beneficial effects. Collagen peptides are hydrolyzed forms of collagen i.e. short chains of amino acids. Collagen is one of the most abundant animal proteins. It is fibrous in nature and forms the basis of mechanical/ structural support in living tissues. The collagen peptides are water soluble and their bioavailability is relatively higher than native collagen. Collagen peptide consumption increases the bone mineral density and supports healthy joints. The peptide also provides better inflammatory response against inflammation arising from training and exercise (<http://www.vitalproteins.com/collagen-peptides.html>). Elderly/aged people suffer from various age-associated degenerative diseases particularly, bone-linked problems. Ageing is associated with inflammation and higher risk of osteoporosis due to changes in bone density (Culross, 2008). Age-related bone loss can be effectively prevented by the dietary supplementation of collagen peptide.

Biscuits are consumed world-wide, mostly due to their pleasant taste and flavor, ready to eat nature, accessible cost, availability and longer shelf time (Sudha *et al.*, 2007). The development of new functional ingredients has the advantage that food manufacturers can add extra value to products with which consumers are already familiar. Biscuits represents a potential choice for the addition of collagen peptide. Daily intake of about 10g collagen peptide is deemed to be helpful in increasing the bone mass density. With this aim, collagen peptide (@ 10%) was

incorporated into biscuits and effect of baking on various time-temperature combinations were studied.

With increasing baking time/ temperature, concomitant increase in darkness was observed (Fig. 1). The biscuits became much darker in appearance after being baked for elevated baking time or temperature. The browning reactions i.e. Maillard and others, occurring in the biscuit matrix probably caused the darkening (intense browning) of biscuits. As depicted in Figure 2, the sensory colour score was highest for biscuits baked at 180 °C for 9 min. and lowest for the ones baked at 200 °C for 9 min. on 9-point Hedonic scale. Sensory flavor scores for all treatment combinations varied minorly i.e. 7 to 8. The biscuits were liked 'moderately' to 'very much' on Hedonic rating by the sensory panelists. This

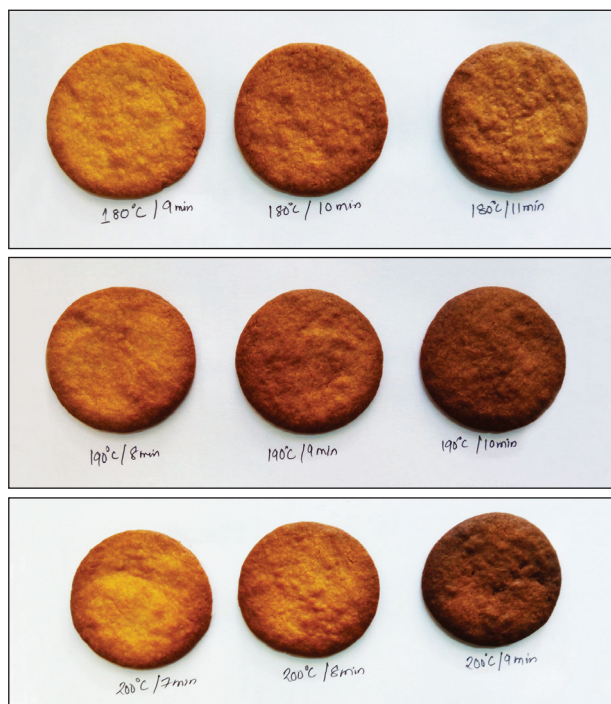


Fig. 1. Biscuits baked at various time-temperature combinations

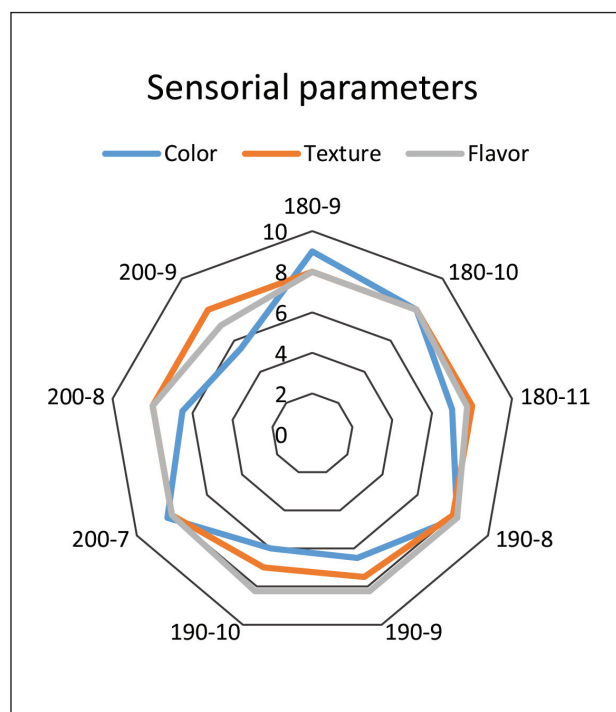


Fig. 2. Sensory characteristics of biscuit baked at various time-temperature combinations

depicts that addition did not cause development of any off-flavor components in the biscuits and likeability of biscuits remained almost similar for

all treatment combinations. Similar sensory scores were also obtained for 'texture' attributes of biscuits. The time-temperature combinations tested in the range given brought out meagre sensorially discernable changes in texture of biscuits.

The study suggests that collagen peptide could be effectively incorporated in biscuits wherein biscuits act as an ideal delivery vehicle through which collagen peptide can be orally ingested. The biscuits may exert preventive effect on age-linked bone disorders and could play an important role in geriatric nutrition.

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Fish caviar substitutes: A novel option for value addition

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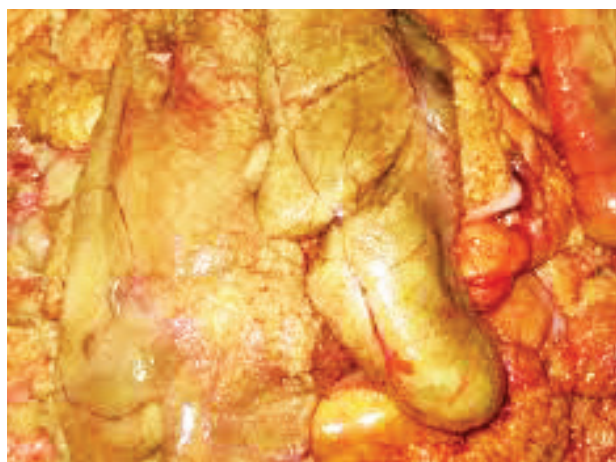
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The term 'roe' refers to the fully ripe internal egg mass in the ovaries of fish and certain other animals. Fish roes are highly nutritious as they contain considerable proportion of poly-unsaturated fatty acids and amino acids. Lipid profile of roes of some commercial fishes indicated higher proportion of phospholipids (as high as 37%) along with eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) in all the lipid classes (Rao *et al.*, 2010). Fish roes are rich in various extractives, particularly small peptides and free amino acids such as alanine, glutamic

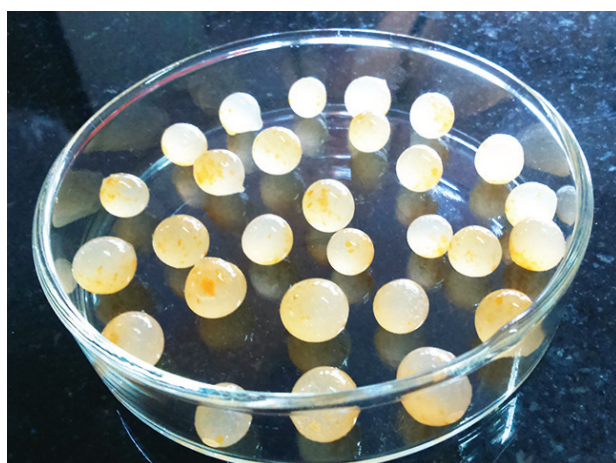
acid, valine, glycine, arginine and methionine, which give characteristic taste and flavour to the roe (Chiou *et al.*, 1988). However, direct use of fish roe in food formulations has several implications due to high susceptibility to fat oxidation, leading to the development of intense off-flavour. Currently, the roe obtained from fish such as salmon, sturgeon and cod has a potential commercial market, whereas roe from other fish species such as carp is either discarded or sold at very low price, as it forms a jelly mass during cooking. In order to diversify and enhance the

utilization of this nutritional resource, fish caviar substitute was formulated by reconstituting the dehydrated carp roe with sodium alginate at different proportions following reverse spherification technique.

A series of trials were carried out using freeze dried roe and sodium alginate to derive the ideal combination of the mixture components for reverse spherification. Further, the caviar forming solution was stabilized with polyphenol mixture extracted from dried oregano (*Origanum vulgare*) leaf. After the addition of oregano extract, the mixture was homogenized at 15 rpm for 10 min. in an ice bath to obtain a homogenous viscous suspension. The reverse spherification of caviar mass was achieved by dropping the suspension in to a cross-linking solution (Fig. 1). The biochemical, microbial and textural character-



Carp roe mass



Caviar substitute

Fig. 1. Caviar substitutes prepared from carp roe

istics of the resultant beads were evaluated under storage at 4 °C. The results were compared with beads made without addition of oregano extract.

The caviar substitutes were found to be shelf stable under chilled storage for a period of 16 days after which deteriorative changes were observed. The addition of oregano extract retarded lipid oxidation process. However textural data revealed that the substitutes containing oregano extract were much softer compared to control samples. Microbiologically, the oregano extract treated samples showed a lower Total Viable Count (TVC) compared to control beads which were in co-relation with the Total Volatile Base Nitrogen (TVB-N) values obtained for the samples. Scanning electron microscopic image suggested a honey-comb like structure for the freeze dried caviar substitute samples with 0.5% oregano extract, congenial for the better retention of polyphenol mixture for an extended period (Fig. 2). In brief, the results indicated that 0.5% concentration of oregano extract was sufficient to prevent oxidative and microbial degradation in the product. Thermal Gravimetric Analysis (TGA) confirmed the stability of oregano polyphenols in caviar substitutes as there was no separate transition band for oregano extract.

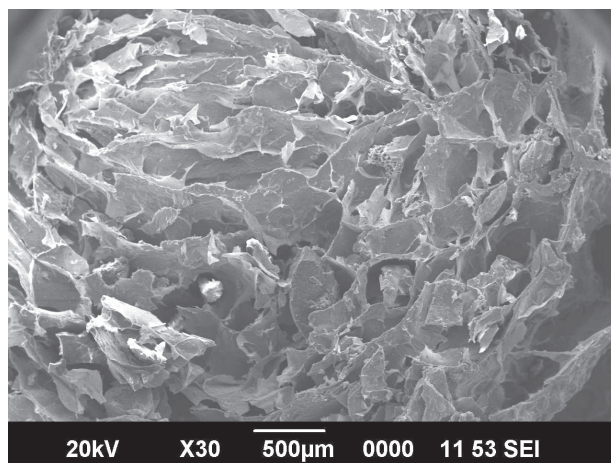


Fig. 2. SEM image of caviar substitute with honey comb structure

The current study identifies the potential of utilizing the roe from freshwater carps by converting the roe mas to novel high value products such as fish caviar substitutes with suitable stabilisers such as plant polyphenols.

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FTIR characterization of sulphated polysaccharide extracted from brown seaweed (*Polycladia indica*)

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In recent years, seaweeds have drawn world-wide attention due to their use in many industrial and pharmacological applications. Seaweeds are known to produce a variety of bioactive components having varied structures and interesting biological activities (Kim and Bae, 2010; Kong *et al.*, 2009; Shibata *et al.*, 2008). Brown seaweed belongs to a very large group, Phaeophyceae and contain fucoxanthine, a greenish brown pigment which gives them their name (Mestechkina and Shcherbukhin, 2010; Reddy and Urban, 2009). Brown seaweeds produces a range of compounds including secondary metabolites such as alkaloids, terpenoids, and phenolics, many of which are economically important and having specific biological activities (You-Jin Jeon *et al.*, 2011). Over the past few decades, bioactive sulphated polysaccharides isolated from brown seaweeds have attracted attention in the field of biochemistry and pharmacology. Functional polysaccharides such as fucans and alginic acid derivatives produced by brown seaweeds are known to exhibit different biological properties including anticoagulant, anti-inflammatory, antiviral, and antitumoral activities (Boisson-Vidal *et al.*, 1995; Costa *et al.*, 2010; Lee *et al.*, 2008).

The characterization of sulphated polysaccharide extracted from a brown seaweed (Fig. 1), using FTIR spectroscopy (Fig. 2), revealed



Fig.1. Sulphated polysaccharide extracted from *Polycladia indica*

a broad band at around 3440 cm⁻¹ assigned to the OH and H₂O stretching vibrations. The bands around 2854 -2925 cm⁻¹ indicates the CH stretching in pyranoid ring and C-6 groups of fucose and galactose units. The peak around 1710-1665 cm⁻¹ is assigned for C=O stretching. The transmission spectra near 1707 cm⁻¹ vibration revealed the presence of some O-acetyl groups in crude fucoidian. Band between 1650-1580 cm⁻¹ is specific to amide group, which is mainly due to

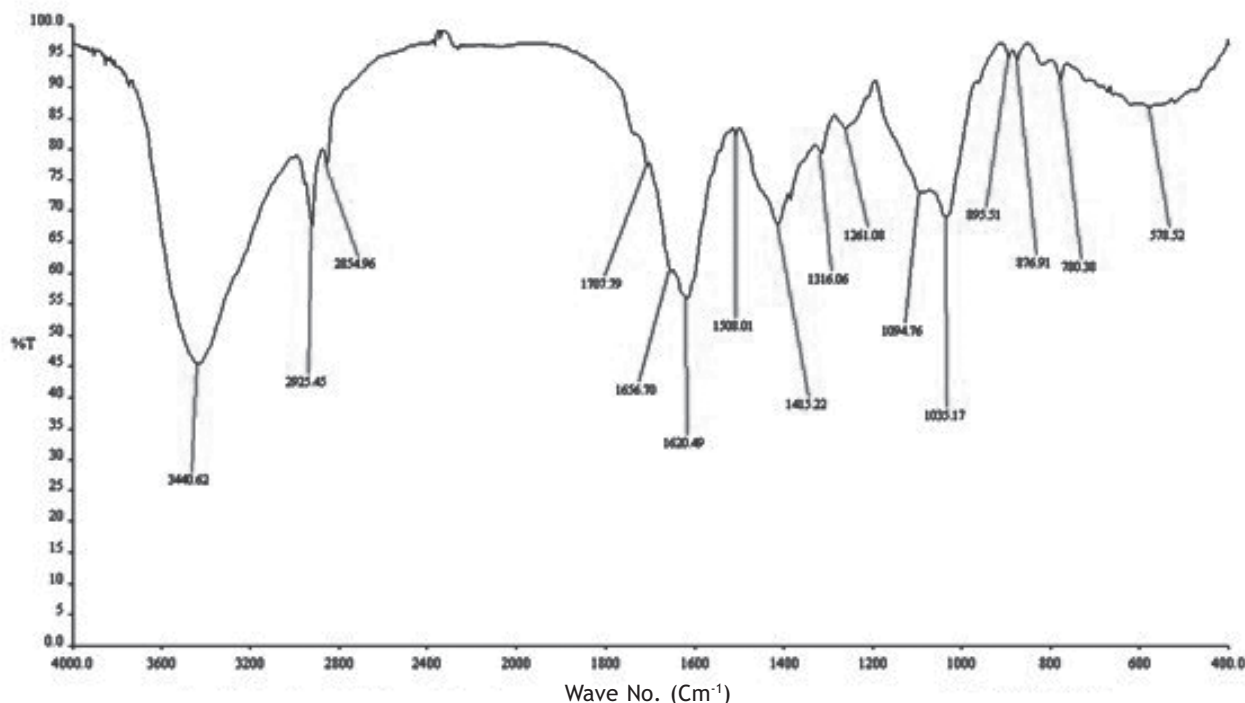


Fig. 2. FTIR Spectra of sulphated polysaccharide extracted from brown seaweed *Polycladia indica*

C=O stretching vibrations of peptide bond or due to the carboxyl functionality affected by adjoining substitutions. The peak near 1620 cm^{-1} is coherent with the presence of uronic acids. The fingerprint region reveal the presence of S=O stretching vibration of ester sulphate group near 1261 cm^{-1} and Peak at 1094 and 780 cm^{-1} confirms the presence of glucuronic and manuronic acid respectively. The extracted polysaccharide contains a peak near 1035 cm^{-1} revealing the presence of D-glucose unit also.

The overall study revealed that the polysaccharide extracted from seaweed *Polycladia indica* has a typical fucoidian structure which contains sulphate group, uronic acid, D-galactose, glucuronic and manuronic acid. The presence of different functionality especially O-acetyl group qualifies the polysaccharide as an efficient immuno-stimulant.

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Effect of squilla protein hydrolysate on lipid oxidation of fish nuggets during refrigerated storage

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Lipid oxidation causes loss of nutritional qualities and gives unpleasant odour in fishery products (Dong *et al.*, 2008). In recent years, the use of natural antioxidants in fish-based products has been evaluated to replace or minimize the use of synthetic additives, satisfying the consumers demand for products with natural characteristics (Sancho *et al.*, 2011). The present study was conducted with an objective to evaluate the effect of Squilla Protein Hydrolysate (SPH) on lipid oxidation and quality changes of fish nuggets during refrigerated storage. Protein hydrolysates were extracted from Squilla as per the method developed by Chang-Feng *et al.* (2005) using three proteases namely Alcalase from *Bacillus licheniformis*, Flavourzyme from *Aspergillus oryzae* and Pepsin from Porcine gastric mucosa. SPH was found to be rich in antioxidant activity.

Fish nuggets were prepared from marine catfish (*Netuma thalassina*; mean weight 3.5kg) mince. Catfish mince was divided into five batches viz., C1: Control without addition of SPH, C2: Standard control with addition of 1% (w/w) ascorbic acid, T1: Mince with 1% (w/w) SPH prepared using pepsin, T2: Mince with 1% (w/w) SPH prepared using Alcalase and T3: Mince with 1% (w/w) SPH prepared using Flavourzyme. Other ingredients were salt (2%) and corn starch (5%). All the ingredients were ground uniformly and spread on aluminum trays (thickness 2-2.5 cm) and steam cooked for 15 mins. After that it was

allowed to cool and cut into nuggets shape. Different batches of fish nuggets were packed in thermofoam trays and stored under refrigerated temperature (Fig. 1). Samples were drawn at regular intervals and assessed for quality parameters viz. total plate count (TPC), thiobarbituric acid reactive substances (TBARS), peroxide value (PV), moisture and sensory properties.

Moisture content of all the samples decreased during storage period. However reduction of moisture was very less in case of T2 i.e. fish nuggets with addition of 1% SPH prepared using alcalase (Fig. 2a). PV of C1 i.e. control sample reached 19.2 meq of O₂ / kg of fat by the end of storage period whereas treated samples (T1, T2 and T3) showed relatively lower PV values as compared to control sample (C1) at the end of 10 days of storage (Fig. 2b). After 10 days of storage, fish nuggets incorporated with SPH showed slightly lower TBARS value (mg MDA/Kg) of oil as compared to C1 (Fig. 2c). However, there is no change in TBARS value in case of fish nuggets containing 1% ascorbic acid (C2). Sensory scores for appearance, colour, flavor, odour, taste and texture were found to be higher for the treated samples (Fig. 2d).

TPC of C1 reached 1300 cfu/g, whereas TPC of treated samples (C2, T1, T2, T3) was 100 cfu/g at the end of 10 days of storage at refrigerated temperature. The results of the study indicate that

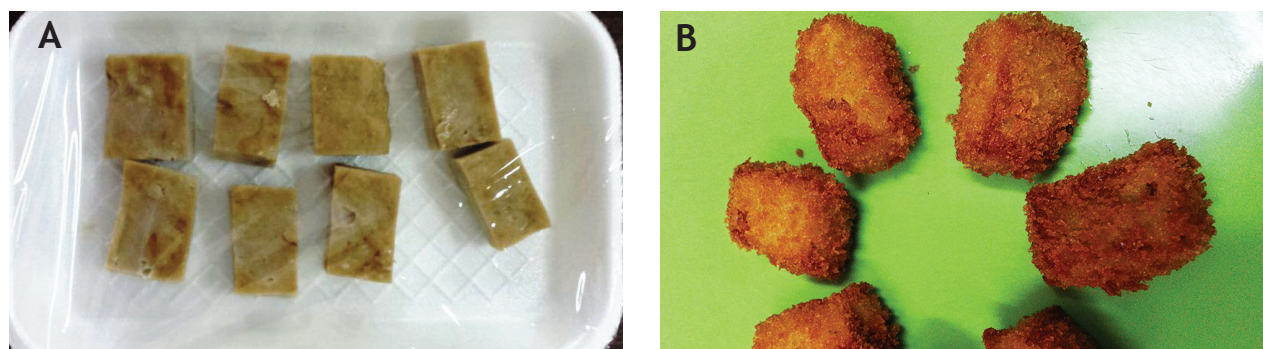


Fig. 1. Fish Nuggets (a) Fish nuggets in thermofoam tray and (b) Fried fish nuggets

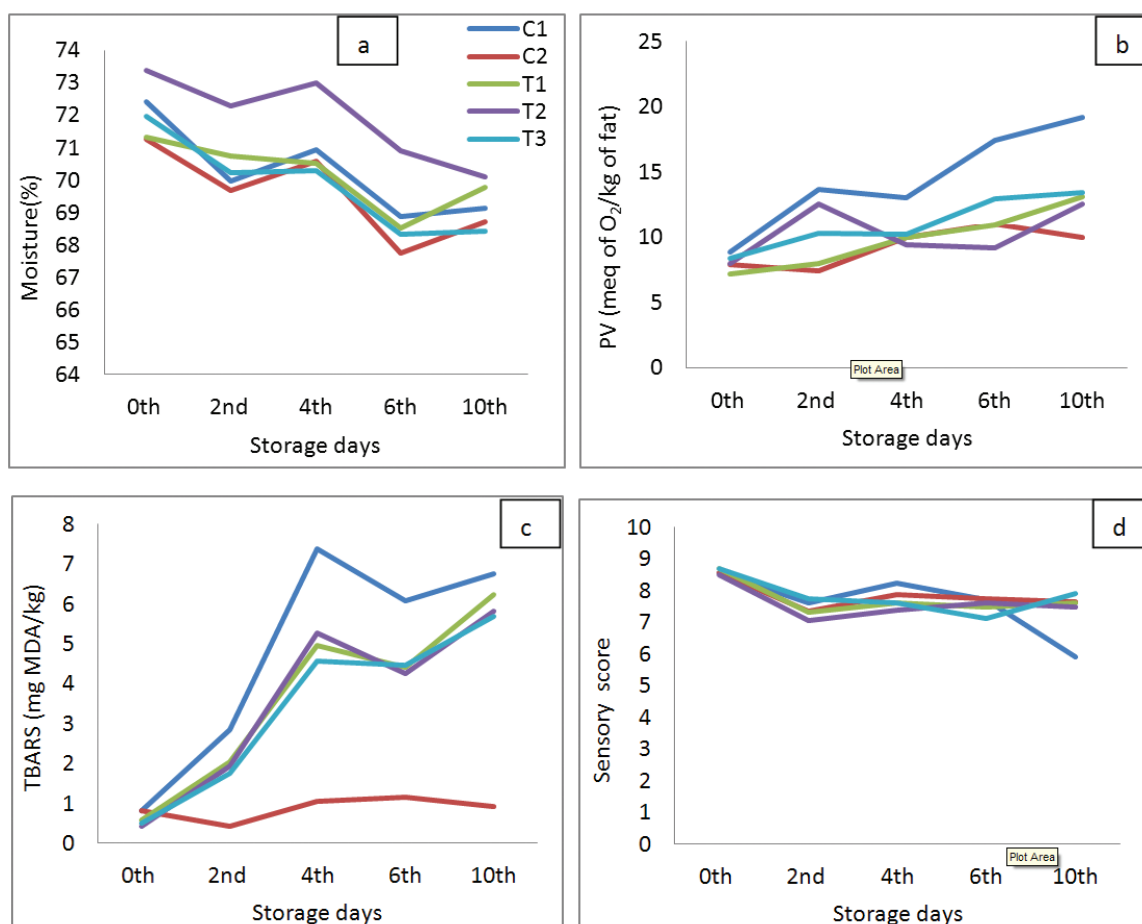


Fig. 2. Changes in untreated and SPH treated samples during refrigerated storage: (a) Reduction of moisture; (b) Changes in PV values; (c) Changes in TBARS values, and (d) Changes in overall acceptability

SPH is a promising alternative to replace harmful synthetic antioxidants in fishery products.

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Chitosan-capped gold nanoparticles: Application as temperature history indicator during frozen storage

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Temperature is the most crucial factor affecting the quality by influencing kinetics of physical, chemical and microbial spoilage in perishable food commodities. The storage temperature of the temperature-sensitive products like chilled, refrigerated and frozen products are monitored strictly to overcome these spoilage-associated changes. At present, the temperature history of frozen products in the food processing establishments is monitored using temperature recorders. There is no mechanism to track the temperature abuse of foods during transportation and distribution and in retail stores. A visible temperature abuse indicator will be useful for maintaining the proper storage conditions at all stages. This can be achieved through nanotechnological interventions by using nanotechnology-based biosensors like time-temperature indicator (TTI) for frozen storage applications. TTI - belonging to the smart packaging technology - are becoming popular as they provide very helpful information on whether a threshold temperature has been exceeded over time or not, visually. Among the metal nanoparticles, gold nanoparticles (AuNPs) have attracted considerable attention across the globe due to its unique therapeutic activity, optical behaviour and inert and non-toxic nature. Although many researchers have demonstrated the synthesis of AuNPs using chitosan (Wang *et al.*, 2006; Huang and Yang, 2004) there is very limited reports on the use of chitosan-capped gold NPs for biosensor applications.

At ICAR-CIFT, Cochin a study was undertaken to optimize the conditions for synthesising the chitosan-capped gold NPs and to assess its application as temperature abuse indicator for frozen stored foods. Low molecular weight chitosan with degree of deacetylation of 81.34% was used to optimize chitosan concentration, heating temperature and time for the synthesis of AuNPs. Chitosan concentration of 0.25% (w/v) at heating temperature of 90 °C for 15 min. was found to be optimum for the synthesis of AuNPs. In UV-Vis spectra, the AuNPs exhibits a Surface Plasmon Resonance (SPR) band at around 526 nm due to collective oscillations of the electron at the surface of the nanoparticles that is correlated with the electromagnetic field of the incoming light. In the present study, λ_{max} was observed at 530 and 540 nm for 0.125 and 0.25% chitosan, respectively, indicating a shifting peak to the right (red-shift) mainly due to the formation of AuNPs of various shapes, size or concentration dependencies (Fig. 1). The size of the chitosan-capped gold NPs was 30.6 nm for 0.25% chitosan compared to 59.8 and 175.6 nm for 0.125 and 0.0625% chitosan, respectively. The zeta potential was least for 0.25% chitosan-capped gold NPs and increased with the decrease in the chitosan concentration. FTIR spectra of chitosan-capped gold nanoparticles exhibited almost similar peaks as that of pure chitosan indicating uniform deposition of chitosan over gold nanoparticles (Fig. 2). To assess the effectiveness of chitosan-capped gold NP as temperature abuse indicators, the frozen AuNPs prepared from different

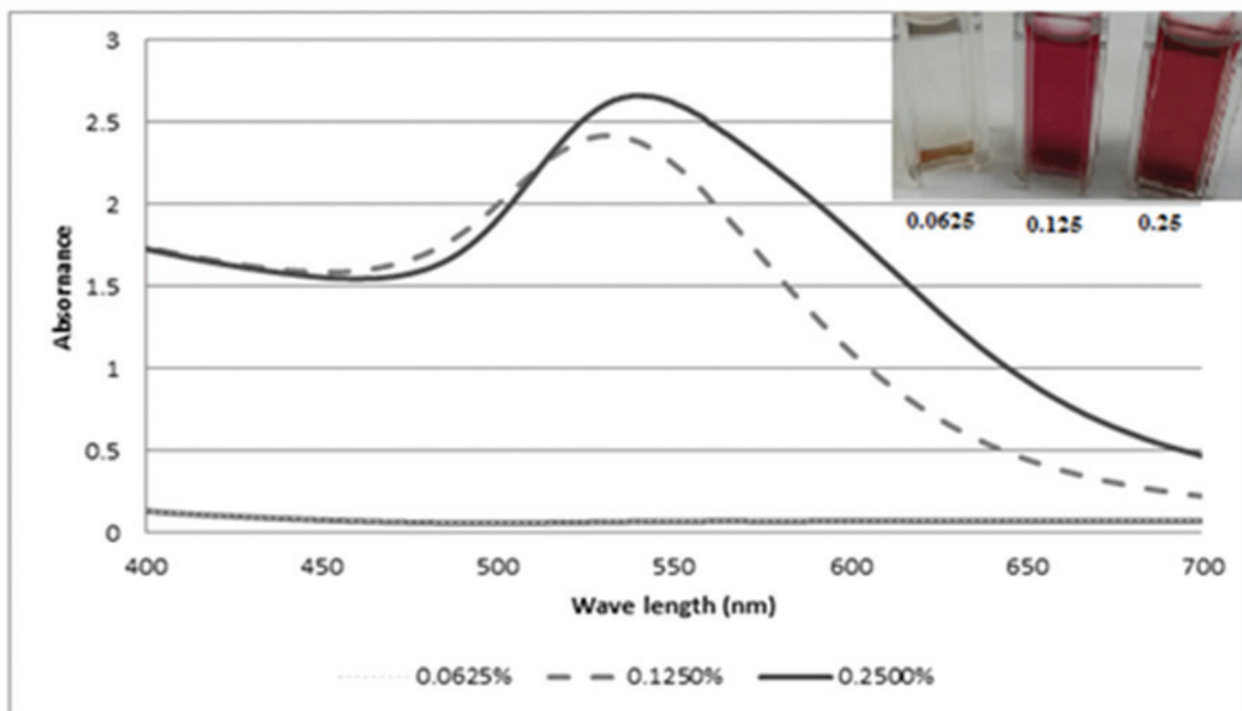


Fig. 1. Effect of chitosan concentration (0.0625, 0.125 and 0.25%) on the UV-Visible spectra and visible colour (inset) of chitosan-capped gold nanoparticles

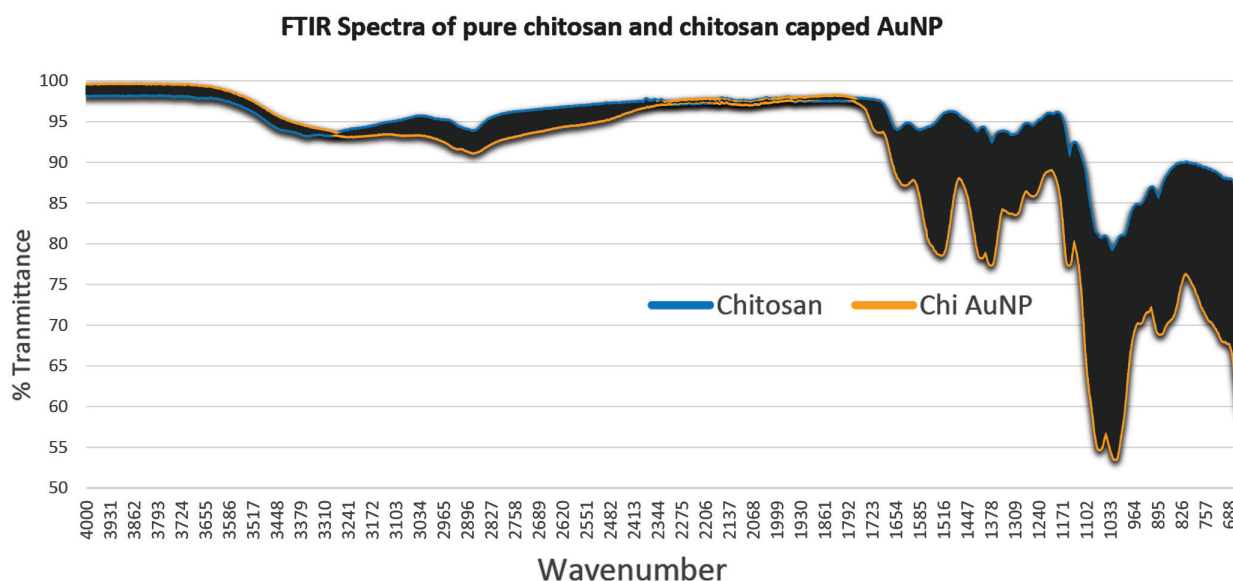


Fig. 2. FTIR spectra of pure chitosan and chitosan-capped AuNP

concentration of chitosan were exposed to temperature abuse condition (37 °C) and variations in the chitosan-capped AuNPs were characterized. Upon exposure to temperature abuse conditions, the peak intensity increased with increase in the period, particularly in 0.25% chitosan-capped AuNP and λ_{max} observed a shift

towards left at 520-524 nm (Fig 3). Exposure to abused temperature for over 4 h showed a clear difference in the peak intensity as well as visible colour changes. The study revealed that chitosan-capped gold nanoparticles can be used as temperature history indicator for food products as well as for pharma products.

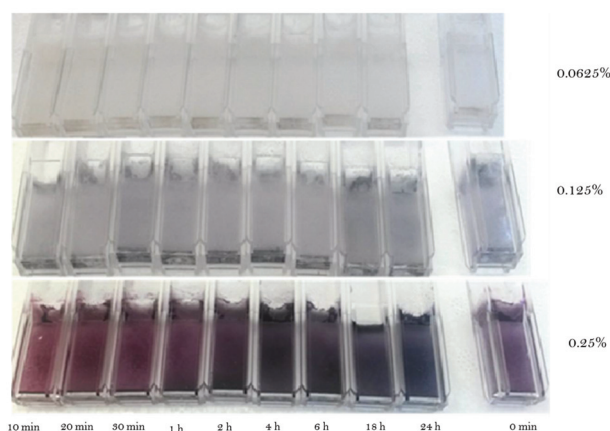


Fig. 3. Effect of temperature abuse on the visible colour change of chitosan AuNP at different concentrations (0.0625, 0.125 and 0.25%) exposed to different time intervals (0 min. to 24 h)

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Slurry ice for improving quality of fish and shellfish onboard

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Total fish production in India during 2013-14 was 9.4 Mt of which 4.60, 2.62 and 0.11 Mt was contributed by East, West coasts and Union Territories, respectively. The ice requirement is same as that of landed fish, as recommended fish to ice ratio is 1:1. Accordingly, total requirement of ice across the coastal states is approximately 10 Mmt. The cost of freshwater ice is around ₹ 2000/ t. In the North West coast of India including Mumbai region, use of slurry ice manufactured using sea water is gaining popularity. The use of slurry ice system for onboard chilling of fish is one of the recent developments. Compared to conventional solid ice, slurry ice offers several advantages like uniform cooling and even heat transfer. Slurry ice engulfs the fish completely without leaving any air pockets and ensures rapid and even heat transfer. Slurry ice also reduces physical damage caused to seafood products due to spherical

microscopic ice particles when compared to aciculate crystals of flake ice. When technical advantages are considered, it is possible to pump the slurry ice mixture thus making fish handling more hygienic. Varying capacities of slurry ice machines from 4 to 10 tons per day are available for installation onboard the fishing vessels. The slurry ice temperature ranges between -2 to -6°C depending on the salt content of seawater. Slurry ice unit can be operated either by diesel engine or through electrical power mode which costs around ₹ 7.5 to 12.5 lakh depending on several factors like capacity. In Mumbai region, four trawlers have installed the unit onboard the fishing vessel and more initiatives have been taken for installation of slurry ice units in Gujarat, Goa, Andhra Pradesh and Tamil Nadu.

Onboard handling is one of the parameters that determine the quality of fish and hence their economic value. The present study was

undertaken to evaluate the effect of slurry ice on the biochemical, textural and microbiological quality of pink perch (*Nemipterus japonicus*) and tiger shrimp (*Penaeus monodon*), stored onboard for seven days. Slurry ice was prepared from filtered seawater (salinity: 3.5%) onboard fishing vessel using ICEFLOW (Chirag Ice Factory Pvt. Ltd., Navi Mumbai) machine working with BOCK F4 compressor using chlorodifluoro methane (R-22) as refrigerant. The temperature of the slurry ice mixture was -2 °C. Pink perch and tiger shrimp with average length of 13.40 cm and 9.36 cm and average weight of 16.77 and 11.09 g respectively were caught and stored onboard fishing vessel under slurry ice conditions.

The L*, a* and b* values were 63.84, 5.61, 17.42 for pink perch and 51.04, 9.35 and 15.99 for tiger shrimp picked meat respectively. The proximate composition of pink perch and tiger shrimp stored under slurry ice is given in Table 1.

Biochemical quality parameters were evaluated for pink perch and shrimp stored under slurry ice and the values are presented in Table 2. The values for pH of pink perch and shrimp meat were found to be in the neutral range. Tri methyl amine nitrogen (TMA-N) and Total volatile base nitrogen (TVB-N) content for

Table 1. Proximate composition of pink perch and tiger shrimp stored onboard under slurry ice

Parameters	Pink Perch	Tiger Shrimp
Moisture (%)	78.23	78.57
Crude protein (%)	18.20	18.43
Crude fat (%)	0.62	0.21
Ash (%)	1.90	1.82

pink perch were within the acceptable limit. Alpha amino nitrogen (AAN) contents were 0.35 and 0.05 mg/kg respectively for pink perch and tiger shrimp samples. The NPN values were found to be higher for shrimp samples when compared to pink perch. Salt content of pink perch and tiger shrimp under slurry ice were 0.81, 0.99%, respectively. Salt soluble nitrogen (SSN) was slightly higher in pink perch samples when compared to shrimp samples.

Textural evaluation of shrimp samples revealed higher hardness values compared to pink perch samples. Cohesiveness, springiness, chewiness and gumminess of samples did not show much difference between the fish and shrimp samples. Microbiological evaluation showed that APC were within the permissible limits for both the samples.

Table 2. Biochemical quality indices of pink perch and tiger shrimp stored onboard under slurry ice

Parameters	Pink Perch	Tiger Shrimp
pH	7.35	7.68
Tri methyl amine nitrogen (TMA-N) (mg%)	1.05	0.35
Total volatile base nitrogen (TVB-N) (mg%)	6.30	17.15
Alpha amino nitrogen (AAN) (mg/kg)	0.35	0.05
Free fatty acid (% of oleic acid)	9.01	15.67
Thiobarbituric Acid Value (mg malonaldehyde /kg of fat)	-	0.05
Non-protein nitrogen (NPN) (mgN/100 g meat)	256.20	504.00
Salt content (%)	0.81	0.99
Salt soluble nitrogen (SSN) (g%)	13.50	10.70

Overall, the fish and shellfish sample stored under slurry ice for seven days exhibited

acceptable level of biochemical and microbiological quality parameters.

Chitosan coating improves the quality of dried Bombay duck

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Bombay duck (*Harpodon nehereus*) is an abundant marine fish along the North West coast of India. Traditionally the demand of fresh fish is limited and major portion of landings are converted to dried product. The physical and organoleptic qualities of the traditional sun dried products available in the local markets does not meet the standards for human consumption due to various reasons which includes poor handling, sanitation and improper processing that often lead to contamination and spoilage. Coating with antioxidants and antimicrobial agents could ensure maximum protection during processing and subsequent storage of dried fish products. Chitosan is a β (1, 4) linked copolymer of D-glucosamine and N-acetyl-D-glucosamine and it has been studied in food applications including antimicrobials, antioxidants, edible film and texture modification. The combined effect of chitosan coating and drying on the quality of Bombay duck was evaluated in this study.

Bombay duck was gutted, split opened and cleaned in potable water. Then it was kept in 5% salt solution for 5 min. to get the desired salt content in the dried product (Generally, for preparation of fish finger from fish fillet 3-5 min. dip treatment at 5% salt solution is used to get desirable salt content in the product. Hence, similar treatment was followed in the present study to get the desired salt content in the final product). After draining of salt water, it was divided in to three lots. The first lot was dip treated with 0.5% chitosan solution (CH), the second one was dip treated with 1% acetic acid (AA) and the third one was kept as control (without dip treatment). All the samples were dried at 50 °C for 12 hrs. Dried samples (Fig.1) were packed in polythene pouches and stored at room temperature and its qualities were evaluated up to three months. Biochemical parameters such as proximate composition, pH, total volatile base



Fig. 1a. Whole Bombay duck



Fig. 1b. Dried Bombay duck

nitrogen (TVB-N), trimethyl amine (TMA-N), peroxide value (PV) and thiobarbituric acid (TBA) were evaluated. Microbiological quality parameters such as Total Plate Count (TPC), *Staphylococcus aureus*, *Escherichia coli*, *Salmonella* and *Vibrio cholerae* were also examined. Dried Bombay duck had moisture and protein contents of 11.25-11.58%, 69.35-71.02%, respectively. Salt content of the dried fish for control, CH and AA was 6.5%, 7.33%, 10.25%, respectively. Accordingly, both CH and AA sample had a salt content within the permissible limit of 7.5% (IS 14950). The difference in the salt content between samples may be due to the sample preparation process followed in the study. Moisture content of the dried samples showed an increased

trend and the values were within the permissible limit of 15% (IS 14950) during storage (Fig. 2).

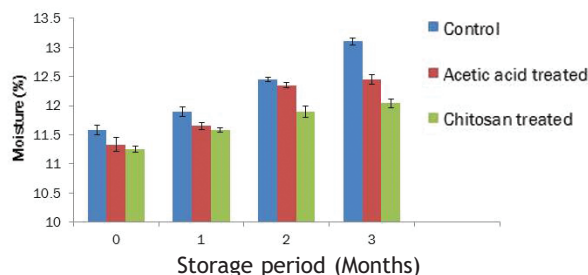


Fig. 2. Changes in moisture content of dried Bombay duck during storage

Biochemical analysis showed an increased trend in pH, TVB-N, TMA-N, PV and TBA during storage and it followed in the order of control > AA > CH samples. Further, it was also found that chitosan treated sample showed less TBA value of 0.42 mg malonaldehyde/kg of oil than untreated sample (1.08 malonaldehyde/kg) of oil at the end of third month. TBA value of 1-2 mg malonaldehyde/kg of fish meat is regarded as the limit beyond which fish will develop an unpleasant odour and taste (Adenike, 2014). In all the samples, TBA values were within the limit throughout the storage period. According to Indian standard specification, the permissible limits of total plate count for dried fish is $5 \log_{10}$ (IS 14950). In the present study, it was observed that samples crossed the permissible limits of total plate count at the end of first month, second month and third month for control ($5.5 \log_{10}$), acetic acid treated ($5.4 \log_{10}$) and chitosan treated ($5.83 \log_{10}$), respectively (Fig. 3). Sensory evaluation revealed that chitosan treated samples had higher score for overall acceptability. It can

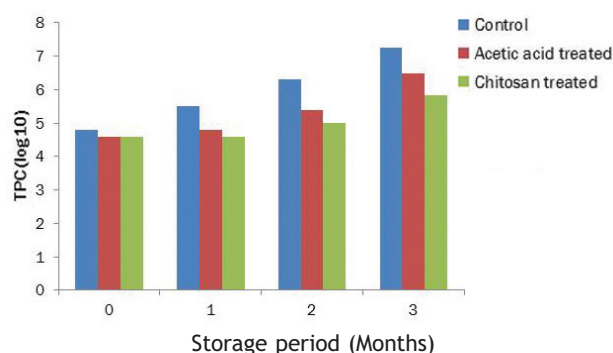


Fig. 3. Changes in total plate count (TPC) of dried Bombay duck during storage

be concluded that the local practice of drying Bombay duck poses problems such as high moisture content, inadequate salting, and contamination with sand and dust which results in poor quality of the final product. Results from the study revealed that 5% salt dip followed by chitosan coating and drying maintained the required salt and moisture content in the dried product. Further, it reduced the oxidation as indicated by lower PV, TBA values and also reduced the total bacterial count in dried Bombay duck during storage which resulted in improved quality of the final products.

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Quality aspects of dry salted shark available in markets of Kerala

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Dried products are preferred in most parts of our country particularly in areas where fresh fish is scarce. Marketing of both conventionally sun dried and dry salted fishes are common. Drying is the

age old practice of fish preservation which is least expensive and traditionally followed in rural areas. Dried fish products exhibit a long shelf life and altered texture due to its low water activity

(Andres *et al.*, 2005) and due to removal of water and other solubles and intake of salt (Ismail and Wootton, 1992). Quality of the dry salted fish depends on the quality and chemical composition of raw materials in general. Among the dry salted items there is a good demand for dry salted chunks of shark meat in Kerala. During dry salting process cut pieces of sharks are kept in alternate layers of salt and fish. These are often sun dried and transported to markets in baskets made of coconut leaves. In the case of small sharks they are split open, salted and dried in whole form. The major issues encountered in salt dried products available in markets are low quality as it is prepared from low quality raw materials, high content of salt, insect infestation and microbial contamination. Apart from that, the practice of curing in unhygienic environment, improper handling practice of processors and improper drying can affect the quality and safety of dry salted shark. In the present study ten samples of dry salted meat of shark marketed in Cochin, Alappuzha and Kottayam districts were collected and evaluated the biochemical and microbial safety aspects.

The higher is the water content, the higher is the a_w and higher is the susceptibility to spoilage. The moisture content of salted and dried shark were in the range of 42.45 to 51.43% (avg 47.44%) and is much higher than the recommended value of 35% (BIS : 2001) (Table 1 and Fig. 1). Presence of salt controlled the a_w of the product which ranged between 0.74 and 0.76 (avg 0.744).

A salt content upto 30% is recommended as per IS 14950: 2001. Inadequate salting and high moisture levels lead to unacceptable condition, thus affecting quality. Using fresh fish of acceptable quality, salting and drying in hygienic condition reduce the adverse effects due to microbial load especially *S. aureus* toxin. Proper packaging of salt dried shark meat while storage, distribution and marketing should be ensured to

Table 1. Biochemical and microbial quality of dry salted shark

Parameters analyzed	Mean values
Biochemical parameters	
Moisture (%)	47.44
Water activity (a_w)	0.744
Salt (%)	22.58
Sand (%)	0.302
Microbial parameters	
Aerobic plate count (cfu/g*)	4.24 log
Coagulase positive <i>Staphylococci</i> (cfu/g*)	0.43 log

* cfu/g - colony forming unit per gram



Fig. 1. Dry salted shark

reduce the harmful effects.

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Influence of moisture content on fungal growth in commercially salted-dried fishes in Kerala

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Salting and drying is the simplest and cheapest method of fish preservation. Salting is generally aimed at reducing water activity (a_w) which inhibits the growth of spoilage microorganism as well as inactivates autolytic enzymes (Horner, 1997). Salted fish products have much demand in many countries including developed countries. One of the main problems faced in the salted dried fish is the fungal contamination which contributes to the quality of cured fish and has been considered as an important quality concern. Therefore determination of the fungal quality of such fishes is very important for safe guarding consumer's health. The dominant fungi in the salted dried fish vary from place to place. The fungal growth in fishes leads to off-flavors, softening of flesh and in certain cases produces potentially dangerous mycotoxins (FAO, 1982). In India, a tolerance limit of water activity of dried/dry-salted fishery products is less than 0.78 at 25 °C and total yeast and mold count less than 500 cfu/g (n=5, c=2, m=100 cfu/g, M=500 cfu/g) has been proposed under the Food Safety and Standards Regulations of FSSAI (2014-under revision). In the present study, fungal contamination of some commercially important dried/salted and dried fishes collected from the

retail markets of Cochin, Alappuzha and Kottayam during different seasons was analyzed.

A total of six different species (n=41), Shrimp (*Metapenaeus dobsoni*), Silver belly (*Leiognathus* sp.), Sole (*Cynoglossus semifasciatus*), Lizard fish (*Saurida tumbil*), Croaker (*Otolithes ruber*) and Mackerel (*Rastrelliger kanagurta*) were sampled in different seasons such as monsoon, post-monsoon and summer seasons. Yeast and mold count varied with seasons. High yeast and mold count of 3.08 log cfu/g and 3.04 log cfu/g were observed during monsoon season in mackerel and silver belly (Table 1). During the post-monsoon season higher yeast and mold count was observed in Lizard fish (2.32 log cfu/g) followed by Sole (1.68 log cfu/g). During summer season higher count was found in Lizard fish (2.36 log cfu/g) followed by Mackerel (2.2 log cfu/g) and Croaker (2.1 log cfu/g). Higher yeast and mold count in the salted and dried fish may be due to the use of contaminated salt, spoiled fish, unhygienic drying and pre-washing of landed catch with contaminated coastal water.

Moisture content in the commercially available dried fishery products ranged from 13.46% (Shrimp) to 48.91% (Mackerel) during

Table 1. Changes in the selected parameters in salted dried fishes during different seasons

Species	Yeast and Mold Count (log CFU/g)			Moisture content (%)			Water activity (a_w)		
	M*	PM*	S*	M*	PM*	S*	M*	PM*	S*
Shrimp	1.60	0.55	<1.00	13.46	14.81	11.01	0.73	0.72	0.64
Silver belly	3.04	1.17	1.36	45.57	43.41	32.98	0.75	0.74	0.75
Sole	2.46	1.68	1.95	42.69	42.50	31.58	0.75	0.75	0.75
Lizard fish	2.35	2.32	2.36	45.01	38.56	41.765	0.75	0.73	0.72
Croaker	2.10	0.45	2.00	44.02	41.34	36.72	0.75	0.75	0.75
Mackerel	3.08	0.90	2.20	48.91	37.33	42.44	0.75	0.75	0.75

* M - Monsoon, PM - Post-Monsoon, S - Summer

monsoon season. During post-monsoon season, highest moisture content of 43.41% was recorded in Silver belly. In summer season it ranged from 11.01-42.49%. The seasonal variation in moisture content of salted and dried fish may be due to the variability in drying time, environmental changes and level of salt used for drying. In this study higher yeast and mold count correlated with high moisture content. Water activity was in the range of 0.73-0.75, 0.72-0.75 and 0.64-0.75 in monsoon, post-monsoon and summer seasons respectively.

Analysis of the results showed a seasonal variation in the quality of dried/salted and dried fishes. The microbial stability of the dried products mostly depend upon water activity and moisture content. When the moisture content is high during drying and storage, the chance of fungal growth is more. Therefore, the rapid reduction in water activity ($a_w < 0.75$) and moisture content is an essential controlling factor to prevent fungal

growth during storage (Kolakowska, 2002). Establishment of protocols for monitoring critical parameters such as temperature, humidity, drying, transportation and storage conditions will help in objective forecast of fungal growth of salted and dried fishery products.

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Marination of fish for establishing safety against *Yersinia enterocolitica*

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Fish marination is an old age technique which is practiced around the world including India even at household level. Marinades include sugar, spices, oil and vinegar or fruit juice, which are used to improve the tenderness, juiciness, flavor and aroma (Cadun *et al.*, 2008). The process of marinating slows down the bacterial and enzymatic activity extending the shelf life of the product (Sallam *et al.*, 2007). Initial reduction in viable bacterial counts are reported after marination which extends the shelf life in the pre-cooking stage (Maktabi *et al.*, 2015). However, reports on the effect of marination against emerging pathogens like *Yersinia enterocolitica* are scanty. *Y. enterocolitica* infection results in diarrhoea (the most common clinical manifestation), acute mesenteric lymphadenitis

(may mimic appendicitis), vomiting, low-grade fever and abdominal pain. *Y. enterocolitica* is transmitted *via* the fecal-oral route by the consumption of contaminated food or water. In recent years, low to moderate prevalence of *Y. enterocolitica* has been reported in Indian fishery products, particularly at primary production centres and fish market environments. Hence a study was undertaken to assess the suitability of fish marination against *Y. enterocolitica*. Fish marination base prepared using turmeric powder, garlic, red chilly powder, salt and Basa fillets (*Pangasionodon hypophthalmus*) were marinated at different time intervals (45, 90 and 120 min.). The overnight grown culture of *Y. enterocolitica* (ATCC 23715) at room temperature (30 °C) was inoculated into 50 g fillets at a constant inoculum

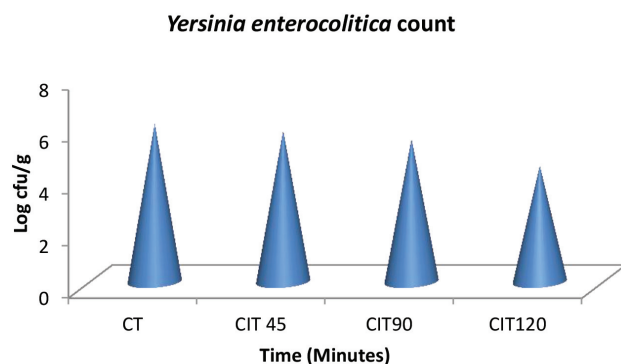


Fig. 1. *Y. enterocolitica* count with respect to time in marinated fish

level of 4.1×10^8 cfu/ml. The prepared marination base was evenly spread on the fish and held at ambient temperature of 45, 90 and 120 min. Uninoculated marinated sample was taken as control. After stipulated time interval, 450 ml of maximum recovery diluent (MRD) was used to homogenize sample at 200 rpm for 60 seconds. Subsequent dilutions were made in the same diluent for plating on CIN agar plates. Characteristic colonies were identified by biochemical methods and enumerated. The initial count of *Y. enterocolitica* was 6.08 log CFU/g which marginally reduced to 5.81 and 5.49 log cfu/g in 45 and 90 min. respectively (Fig. 1). A two log reduction of this pathogen was observed

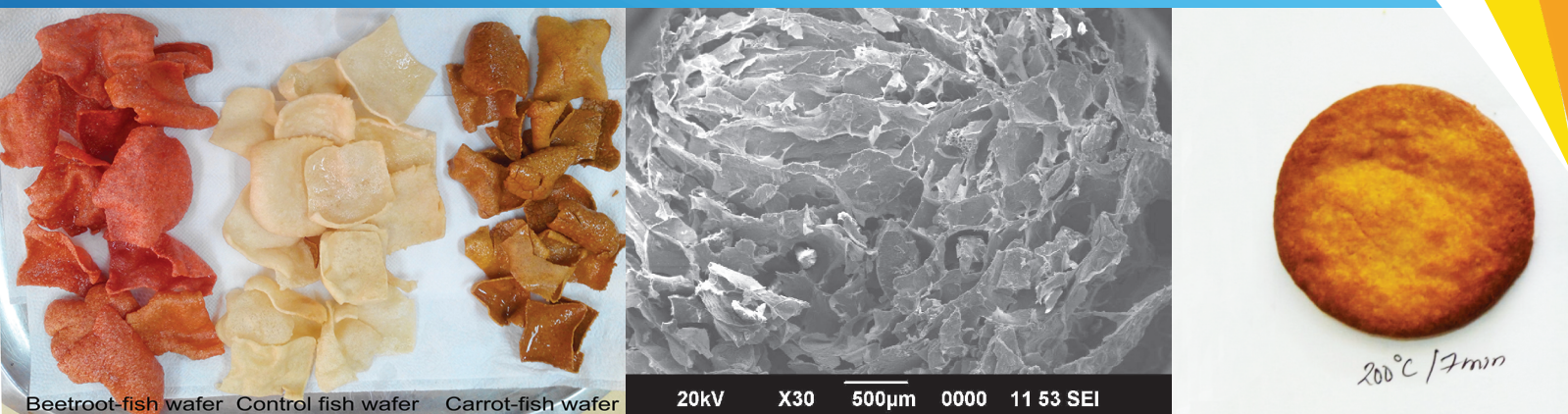
in 120 min. of marination, indicating efficacy of this process with higher contact time.

In conclusion, the marination of fish masala is an easy and reliable way to control and reduce emerging pathogens responsible for enteric diseases in humans. Apart from inhibition of pathogens, developed marination base may help to enhance the sensory attribute of fishes. However, marination composition and treatment time need to be established separately for each variety of fish and pathogens in question and consumer preference.

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