



ICAR-CIFT

# ANNUAL REPORT

2015-2016



ICAR-Central Institute of Fisheries Technology  
Kochi



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## 2015 - 2016



ICAR-Central Institute of Fisheries Technology

(Indian Council of Agricultural Research)

CIFT Junction, Matsyapuri P.O, Kochi - 682 029

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# Contents...

	Page No.
From the Director's desk	V
Executive Summary	IX
Introduction	XIII
Budget and Staff Position	XIV
Organogram	XVI
<b>Research Achievements</b>	1
Fishing Technology	3
Fish Processing	13
Quality Assurance and Management	29
Microbiology, Fermentation and Biotechnology	37
Biochemistry and Nutrition	47
Engineering	55
Extension, Information and Statistics	59
Externally Funded Projects	65
<b>General Information</b>	93
<b>Publications</b>	94
Papers Published in Refereed Journals	94
Contributions in Books	100
Popular Articles	100
Other Publications	101
<b>Communicating Research Outcomes</b>	103
Participation in Symposia/Seminars/Workshops etc.	103
Training/Awareness Imparted	103

Outreach Programmes	112
North East Hill (NEH) Region Programmes	114
Tribal Sub Plan Programmes	115
Workshops/Short Courses/Seminars etc. Conducted	119
<b>Representation in Committees</b>	122
<b>Training and Capacity Building</b>	128
Human Resource Development Activities	128
Participation in Trainings	128
Visits Abroad	133
<b>Linkages/Partnerships</b>	134
Collaboration with Other Institutes	134
Consultancies	134
Analytical Services	137
<b>Past year in the life of ICAR-CIFT</b>	138
Events	138
Meetings	139
Celebrations	140
Mera Gaon Mera Gaurav Programmes	141
Awards and Recognitions	143
Post Graduate Studies	145
Important Visitors	145
Invited Talks	146
<b>Agricultural Technology Information Centre</b>	146
<b>Administration</b>	146
<b>Priority setting, Monitoring and Evaluation Cell</b>	147
<b>Official Language Implementation</b>	148
<b>Library</b>	148
<b>Agricultural Knowledge Management Unit</b>	149
<b>NABL Activities</b>	150
<b>Committees</b>	150
<b>On-going Research Projects</b>	151
<b>List of Personnel in ICAR-CIFT</b>	160



# From the Director's desk

Dr. Ravishankar C.N.

The ICAR-Central Institute of Fisheries Technology is successfully completing 59 years of its useful existence, in the year 2016. Standing at the threshold of the forthcoming Diamond Jubilee year, we project our achievements during the year 2015-16 with pride and satisfaction. During the year under report also, the Institute continued to serve the fishing and fish processing industries by extending all technical guidance and help in the context of their changing needs.

In our programmes in fishing technology the past year, we had given importance to studies on the application of nano technology for evolving improved craft and gear materials. Studies on anti-fouling resistance of nano titanium/copper oxide-incorporated polymers or polymeric hydrogels yielded promising results. The construction of 19.75 m energy efficient fishing vessel, christened as *MFV Sagar Haritha*, was completed at the Goa Shipyard Ltd., Goa. Life Cycle Analysis (LCA) studies gave a new uplift to studies on impact of fishing systems. Our studies on behaviour of fish resulted in the design and development of collapsible traps. Preliminary productivity studies were also taken up in collaboration with INCOIS.

On the post harvest side, the emphasis was on utilization of fibre-rich seaweeds like *Caulerpa racemosa* and *Ulva lactuca* for preparation of semi-sweet biscuits and extruded snack products. From seaweed we could extract sulphated polysaccharides with rich antioxidant properties. Crystallin protein isolated from tuna eye ball showed high thermal stability. Tuna protein hydrolysate-incorporated health drink was formulated. Another study revealed that microencapsulated fish oil with fish protein hydrolysate exhibits improved oxidative stability. A shrimp analogue from tuna mince was developed using food grade plastic mould. A prototype mould for the preparation of shrimp analogue product from fish mince was also fabricated.

Quality assurance studies revealed that exclusive presence of enterohaemorrhagic *Escherichia coli* O157:H7 and *Yersinia enterocolitica* in seafood sourced from local markets was the result of cross contamination from animal meat. Further hazard profiling of milkfish (*Chanos chanos*) from aquaculture grow-out ponds indicated high risk of histamine formation for the species in temperature abuse conditions. Another major milestone in research was the development of an LC-MS/MS method for determination

of 160 pesticides in fish and fishery products and simultaneous analysis of tetracycline and sulphonamide antibiotic residues in shrimps. Another study revealed that *Clostridium botulinum* occurs in 7% of the canned, ready to cook, fresh fish and fish products from retail markets. A protocol was also standardized for pulse field gel electrophoresis of *Vibrio parahaemolyticus* strains isolated from fish and fishery environments.

The Biochemistry and Nutrition Division was successful in developing a process for microencapsulation of squalene by emulsification-spray drying technique. Fruit juice could be enriched with 30% sargassum extract without affecting the sensory properties of the juice. Our investigations into the molecular basis of action of bio-molecules like PUFA and proteoglycans showed promising results. Studies also resulted in the preparation of an iron and calcium-fortified fish soup powder by employing response surface methodology by varying concentrations of starch and fish meat (protein content).

Database on varying size and power of boats, propeller fabrication and skill level of operatives were made. A prototype of dryer (10 kg capacity) with electrical back up was designed and fabricated besides fabrication of a prototype of cutting machine for fresh and frozen fish. Under the socio-economic studies, the input and output indicators (quantitative and economical aspects) of trawl fisheries in Kerala were collected, covering three selected districts viz., Kozhikode, Ernakulam and Kollam from north, central and south regions, respectively. Product-wise and activity-wise energy consumption of the seafood processing units showed that shrimp was the major product which consume high energy followed by cephalopods. The energy consumption is high for the cold storage activity (40%).

Research Centres of the Institute tackled location specific problems of the respective regions. Extensive training programmes and demonstrations were conducted under the Tribal Sub Plan Programmes of Government of India. Demonstration of responsible fishing techniques carried out under GEF-UNDP resulted in adoption of square mesh codend by all trawl fishermen of Sindhudurg in Maharashtra.

The year thus witnessed creditable work, for which I compliment my colleagues. I also take this opportunity to thank the fishing and fish processing industries the State Government and the ICAR, for their help and co-operation in all our activities. I would also request for constructive criticism and helpful suggestions to improve our work, so that we can continue to serve the nation better in the coming years.

Kochi  
20 June 2016



(Ravishankar, C.N.)



# निदेशक की ओर से

डॉ. रविशंकर सी.एन.

भा कृ अनु प-केन्द्रीय मात्स्यिकी प्रौद्योगिकी संस्थान ने वर्ष 2016 में अपने उपयोगी अस्तित्व के 59 वर्ष सफलतापूर्वक पूरे कर रहा है। आगामी हीरक जयंती वर्ष की दहलीज पर खड़ा है, हम वर्ष 2015-16 की हमारी उपलब्धियों को गर्व और संतोष के साथ प्रस्तुत करते हैं। इस रिपोर्ट अवधि के दौरान भी, यह संस्थान मत्स्यन एवं मत्स्य संसाधन उद्योगों की सेवा उनकी बदलती जरूरतों के संदर्भ में सभी तकनीकी मार्गदर्शन और मदद देने से जारी रखा।

पिछले वर्ष हमारे मत्स्यन प्रौद्योगिकी के कार्यक्रमों में, हम यान और गियर सामग्री में सुधार विकसित करने के लिए नैनो प्रौद्योगिकी के अनुप्रयोग पर अध्ययन को महत्व दिया। नैनो टाइटैनियम के विरोधी दूषण प्रतिरोध/तांबे ऑक्साइड शामिल पॉलिमर या बहुलक हाइड्रोजेल पर अध्ययन आशाजनक परिणामों को दिए। 19.75 मीटर ऊर्जा कुशल मत्स्यन यान का निर्माण, जिसे *एम एफ बी सागर हरिता* के रूप में नाम दिया गया, गोवा शिपयार्ड लिमिटेड, गोवा में पूरा किया गया। मत्स्यन प्रणालियों के प्रभाव पर किया गया अध्ययन जीवन चक्र विश्लेषण (एल सी ए) के अध्ययन में एक नए उत्थान को दिया है। मत्स्य के व्यवहार पर किए हमारे अध्ययन के परिणाम स्वरूप अभिकल्प और सिमटने वाले फंदों का विकास हुआ। आई एन सी ओ आई एस के सहयोग से प्राथमिक उत्पादकता के अध्ययन भी किए गए हैं।

पश्च प्रग्रहण की दिशा में, अर्धमीठे बिस्कुट और निष्कर्षित जलपान उत्पादों की तैयारी के लिए कौलरेपा रसीमोसा और उल्वा लैक्टीका जैसे फाइबर युक्त समुद्री शैवाल के उपयोग पर जोर दिया गया। समुद्री शैवाल से हम अधिक प्रतिऑक्सीकरक गुण के साथ सल्फेटेड पॉलीसैकीरीड निकाल सकते हैं। ट्यूना आंख की पुतली से अलग किए क्रिस्टलीन प्रोटीन में उच्च तापीय स्थिरता देखी गई। ट्यूना प्रोटीन हाइड्रोलैसेट को शामिल करने से स्वास्थ्य पेय को तैयार किया गया। एक अन्य अध्ययन प्रकट किया है कि मत्स्य प्रोटीन हाइड्रोलैसेट प्रदर्शन के साथ मत्स्य तेल सूक्ष्मसंपुटित ऑक्सीडेटिव स्थिरता में सुधार करना। खाद्य श्रेणी प्लास्टिक मोल्ड का उपयोग कर ट्यूना कीमे से एक झींगा अनुरूप विकसित किया गया। मत्स्य कीमे से झींगा अनुरूप उत्पाद की तैयारी के लिए एक प्रोटोटाइप साँचे को भी निर्मित किया गया।

गुणवत्ता आश्वासन अध्ययन से पता चला है कि स्थानीय बाजारों से स्रोत समुद्री भोजन में एटरोहेमोरेहेजी कोली टी 157 : 1 और येरसीनीय एन्टेरोकोलीटीका की विशेष उपस्थिति पशु मांस से पार संक्रमण के परिणाम स्वरूप थी। आगे एक्वाकल्चर पालन तालाबों से मिल्कफिश

(चनोस चनोस) का खतरा प्रोफाइलिंग तापमान दुरुपयोग की स्थिति में प्रजातियों के लिए हिस्टामिन गठन के उच्च जोखिम का संकेत दिया। अनुसंधान के क्षेत्र में एक और महत्वपूर्ण मील का पत्थर मत्स्य और मत्स्य उत्पादों और ट्रेट्रासाइक्लिन का एक साथ विश्लेषण और झींगो में सल्फोनमीड एंटीबायोटिक अवशेषों में 160 कीटनाशकों के निर्धारण के लिए एक एल सीएम एस/एम एस पद्धति को विकास किया गया। एक अन्य अध्ययन में पता चला है कि क्लोस्ट्रीडियम बोटुलिनम डिब्बाबंद, पकाने के लिए तैयार, ताजी मछली और मछली खुदरा बाजार से उत्पादों की 75 में होता है। मत्स्य एवं मत्स्यन वातावरण से विब्रियो पराहेमोलीटीकस वित्तियों के पाल्स फिल्ड जेल वैद्युतकण संचलन के लिए एक प्रोटोकॉल को भी मानकीकृत किया गया।

जैव रसायन और पोषण प्रभाग पायसीकरणस्ये सुखाने की तकनीक द्वारा स्ववालीन के सूक्ष्मसंपुटन के लिए एक प्रक्रिया विकसित करने में सफल रहा। फलों के रस के रस का संवेदी गुणों को प्रभावित किए बिना 30s सरगसम निकालने के साथ समृद्ध बनाया जा सकता है। पी यू एफ ए और प्रोटेयोग्लाइकैन्स की तरह जैव अणुओं की क्रिया के आणविक आधार में हमारी जांच आशाजनक परिणामों को दिखाई। अध्ययनों के परिणाम स्वरूप भिन्न सांद्रणों से स्टार्च और मत्स्य मांस (प्रोटीन सामग्री) से प्रतिक्रिया सह कार्यप्रणाली के नियोजन को एक लोहे और कैल्शियम पुष्ट मत्स्य सूप पाउडर की तैयारी में भी किया गया।

भिन्न आकार के ऊर्जा नावों, प्रोपेलर निर्माण और परिचालन के कौशल स्तर पर आंकड़ा आधार को तैयार किया गया। ऊर्जा समर्थित के साथ एक शुष्कक के प्रोटोटाइप (10 किलो क्षमता) को अभिकल्पित एवं निर्माण के अलावा ताजे और अवरूद्ध मत्स्य को काटने के एक प्रोटोटाइप मशीन को भी निर्मित किया गया। सामाजिकआर्थिक अध्ययन के तहत, केरल में ट्राउल मत्स्य पालन के इनपुट और आउटपुट संकेतक (मात्रात्मक और आर्थिक पहलुओं) को तीन चयनित जिलों कोषीकोड, एर्नाकुलम और कोल्लम उत्तर, मध्य और दक्षिण क्षेत्रों में क्रमशः से एकत्रित किए गए। उत्पाद के लिहाज से और समुद्री खाद्य प्रसंस्करण इकाइयों की गतिविधि के लिहाज से ऊर्जा की खपत से पता चला है कि झींगा प्रमुख उत्पाद है जो उच्च ऊर्जा का खपत करता उसके बाद शीर्षपद का स्थान है। कोल्ड स्टोरेज गतिविधि (40s) के लिए ऊर्जा की खपत अधिक है।

संस्थान के अनुसंधान केन्द्र अपने क्षेत्रों के स्थान विशिष्ट समस्याओं को सुलझने की कोशिश की। भारत सरकार की जनजातीय उप योजना के तहत व्यापक प्रशिक्षण कार्यक्रमों और प्रदर्शनियों का आयोजन किया गया। जी ई एफयू एन डी पी के तहत उत्तरदायी मत्स्यन तकनीकों को निर्दिष्ट के परिणाम स्वरूप सिंधुदुर्ग के सभी ट्राउल मछुआरे वर्ग मेश कोडएन्ड को अपनाए।

इस प्रकार यह वर्ष प्रशंसनीय कार्य का था, जिसके लिए मैं अपने सहयोगियों को बधाई देता हूँ। मैं इस अवसर पर मत्स्यन और मत्स्य संसाधन उद्योगों, राज्य सरकार और भा कृ अनु प का भी हमारे सभी गतिविधियों में उनकी मदद और सहयोग के लिए, शुक्रिया अदा करता हूँ। मैं हमारे कार्य में सुधार करने के लिए रचनात्मक आलोचना और उपयोगी सुझाव का अनुरोध भी करता हूँ, जिसे कि आने वाले वर्षों में हम राष्ट्र की सेवा बेहतर ढंग से जारी रख सकें।

कोच्चि

20 जून 2016

(रविशंकर, सी.एन.)



# Executive Summary

- Netting material treated with 0.002% each of nano titanium and copper oxide hydrogel showed excellent fouling resistance.
- The average CPUE in the square mesh codend operated along Sindhudrug coast (Maharashtra) by private vessels was 18.0 kg/h and the escapement was 3.18 kg/h with a normalized value of INR 7.0.
- In field trials with JTED with 1 cm spacing it was observed that 27 commercial species were retained in the codend and 12 species had escaped into the cover codend.
- The construction of the 19.75 m energy efficient fishing vessel, christened as *MFV Sagar Harita*, was completed at the Goa Shipyard Ltd., Goa.
- The total tension offered by the gear increased from 8 KN to about 15 KN, when the speed was increased from 2.0 to 3.4 knots, while operating the 33.0 m shrimp trawl attached with BRD.
- Life cycle analysis showed that motorized ring seine fleet was having higher impact when compared to mechanized ring seine fleet with a 24% higher value for Global Warming Potential.
- Two canoes of dimensions 9.00 m  $L_{OA}$ , 1.50 m breadth and 0.70 m depth were constructed using treated coconut panels and is being used for gillnetting, seining etc. in the artisanal sector.
- The contribution of CDOM was less than 25% towards total absorption which increased to 25-100% during the post-monsoon season along the coastal waters off Kochi.
- The concentration of chlorophyll and temperature of water were significantly ( $p < 0.05$ ) correlated with the abundance of *Acetes* sp. along the Veraval coast of Gujarat.
- Fibre-rich seaweed (*Caulerpa racemosa* and *Ulva lactuca*) incorporated semi-sweet biscuits and extruded snack product was developed.
- Incorporation of nano-chitosan in biodegradable polylactic acid-based films enhanced antimicrobial activity.
- A prototype mould for the preparation of shrimp analogue product from fish mince was fabricated and analogue prepared.

- The average annual energy consumption and energy cost for seafood processing units in Kochi was 42,137.33 KW units and expenditure was ₹. 7, 84,258.50/-, respectively.
- A reduction of 13.34 and 8.4% process time was observed thermal processed fish processed in steam-air and water spray retorts, respectively compared to water immersion retorts.
- Crystallin protein isolated from tuna eye ball had higher thermal stability at freezing and above ambient temperature.
- Antioxidant properties and amino acid composition of squilla protein hydrolysates were characterized.
- Extracted sulphated polysaccharides with rich antioxidant properties from seaweed.
- Microencapsulated fish oil with fish protein hydrolysate exhibited improved oxidative stability.
- Tuna protein hydrolysate-incorporated health drink was formulated. Up to 10% hydrolysate incorporation was sensorily acceptable with improved functionality.
- Addition of maltodextrin and gum arabic in fish protein hydrolysates (FPH) effectively masked the bitter taste of FPH in sweet corn vegetable soup.
- Exclusive presence of enterohaemorrhagic *Escherichia coli* O157:H7 and *Yersinia enterocolitica* in seafood sourced from local fish markets revealed cross contamination from animal meat. Among pathogens, highest prevalence was recorded for *E. coli* (25%), followed by *Salmonella* (18%), *Vibrio parahaemolyticus* (15%), *Listeria monocytogenes* (2%), *Aeromonas hydrophila* (1.2%) and *V. vulnificus* (0.87%).
- Progressive hazard profiling in the value chain of oil sardine (*Sardinella longiceps*) indicated one log increase in bacterial load (4.49-5.57 log cfu/g) subsequent to landing from the boat, through transportation and till it reached the retailer level in the market.
- In salted and dried fishery products, *Staphylococcus aureus* was detected as the major contaminating pathogen. A moderate level (23.8%) of the isolates were capable of producing enterotoxin.
- Hazard profiling of milkfish (*Chanos chanos*) from aquaculture grow-out ponds indicated high risk of histamine formation for the species in temperature abuse conditions.
- Application of lytic bacteriophages for control of *Salmonella* and *Listeria* in seafood processing was evaluated. A minimum exposure time of 2.5 hours was optimized to bring down surface contaminated *Salmonella* in tuna products by 6 logs and 5 logs for cooked clam meat.
- Recontamination potential of *Salmonella* in cooked and raw shrimp products was assessed. Higher recovery (67.04%) and higher survival (95-100%) of *Salmonella typhimurium* was recorded in cooked and frozen shrimp (*L. vannamei*) compared to raw product.
- Risk assessment of commercially available heat shucked clams indicated *E. coli*, *S. aureus* and *Salmonella* as potential hazards and suitable mitigation measures were developed.
- LC-MS/MS method for determination of 160 pesticides in fish and fishery products and simultaneous analysis of tetracycline and sulphonamide antibiotic residues in shrimp were developed.
- A multi-residue analysis of persistent organic pollutants in seaweeds was developed by ethylacetate extraction, solid phase dispersive cleanup followed by GC MS/MS analysis. The micro-pollutants had 65-120% recovery by this method.
- Surveillance sampling and root-cause analysis of export rejections was carried out for hazards like *Salmonella*,



Crystal violet, Coliform and *L. monocytogenes* for various seafood establishments and mitigation measures were suggested.

- Biogenic amine build up in high pressure treated tuna was modelled for predictive analysis during subsequent chilled storage conditions.
- Occurrence of *C. botulinum* was seen in 7% of the canned, ready to cook, fresh fish and fish products from retail markets.
- Incidence of *V. parahaemolyticus* which carry *tdh* gene, a marker for virulence was seen in commercial fish samples, water and sediment from aquaculture farms.
- About 62.5% of *V. cholerae* isolates were resistant to ampicillin (10µg), 37.5% to cefotaxime (30µg), and 12.5% to ceftriaxone (30µg) and nitrofurantoin (300µg). Thyme oil was effective in inhibiting cholera toxin gene positive *V. cholerae* followed by clove bud oil.
- A protocol was standardized for Pulse Field Gel Electrophoresis of *Vibrio parahaemolyticus* strains isolated from fish and fishery environments.
- MLST data of MRSA revealed that the strain SA635, MRSA7 and MRSA9 belonged to ST5.
- A new spa type of MRSA was identified and was assigned spa type t15669 in the RIDOM server.
- Genotyping of eight isolates of *Aeromonas* spp. from a fish disease outbreak in Mangalam dam, Thrissur District revealed a genotype of *Aer*<sup>+</sup>, *Alt*<sup>+</sup>, *Ast*<sup>+</sup>, *Act*<sup>+</sup>, *Ahp*<sup>-</sup>, *ascV*<sup>-</sup> and *aopB*.
- Antibiotic sensitivity profile of 12 MRSA cultures revealed that all the strains were multi-drug resistant (MDR). MDR of the strains ranged from three to eight classes of antibiotics. Two out of 18 Actinomycetes strains isolated from marine sediments were found to be active against MRSA ATCC 43300 by agar overlay method.
- ISP-2 medium along with sample treatment of dry heat and benzalkonium chloride and SDS with 6% yeast extract was best suited for isolation of Actinobacteria from marine sediments.
- The LD<sub>50</sub> value of 15 strains of *A. hydrophila* and nine strains each of *A. jandaei* and *A. veronii* isolated from farms with disease outbreak revealed that majority of the *A. hydrophila* strains are highly virulent in rohu fingerlings.
- Nineteen strains of *Bacillus* sp. were found to have the ability to inhibit fish and shrimp pathogens; *A. hydrophila*, *E. tarda*, *V. cholerae* and *V. vulnificus* by well diffusion test for use as probiotic in aquaculture farm.
- Microbial profiling of Hentek and Shidal, two fermented fish products was done.
- *V. cholerae* belonging to the pathogenic O139 serogroup was isolated from freshwater fish, *Catla catla* procured from a fish market in Visakhapatnam for the first time.
- Fish protein hydrolysates enhanced antimicrobial activity of chitosan against bacterial strains of *Escherichia coli* and *Bacillus cereus*. Similarly green tea extract exhibited high antimicrobial activity against *Brochothrix thermosphacta*, *Pseudomonas* species and *Bacillus cereus*.
- A process for microencapsulation of squalene by emulsification-spray drying technique was developed. A combination of maltodextrin and whey protein was found to be good for microencapsulation taking into consideration the high encapsulation efficiency (92%) and oxidative stability.
- Fruit juice was enriched with 30% Sargassum extract and its nutritional level was determined. Macroporous adsorbent resin, Sepabead 207 treatment did not affect the phytochemical composition and antioxidant activity of the extract.

- Iron and calcium-fortified fish soup powder was prepared by employing response surface methodology by varying the concentrations of starch and fish meat and nutritional evaluation was carried out.
- Proteoglycans extracted from *Scolidon* spp. cartilage was characterized and evaluated for their anti-proliferative activity against MCF-7 cell lines. Significant cytotoxic effect of 73% cell death was observed for 100 µg/ml treated sample.
- In anti-ulcer property studies of fish collagen against ethanol-HCl induced peptic ulcer in rats, partial resistance to denudation of the mucosal layer was observed in collagen treated group of rats, which could be due to the protective effect of collagen supplementation.
- Proteases were extracted from visceral waste of fish species from three different habitats. Marine fish proteases exhibited higher specific enzyme activity and recovery when compared with other habitat species.
- In order to establish and quantify significant variables (related to design and construction practices) affecting quality of fishing vessels, 12 aspects were finalized for detailed study based on an initial study conducted on 24 boats constructed from six boat yards in Kerala
- Data base on varying size and power of boats, propeller fabrication and skill level were made.
- Designed and fabricated a prototype of dryer (10 kg capacity) with electrical backup.
- Fabricated a prototype of cutting machine for fresh and frozen fish.
- Based on the analysis of data collected from the validation of engines (January, 2015) and monitoring of the same makes on 12 vessels in field during the period (July 2015 - January, 2016), an engine validation method has been finalized and is under preparation for release.
- Numerous hull form designs that have been tested under commercial conditions are available with industry without any reasonable IP management system to benefit the traditional boat building industry. An IP management system is being devised.
- The input and output indicators (quantitative and economical aspects) of trawl fisheries in Kerala were collected, covering three selected districts viz., Kozhikode, Ernakulam and Kollam from north, central and south regions, respectively.
- The fish supply chain analysis of domestic fish markets in Ernakulam revealed that the inter-market efficiency ranged from 3.11 to 3.46 and intra-market efficiency from 2.04 to 4.87.
- The constraint analysis of domestic fish markets indicated that poor road connectivity and absence of separate assemblage area for display are major constraints.
- The perception analysis of mechanized trawl owners of Visakhapatnam showed that majority of the fishermen had a neutral perception on availability of excess fishing fleets in the coast (75%) and increasing fishing pressure over the years (70%). The reason for excess capacity was entry of large number of fishing fleets into marine fisheries (35%) and indiscriminate use of high power engines (25%).
- Product-wise and activity-wise energy consumption of the seafood processing units showed that shrimp was the major product which consumes high energy followed by cephalopods. The energy consumption is high for the cold storage activity (40%).

# ICAR-Central Institute of Fisheries Technology

The ICAR-Central Institute of Fisheries Technology (named at the time of inception as Central Fisheries Technology Research Station) was set-up following the recommendation of a high power committee constituted by the Ministry of Food and Agriculture, Government of India. It started functioning at Cochin on 29th April 1957 under the Department of Agriculture of the then Ministry of Food and Agriculture with a small nucleus of staff for research work in fishing craft and gear. Other Divisions soon followed. The administrative control of the Institute was brought under the Indian Council of Agricultural Research on 1 October, 1967.



## Vision

To facilitate sustainable harvesting and total utilization of fishery resources through innovations in harvest and post-harvest technologies

## Mission

Ensure responsible harvesting of fishery resources through eco-friendly, energy efficient and economical means; ensure total utilization of the harvested fish through appropriate processing, value addition, packaging and waste utilization; ensure food safety and nutritional security to the consumer and minimize carbon & water footprint per unit volume; and to ensure equitable benefits to the stakeholders, across the value chain.



## Overview

The Institute is the only national centre in the country where research in all disciplines relating to fishing and fish processing is undertaken. Research Centres function at Visakhapatnam (Andhra Pradesh), Veraval (Gujarat) and Mumbai (Maharashtra).

## Mandate

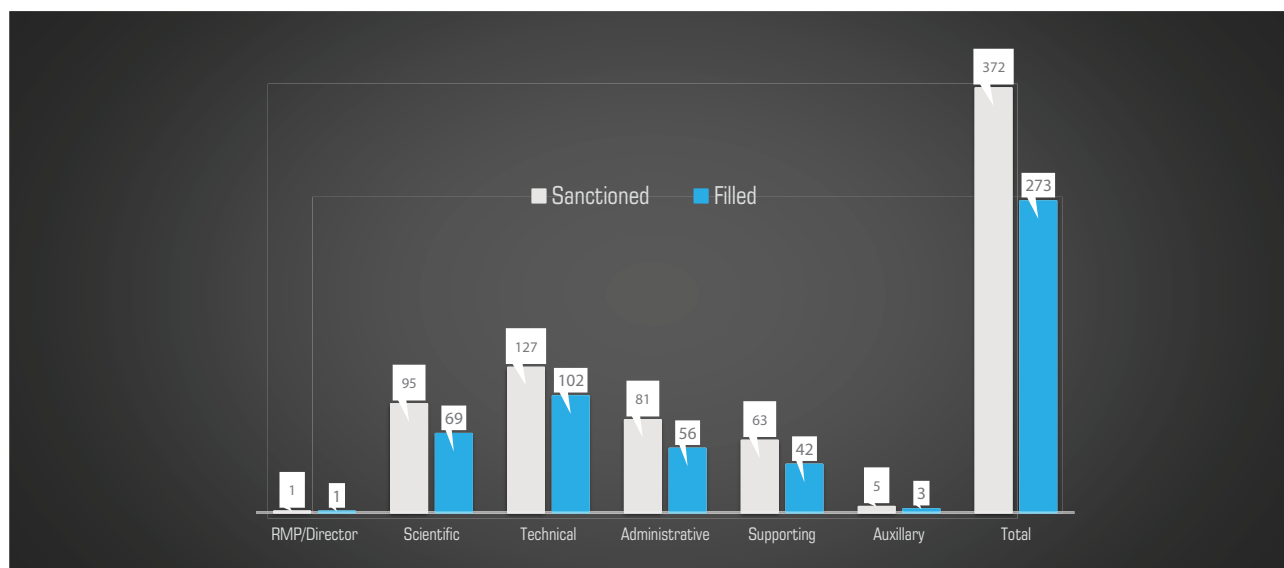
- To conduct basic, strategic and applied research in fishing and fish processing.
- To develop designs of fuel efficient fishing vessels and fishing gear for responsible fishing.
- To develop technologies for commercial isolation of bioactive compounds and industrially important products from fish and fishery wastes.
- To design innovative implements and machineries for fishing and fish processing and pilot plants for facilitating commercialization of technologies developed.
- To do advanced research in food safety in fish and fishery products
- To provide training and consultancy services in fishing and fish processing.



**Budget allocation and expenditure**

(For the year 2015-2016 – All values in INR in Lakhs)

Particulars	Non-plan		Plan	
	Allocation	Expenditure	Allocation	Expenditure
<b>Budget Head</b>				
Establishment Charges	2199.50	2165.77	-	-
Overtime Allowances	0.50	0.40	-	-
Travelling Allowances	25.00	25.00	30.00	30.00
Works	-	-	456.00	456.00
Other Charges (Equipments)	20.00	20.00	52.00	52.00
Other Charges (Contingencies)	353.00	352.99	340.00	339.99
Furniture and Fixtures	3.00	3.00	2.00	2.00
Library	2.00	2.00	13.00	13.00
Information Technology	-	-	5.00	5.00
Pension and Retirement Benefits	235.00	234.97	-	-
Loans and Advances	15.00	13.25	-	-
NEH Programme	-	-	25.00	25.00
Tribal Sub Plan	-	-	20.00	20.00
<b>Total</b>	<b>2853.00</b>	<b>2817.38</b>	<b>943.00</b>	<b>942.98</b>

**Staff position as on 31 March, 2016**

# ICAR-CIFT

[www.cift.res.in](http://www.cift.res.in)



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Ph. 022 27826017, Fax: 022 27827413  
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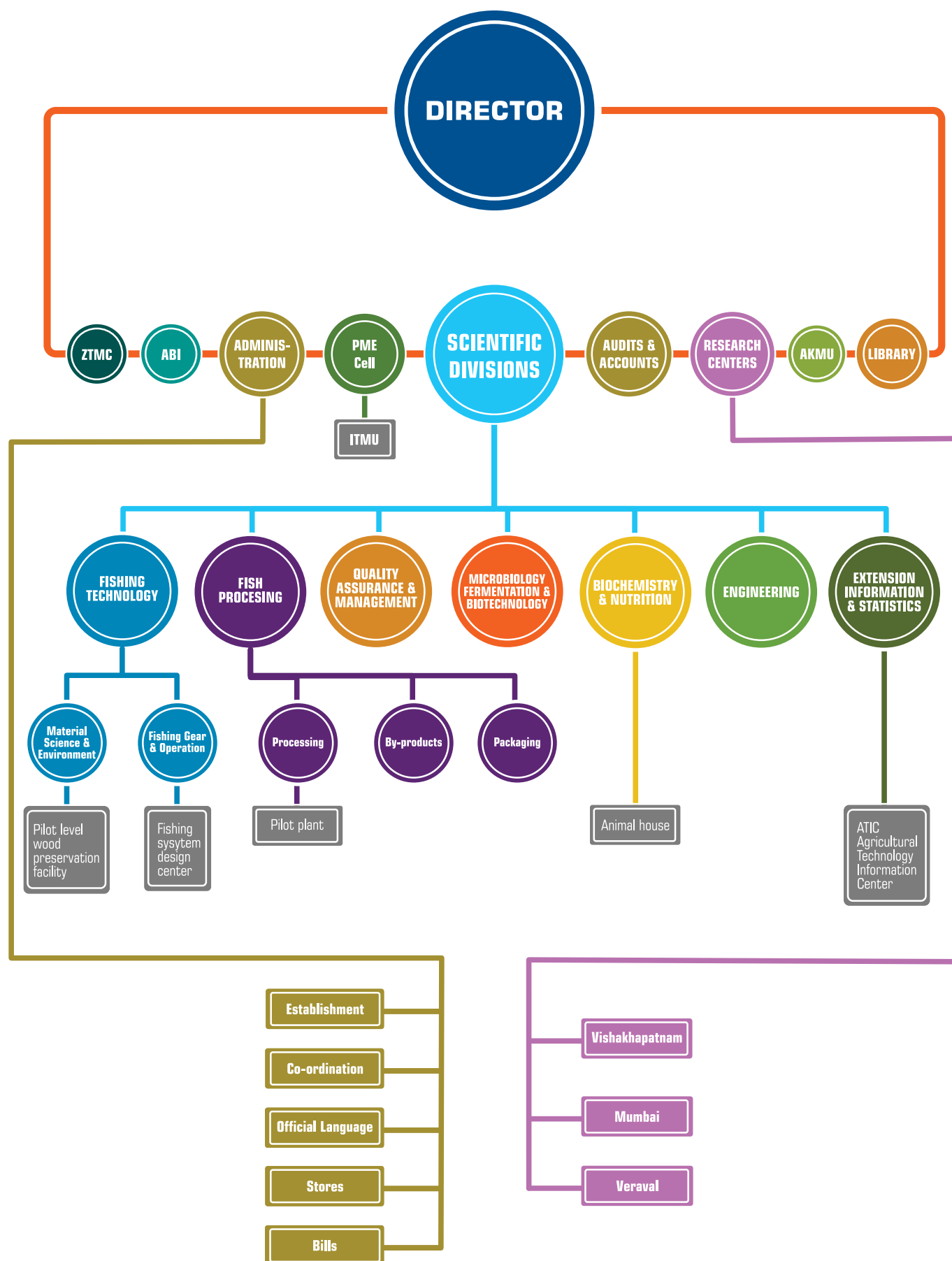
## Visakhapatnam

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## Kochi

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# RESEARCH ACHIEVEMENTS







# FISHING TECHNOLOGY



## Research projects handled

### Institute projects

- Nano-technological interventions to mitigate fishing craft and gear material degradation
- Design development and standardization of deep sea fishing vessel and gear systems for commercial operations
- Investigations on fish behaviour and responsible fishing systems

### Externally funded projects

- Exploration and assessment of demersal fishery resources along the continental slope (200-1200 m) of Indian EEZ and central Indian Ocean
- Validation of tuna advisories off east coast
- Assessment of myctophid resources in Arabian Sea and development of harvest and post harvest technologies
- Retrieval of phytoplankton biomass and associated optical constituents based on long term bio-optical studies
- Techno-economic feasibility of coconut wood canoes for small scale fisheries sector in the south west coast of India and Lakshadweep
- Green fishing systems for tropical seas
- Studies on the ecological linkages between plankton production and *Acetes* sp. abundance along Gujarat coast
- Demonstration and field testing of bycatch reduction and juvenile excluder devices along Sindhudurg district, Maharashtra

## Most significant achievements

- Netting material treated with 0.002% each of nano titanium and copper oxide hydrogel showed excellent fouling resistance.
- The average CPUE in the square mesh codend operated along Sindhudrug coast (Maharashtra) by private vessels was 18.0 kg/h and the escapement was 3.18 kg/h with a normalized value of INR 7.0.
- In field trials with JTED with 1 cm spacing it was observed that 27 commercial species were retained in the codend and 12 species had escaped into the cover codend.
- The construction of the 19.75 m energy efficient fishing vessel, christened as *MFV Sagar Harita*, was completed at the Goa Shipyard Ltd., Goa.
- The total tension offered by the gear increased from 8 KN to about 15 KN, when the speed was increased from 2.0 to 3.4 knots, while operating the 33.0 m shrimp trawl attached with BRD.
- Life cycle analysis showed that motorized ring seine fleet was having higher impact when compared to mechanized ring seine fleet with a 24% higher value for Global Warming Potential.
- Two canoes of dimensions 9.00 m  $L_{OA}$ , 1.50 m breadth and 0.70 m depth were constructed using treated coconut panels and is being used for gillnetting, seining etc. in the artisanal sector.
- The contribution of CDOM was less than 25% towards total absorption which increased to 25-100% during the post-monsoon season along the coastal waters off Kochi.
- The concentration of chlorophyll and temperature of water were significantly ( $p < 0.05$ ) correlated with the abundance of *Acetes* sp. along the Veraval coast of Gujarat.

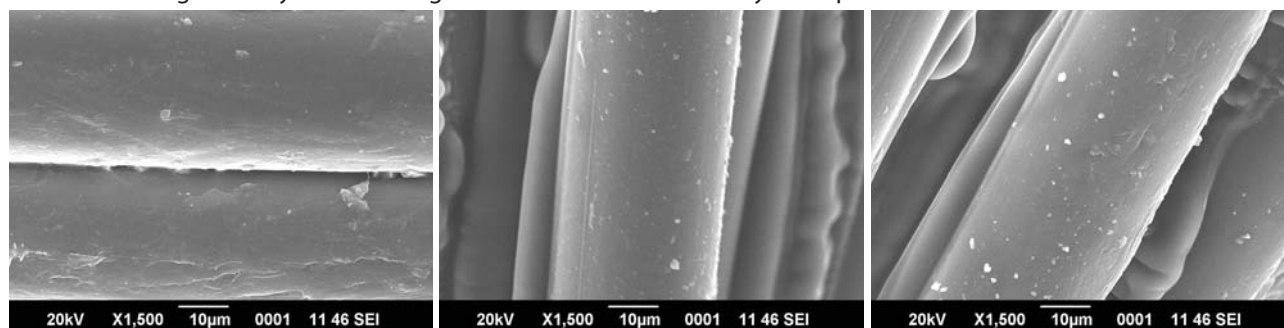
## Chief findings

### Institute projects

#### Nano-technological interventions to mitigate fishing craft and gear material degradation

#### Anti-fouling resistance of nano titanium / copper oxide-incorporated polymers or polymeric hydrogels

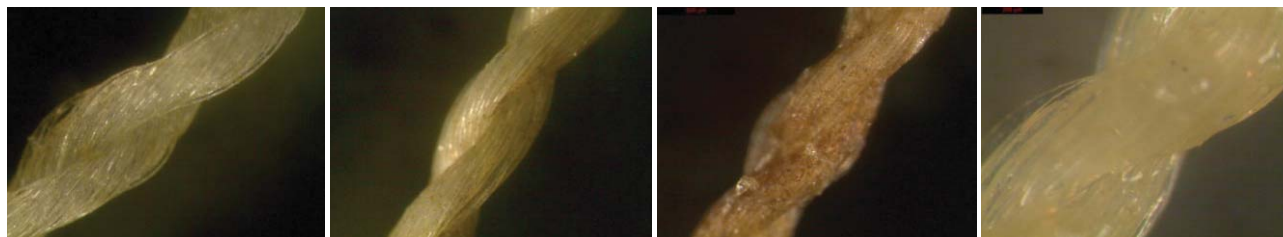
The netting treated with 0.002% each of nano titanium and copper oxide hydrogel showed excellent fouling resistance. The order of fouling resistance was 0.002% Cu-Ti hydrogel net > hydrogel alone net > 0.004% Cu-Ti hydrogel net > control. The nylon nets treated with hydrogel, hydrogel with nano copper oxide and nano  $\text{TiO}_2$  (1:1) of 0.002 and 0.004% were subjected to TEM analysis. The hydrogels incorporated with nano copper and titanium oxides at 0.002% each showed significantly lower fouling on the nets even after 60 days of exposure.



V1 Control V2 Hydrogel alone V3 CuO  $\text{TiO}_2$  0.002%  
Surface characterization of nylon netting materials treated with hydrogel and hydrogel incorporated with  $\text{TiO}_2$  and CuO



Untreated nylon netting material



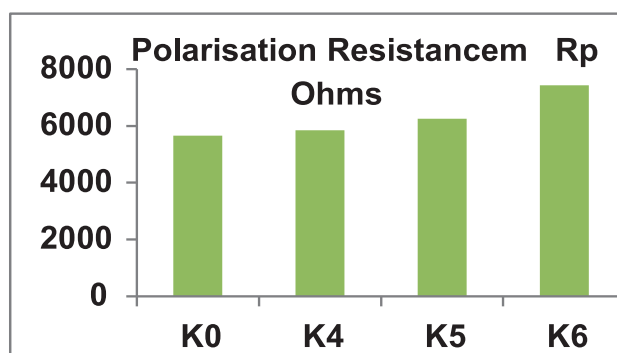
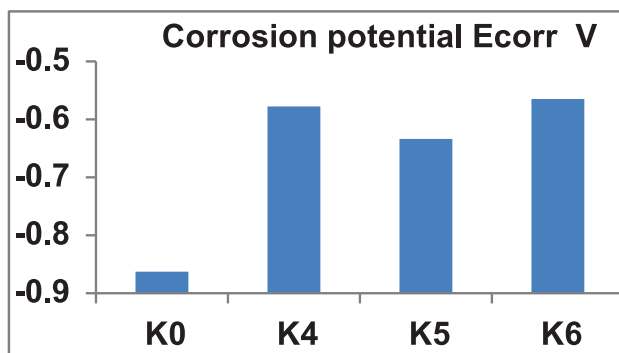
0.002% each of nano CuO and  $\text{TiO}_2$

The untreated nylon nettings and hydrogel incorporated with 0.002% each of nano copper oxide and nano titanium oxide treated netting material after exposing in the Kochi estuary for 7, 15, 30 and 60 days

#### Surface modification of boat building steel using multi-walled carbon nanotube and nano titanium dioxide composites

Boat building steel surface treated with MWCNT-nano  $\text{TiO}_2$  composite dispersed in 1:2 polyhydroxymethacrylate: ethanol, showed corrosion potential, corrosion current density and polarization resistance from -0.863 to -0.578 V,  $2.68 \times 10^{-6}$  to  $1.74 \times 10^{-5}$  A/cm<sup>2</sup> and 5663 to 7428 Ohms respectively. The polarization resistance at high frequency region and low frequency region varied from 25.43 to 28.04 Ohms and 165 to 510 Ohms respectively. The boat building steel treated with 0.02% MWCNT and 0.01% nano  $\text{TiO}_2$  showed good corrosion resistance compared to control.

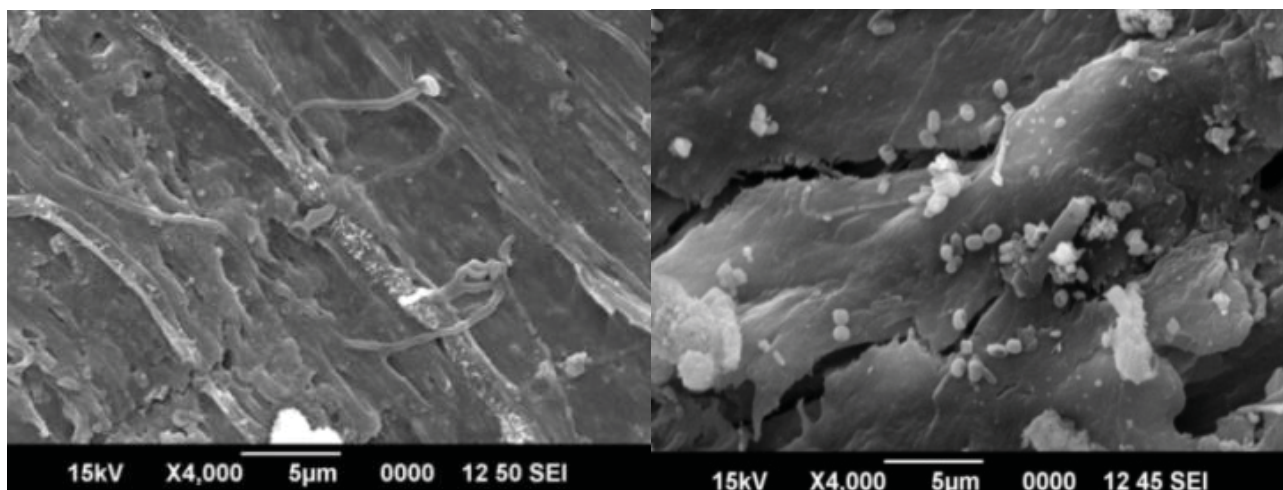




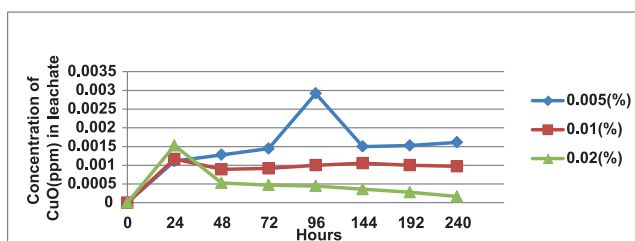
Linear sweep voltammetric data of MWCNT-nano titanium oxide composite treated boat building steel (K0. untreated steel, K4. 0.01% MWCNT and 0.005% TiO<sub>2</sub>, K5. 0.01% MWCNT and 0.01% TiO<sub>2</sub>, K6. 0.02% MWCNT and 0.01% TiO<sub>2</sub>)

### Preservative treatment and leachability studies of nano materials on rubber wood panels

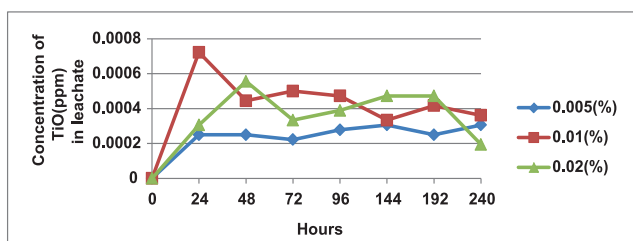
Rubber wood panels treated with 0.04% each of nano CuO and nano TiO showed high retention (0.133 kg/cm<sup>2</sup>). SEM micrographs exhibited evenly distributed nano particles in the matrix. Rate of leaching of nano copper and titanium oxide was high during first 24 h and leaching of TiO<sub>2</sub> was comparatively lower than nano CuO from the treated wood.



Scanning electron micrograph of untreated and nano CuO and nano TiO treated rubber wood specimens. The nano particles on the surface of rubber wood are evenly distributed.



Leachability of nano CuO during accelerated leaching experiment



Leachability of nano TiO during accelerated leaching experiment

### Development of nano material-based antifouling strategies for synthetic nettings

Coatings of mixture of nano-sized (APS 40 nm) copper oxide and titanium oxide (TiO<sub>2</sub>) in different concentrations applied on nettings of polyamide (nylon)

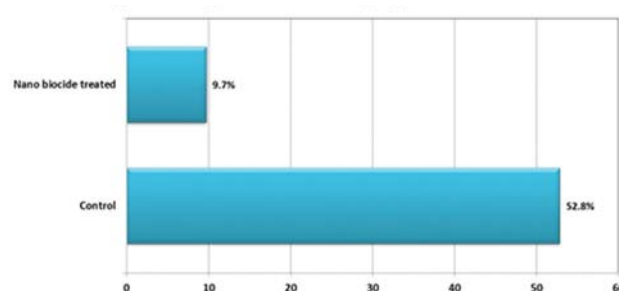
Fouling accumulation on control and nano biocide coated nylon netting after 90 days exposure to estuarine waters



210 x 2 x 2 having 30 mm mesh size showed that netting, coated with Cu O (0.01%) + Ti O<sub>2</sub> (0.02%) inhibited fouling up to 90 days.

### Mesh occlusion studies

Mesh opening of both control and nano biocide coated netting was reduced after 90 days exposure to estuarine waters by 52.8% and 9.7%, respectively.



Reduction of mesh opening of netting due to fouling accumulation

### Physical and mechanical properties of exposed control and treated nylon webbings

A reduction in mesh break load by 13.9% occurred due to the nano treatment of polyamide netting. However, on exposure to marine environment, the control showed 22.6% reduction in mesh break load while treated netting had only 8.2% reduction.

### Design development and standardization of deep sea fishing vessel and gear systems for commercial operations

#### Design of standard deep sea fishing vessels and gear systems

The general arrangement plan of a 24.0 m L<sub>OA</sub> multipurpose fishing vessel with 7.0 m breadth and 2.85 m depth for long lining, gillnetting and squid jigging facilities on-board was prepared. Experimental long lines gear with 50 branch lines, consisting alternately of 25 "circular" hooks and 25 "J" hooks each was designed and fabricated for deep sea experimental operations.

#### Bycatch of commercial deep sea gillnets

Data collected on design and operational details and bycatch from 19 commercial gillnet units based at Kochi fishing harbor revealed that gillnets targeting seer and tuna used polyamide (nylon) (210 x 8 x 3 and 210 x 10 x 3) netting with mesh sizes ranging from 90 to 145 mm. Total fleet length of the net ranged from 5600 to 18500 and depth varied between 6.5 to 18 m. Tuna and seerfish were the target catch while shark, rays and barracuda were caught as bycatch. Dolphins were the only marine mammals encountered in gillnet fishery. Three dolphins per fleet and 1-7 turtles were caught per trip.

#### Design and field testing of experimental gillnets for deep sea fishing

Experimental gillnets were designed and fabricated with the twine size (210 x 9 x 3) and mesh size (140 mm) most commonly used by commercial fishers was selected. One set of operation was made off Kochi through a commercial gillnet fishing unit. Since the season was almost over (March end) the catch was negligible.



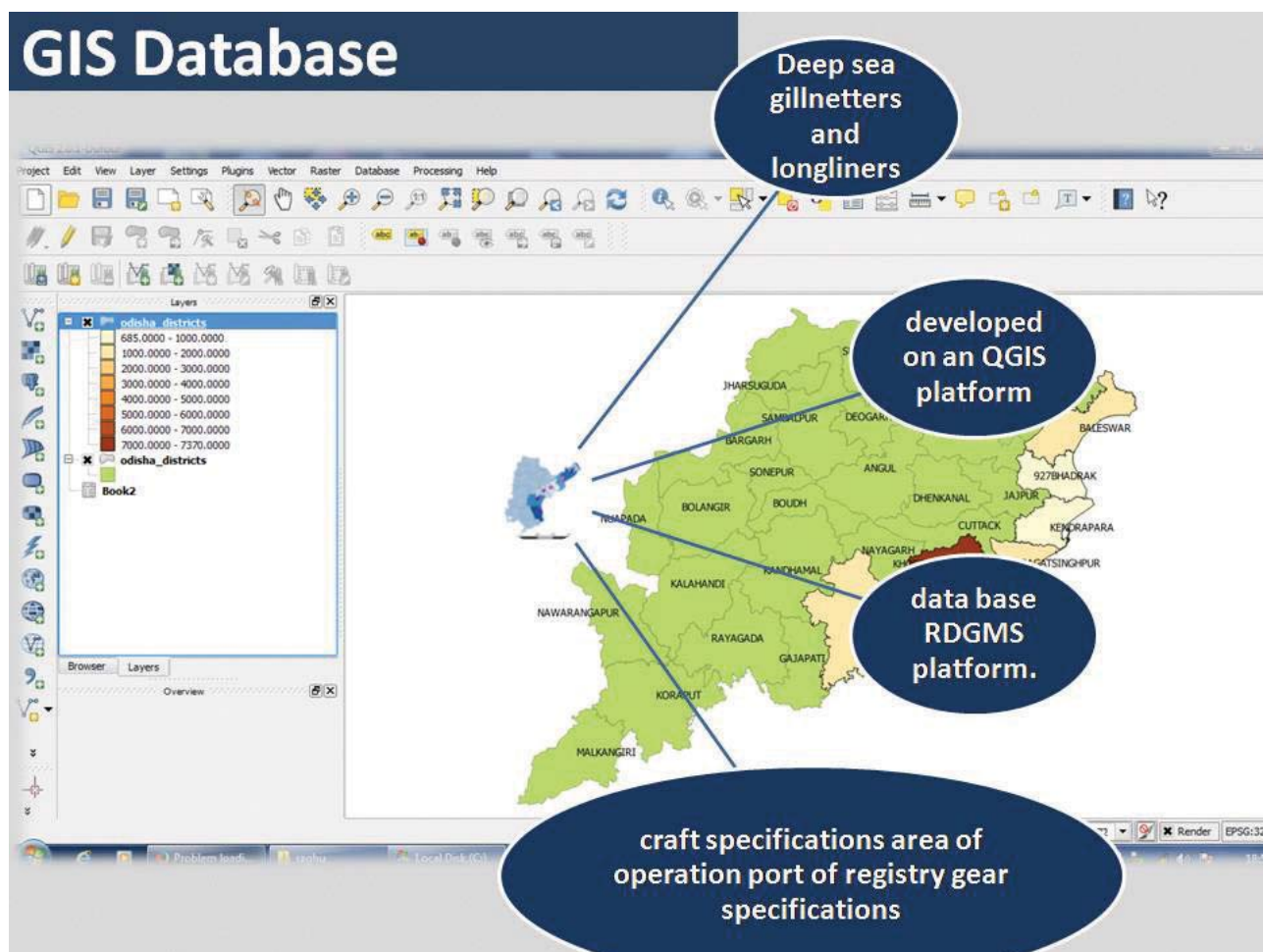
Deep sea gillnets ready for operation

### Carbon footprint from fishing systems

Data is being collected from five deep sea gillnetters engaged in gillnetting cum long lining to estimate the carbon footprint. During gillnetting, 1.05-1.70 kg CO<sub>2</sub> was emitted per kg of fish. During gillnetting, the average fuel consumption was about (2000 l /voyage which is about 9-10 days) with 1000 kgs of catch. During long lining, 1.12-1.40 kg CO<sub>2</sub> was emitted per kg of fish. During long lining, the average fuel consumption was about (1500 l /voyage which is about 9-10 days) with 1000 kgs of catch.

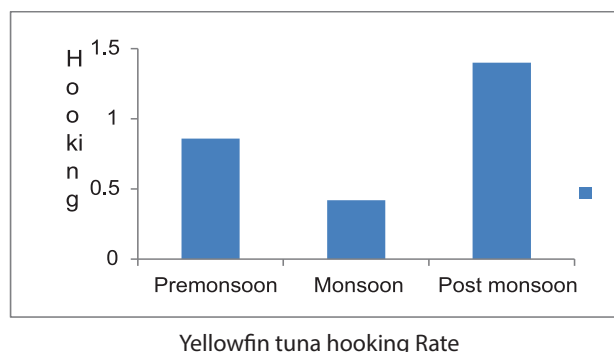
### GIS data base of craft and gear of Andhra Pradesh

GIS data base of craft and gear of Andhra Pradesh was created on an RDBMS platform and linked to QGIS to use GIS as a tool for effective fisheries management using QGIS. Thematic maps were generated using this data base. The data will be linked to more spatial data to facilitate to help fishery managers use this data for disaster management, extension activities, fisheries marketing and overall fisheries management.



### Studies on line catches off east coast

Survey was conducted to analyze the long line catches from long line operators and catamarans of Visakhapatnam harbour and Pudimadaka fish landing centre during April, 2015 to March, 2016. The line catches were dominated by Yellowfin tuna (*Thunnus albacares*).





## Investigations on fish behaviour and responsible fishing systems

### Species composition in Semi Pelagic Trawl System

The top ten species in terms of CPUE constituted exclusively of off-bottom species in the catches of SPTS, which shows its capability of selective capture of off-bottom and pelagic species. The highest CPUE was observed for *P. argenteus*. Jellyfish followed by *M. dobsoni* constituted the major catches in 33 m bottom trawl.

### Collapsible fish trap designed

An innovative collapsible fish trap of 1.5 m x 0.8 m size with two entrance funnel on both sides was designed and fabricated. The fish species caught were *Epinephelus chlorostigma* and *Lutjanus rivulatus* with length ranging from 17.5 cm to 36.3 cm and their corresponding weights ranged from 110 g to 363 g. The crab species trapped were *Charybdis feriatus* and *Galena bispinosa*.



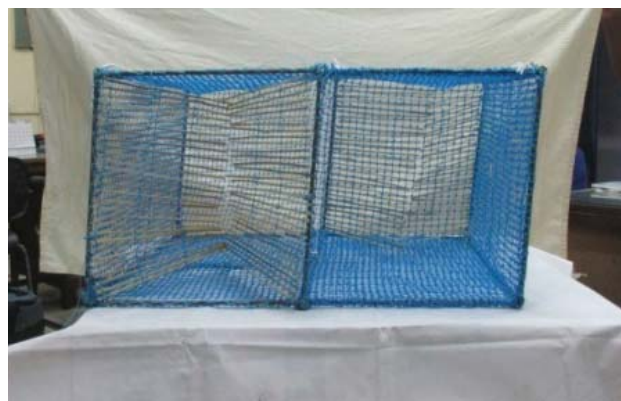
Collapsible fish trap

### Fold and Take Spring-Type Trap

A new "Fold and Take Spring-Type Trap" (FTST) was designed and prototype fabricated. This new trap has a stretched length of 1.0 m and diameter of 0.5 m. The frame is made of stainless steel with 8 mm diameter and the mesh cover is made of HDPE twine with a mesh size of 20-60 mm.

### Testing of foldable traps at Harbhangi reservoir

Foldable traps are field tested at Harbhangi reservoir, Adava, Gajapati district, Odisha. The catch composition of *Labeo* spp. 4 kg/trap and crab 1-1.5 kg per trap was recorded. Foldable traps were fabricated to be tested in the fast flowing rivers of Arunachal Pradesh and other NEH rivers. A skate net is ready for operation in the fast flowing rivers.



Foldable stakenet cum trap for fast flowing rivers

### Development of Bycatch Reduction Devices

Three designs of BRDs to separate *Squilla* from shrimp were designed and prototype developed with different grid spacing and dorsal spacing.

### Studies on recreational fisheries

Primary data collected on recreational fisheries showed an extensive opportunity for recreational fishery for Mahseer in Uttarakhand. License issued by DFO is mandatory for angling and more than 1000 anglers report per year. Lack of single window system for issue of permit, presence of poachers, etc. are cited as problems hindering the development of angling in the region.

### Studies on evaluation of mechanized fishing system

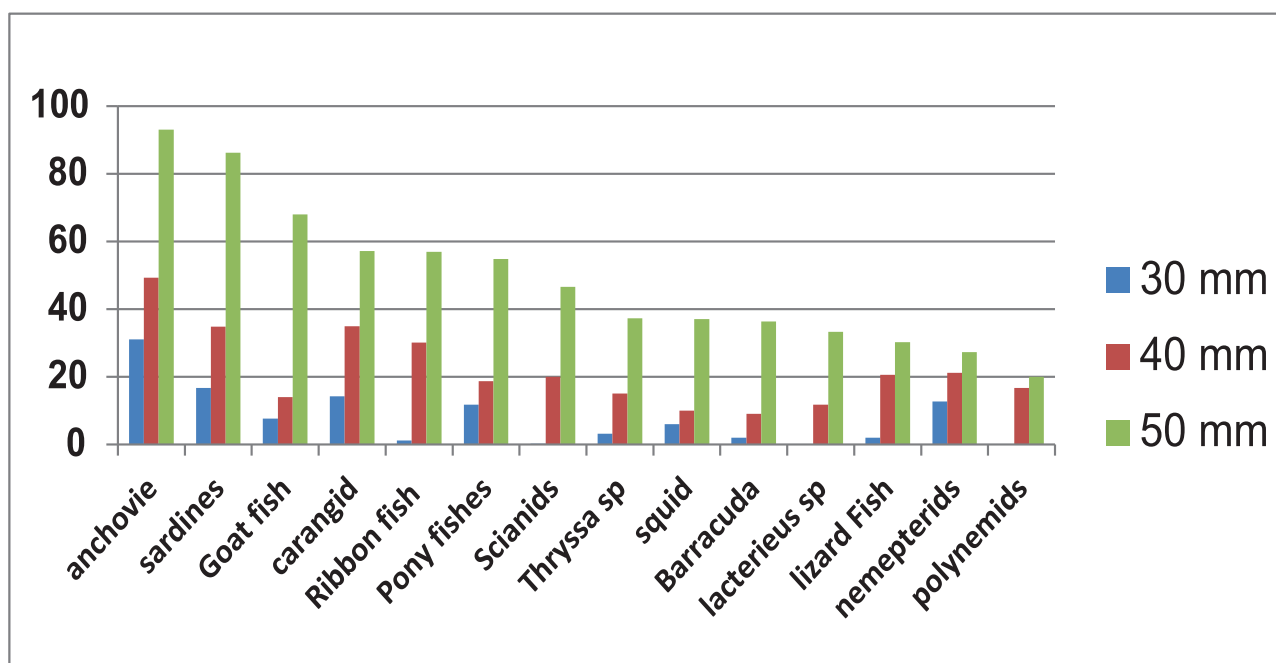
Economic evaluation of different mechanized fishing systems along Andhra Pradesh and Odisha coasts before and after the trawl ban period showed that average operational profit of multi-day trawlers were higher after trawl ban period (₹ 84,005/- and ₹ 1,40,292/-, respectively) compared to pre-trawl ban period (₹ 26,100/- and ₹ 46,020/-).

### Development of selectivity profiles of trawling system

Selectivity experiments were carried out onboard CIFTECH off Visakhapatnam coast, using a 30 m demersal trawl fitted with 40 mm square mesh codend. A total of 38 species were retained in the codend with 40 mm square mesh codend. Eighteen species escaped and five species showed escapement between 20 to 50%, six species showed escapement over 50%, four species showed between 5-20% and the rest showed 100% retention. The species which had escaped were mainly dominated by squid juveniles (30%), Ribbonfish (25%), Upeneus (20%), silverbellies (15%) Nemipterids and Lizardfish (10%). Selectivity parameters were estimated for commercially important species.



Trawl selectivity studies onboard



Percentage escapement of different species from 30 mm, 40 mm and 50 mm square mesh codend

### Design of 30 m four seam box trawl

Designed and developed 30m four seam box trawl with equal head and foot rope length for exploitation of semi pelagic fish. In the field trials conducted using CIFTECH 1, the four seam semi pelagic fish trawl yielded CPUE of 40 kg/hr.

### Whole trawl selectivity

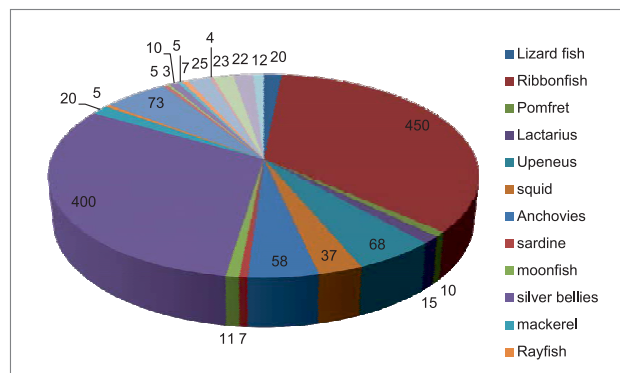
Whole trawl selectivity was estimated using 60 mm square mesh test panels attached at the upper panel of each belly covered with 15 mm nylon pockets on the body of the 30 m fish trawl net. Field trials conducted revealed that a total of 32 species were retained in the codend and seven species escaped through the test panels of the trawl into



pouches i.e *Stolephorus commersonii*, *S. indicus*, *Lactarius lactarius*, *Thryssa mystax*, *Lepturacanthus savala* and *Loligo duvaucelii*. Escapement occurred through last three bellies of the trawl. *Thryssa* spp. were found to escape in relatively large numbers.

### Codend selectivity studies

A total of 35 mm square, diamond and T 90 codends were fabricated and field tested at Kakinada and Visakhapatnam. Large quantities of squid juveniles (40-50%), ribbonfish (20%), anchovies (15%) and silver bellies (15%) escaped from the codends.

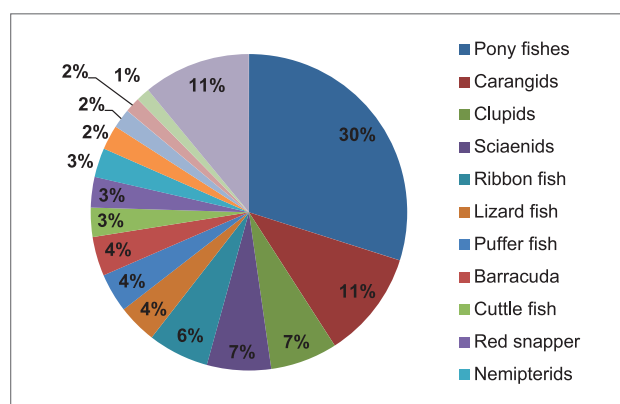


Escapement of various fishes from the codend

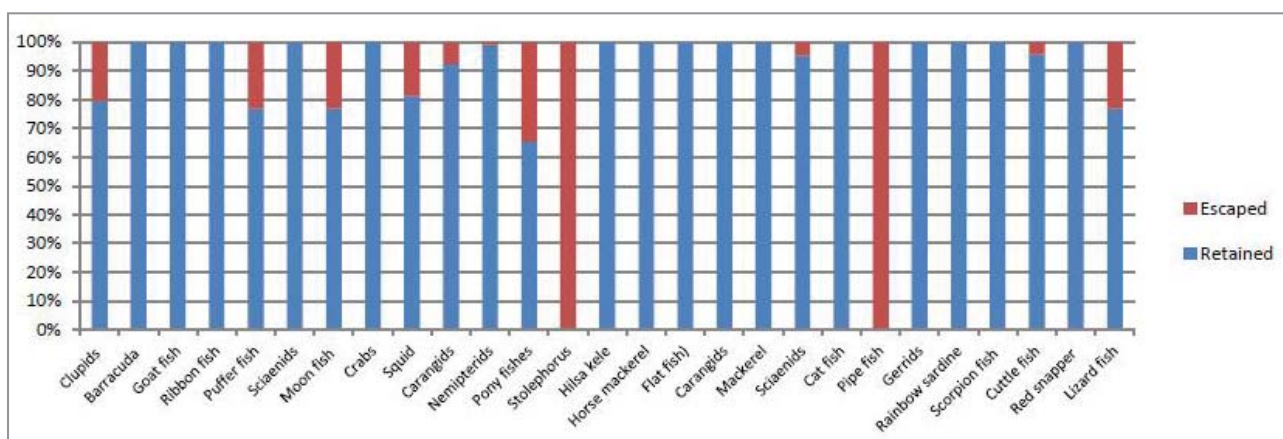
### Field trials using Juvenile and Trash Excluder Device

During field trials with JTED with 1 cm spacing it was observed that 27 commercial species were retained in the codend and 12 species had escaped into the cover codend. Two species showed 100% escapement, five species showed escapement from 20% to 40% and four species up to 20%.

During another field trial with JTED with 1 cm spacing it was observed that 20 species were retained in the codend and 11 species had escaped into the cover codend. Three species showed escapement between 20 to 50%, three species showed escapement over 50% and three species showed between 5-20% and the rest showed 100% retention.



Percentage composition of catch during JTED operations



Group exclusion and retention from 1 cm JTED

### Biodiversity studies of trawl catches

Quarter-wise biodiversity parameters were computed for the trawl catches. It was observed that in accordance in similarity of the species caught Quarter 3 and 4 are very closely related.





# FISH PROCESSING





## Research projects handled

### Institute projects

- Development of standard processes and protocols for innovative products from aquatic resources, shelf life modelling and assessment of energy use
- Development of high value byproducts from fish and shellfish processing discards
- Innovative product development for value addition, nutrient fortification and shelf life extension of farmed and wild freshwater and marine fish
- Species specific technologies for the improved utilization of the fishery resources of Maharashtra region

### Externally funded projects

- Development of bioplastic based sustainable nano-biocomposite food packaging – “Sustain Nano-Pack”
- Use of natural resins and gums for preservation and value addition of fishery products
- Agri-business Incubation

## Most significant achievements

- Fibre-rich seaweed (*Caulerpa racemosa* and *Ulva lactuca*) incorporated semi-sweet biscuits and extruded snack product was developed.
- Incorporation of nano-chitosan in biodegradable polylactic acid-based films enhanced antimicrobial activity.
- A prototype mould for the preparation of shrimp analogue product from fish mince was fabricated and analogue prepared.
- The average annual energy consumption and energy cost for seafood processing units in Kochi was 42,137.33 KW units and expenditure was ₹ 7, 84,258.50/-, respectively.
- A reduction of 13.34 and 8.4% process time was observed thermal processed fish processed in steam-air and water spray retorts, respectively compared to water immersion retorts.
- Crystallin protein isolated from tuna eye ball had higher thermal stability at freezing and above ambient temperature.
- Antioxidant properties and amino acid composition of squilla protein hydrolysates were characterized.
- Extracted sulphated polysaccharides with rich antioxidant properties from seaweed.
- Microencapsulated fish oil with fish protein hydrolysate exhibited improved oxidative stability.
- Tuna protein hydrolysate-incorporated health drink was formulated. Up to 10% hydrolysate incorporation was sensorily acceptable with improved functionality.
- Addition of maltodextrin and gum arabic in fish protein hydrolysates (FPH) effectively masked the bitter taste of FPH in sweet corn vegetable soup.

## Chief findings

### Institute projects

#### Development of standard processes and protocols for innovative products from aquatic resources, shelf life modelling and assessment of energy use

#### Development of seaweed-incorporated biscuits

Time-temperature combination of 190 °C for 15 min. and 1% seaweed (*Caulerpa racemosa*) incorporation was found optimum for the development of semi-sweet biscuits compared to 5 and 10%. The spread ratio increased to 9.26-13.97 in seaweed-incorporated biscuits compared to 9.63 for control samples.



Seaweed (*Caulerpa racemosa*) and seaweed-incorporated semi-sweet biscuits

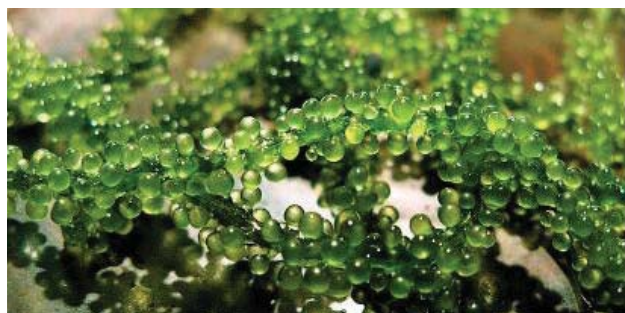
#### Development of seaweed-incorporated snacks

Fibre-rich extruded snack incorporated with seaweed (*Ulva lactuca*) showed highest expansion ratio for 3% seaweed-incorporated product. Lowest porosity was observed for 5% seaweed-incorporated product.



*Ulva lactuca*

#### Sea grape extract for enhancement of shelf life of mullet



Sea grape (*Caulerpa lentillifera*)

Edible coating of 1% sea grape (*Caulerpa lentillifera*) extract enhanced the shelf life up to 12 days for grey mullet (*Mugil cephalus*) steaks compared to only eight days for control samples under chilled conditions.



Squid masala in multi-layered container

#### Thermal processing of RTE squid masala

Polypropylene and EVOH based multi-layered containers (450 ml capacity) were used for thermal processing ready to eat squid masala. The ball process time and total process time was 48 and 53.8 min., respectively for

lethality of 8 min. at 121.1 °C. Squid masala had a shelf life of one year at ambient storage temperature (28±2 °C).

### Fortification of sardine oil

Fortification of sardine oil (1, 2 and 4%) resulted in enhancement of PUFA content in ready to eat seerfish moily processed to an  $F_0$  value of 8.2 min. in retortable pouches. Loss of EPA was only 18.1% for 4% sardine oil-fortified samples compared to 84.2, 64.3 and 51.8% for control, 1 and 2% fortified samples.



Seerfish (*Scomberomorus commersoni*) and seerfish moily

### Gel strength studies in Jewfish sausage

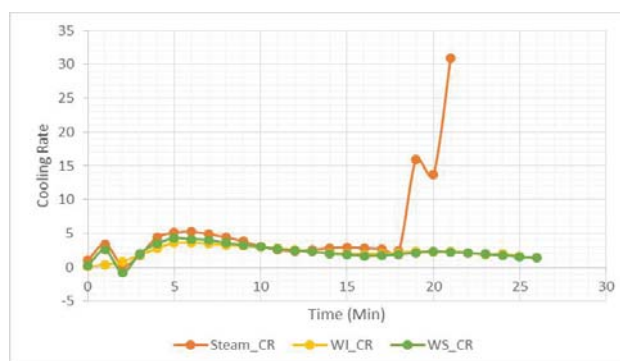
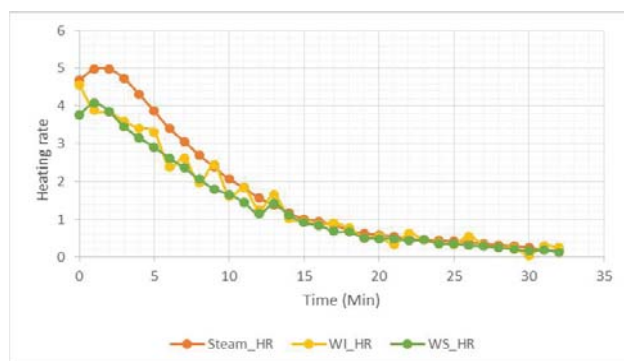
Incorporation of Malabar tamarind (*Garcinia cambogia*) extract containing 50 and 60% of hydroxycitric acid (HCA) with potassium salt at 0.75, 1.00 and 1.25% HCA level in Jewfish sausage resulted in decrease of gel strength, hardness and chewiness. Among different levels, sausage incorporated with 0.75% level of *Garcinia* extract containing 60% HCA exhibited least variation in gel strength and other textural attributes.



Malabar tamarind, extract of Malabar tamarind and Jewfish sausage

### Thermal processing of dolphinfish in brine medium

Thermal processing of dolphinfish (*Coryphaena hippurus*) in brine medium packed in TFS can indicated a reduction of 13.34 and 8.39% process time for steam-air and water spray retorts compared to water immersion retorts for equal lethality ( $F_0$  10 min.). Loss of poly unsaturated fatty acid was least for water immersion retorts followed by water spray and steam-air retorts.



Heating and cooling rate of thermal processed dolphinfish

### Nutritional bar from rohu mince

Incorporation of 15% fish powder from rohu mince was found optimum for developing nutritional bar based on sensory acceptability.



### Heat penetration studies of milkfish

Effect of heating medium (steam-air and water immersion) and packing medium (oil and natural packs) on the heat penetration characteristics of milkfish in retortable pouches resulted 29.37% less process time in steam-air medium compared to water immersion medium. Among the different packing mediums, milkfish processed in steam-air resulted in 31.33% less process time for natural style pack, whereas it was 22.34% in water immersion retort.



Fresh milkfish, fresh and smoked fish steaks and ready to eat milkfish steaks in retort pouches

### Development of extruded snack product

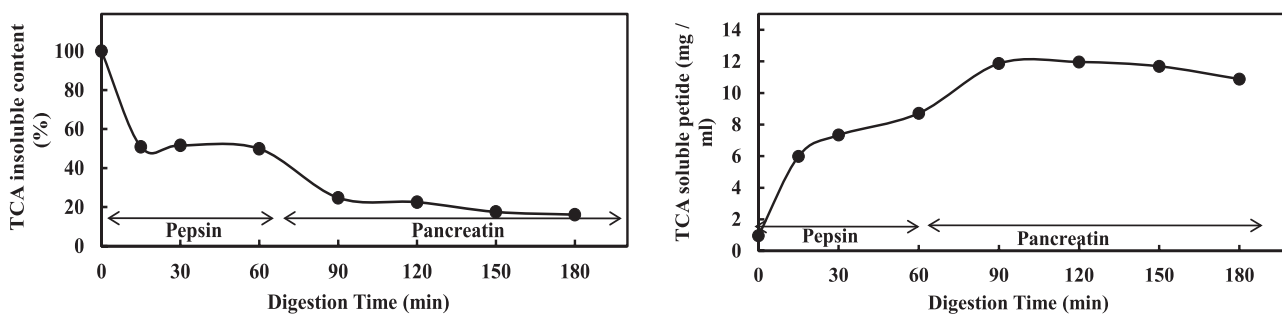
Incorporation of *Saurida tumbil* meat in different forms (raw, cooked and dried) at four different levels (5, 10, 15 and 20%, respectively) for the development of extruded snack product resulted in highest expansion ratio (3.03) for 5% level. Cooked fish meat incorporated at lower levels (5%) was found to have desirable properties like lower bulk density and higher expansion with significant increase in protein content.

### Suitability of batter mixes for coated products

Efficiency of different combinations of batter mix (five unleavened and five tempura batter mixes) incorporated with three different hydrocolloids viz. Guar gum, Carboxy Methyl Cellulose and Carboxy Methyl Chitosan were evaluated for the functional properties for coated shrimps. Guar gum was found to be better in terms of functional properties and batter consistency.

### Simulated gastro-intestinal digestion of croaker sausage

Simulated gastro-intestinal digestion of croaker sausage using pepsin and pancreatin indicated TCA insoluble solid content. The undigested proportion was reduced to 50% (dry weight basis) at the end of pepsin digestion and to 16% at the end of pancreatic digestion indicating digestion of 84% of total solids by sequential digestion of pepsin and pancreatin.



Changes in TCA insoluble content and soluble peptide during digestion

### Live tilapia transportation

Clove bud oil (5ppm) was optimum dosage as anaesthetic for live tilapia transportation compared to MS 222, Aqui-S.

### Effect of dehydration methods of croaker (*Otolithes ruber*) sausage

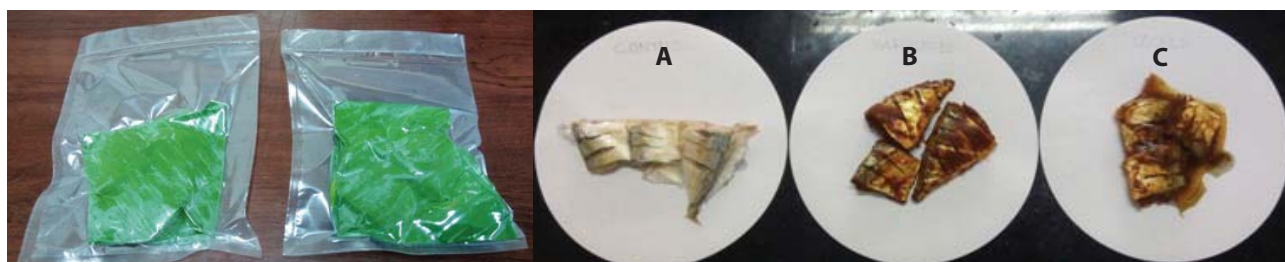
Effect of dehydration methods like vacuum drying (VD), fluidized bed drying (FBD) and solar drying (SD) resulted in reduced water activity to 0.49, 0.53 and 0.48 respectively for croaker sausage. Rehydration ratio for FBD (0.37) samples was lower than VD and SD (0.48).



Fresh and dried fish sausage prepared from croaker

### Banana leaf wrapping and quality of 'Ah-eemo'

Effect of natural banana leaf wrapping on the quality of "Ah-eemo" (a traditional fish product of Tripura) indicated a shelf life of 15 days for marinated product without cooking compared to 30 days for cooked samples under refrigerated storage.



Wrapped and vacuum packed Indian mackerel in PEST-PE laminate (A= Control (Cooked), B= Marinated (Uncooked), C= Marinated and cooked)

### Shelf life extension of tilapia and milkfish

A pressure of 300 MPa was found optimum for fresh tilapia (*Oreochromis mossambicus*) to maintain quality without increasing lipid oxidation compared to 150 MPa. For marinated tilapia fillets, 400 MPa extended shelf life up to 36 days during chilled condition.

### Accelerated shelf life prediction for low temperature stored fishes

Accelerated shelf life prediction study of milkfish (*Chanos chanos*) indicated a shelf life of 20 days in ice stored condition and 11 days in refrigerated condition based on principal component index to predict shelf life.

### Restructured product from Pangasius-green mussel mince

A protocol was standardized for preparing restructured nuggets from Pangasius fish with the addition of green mussel mince. Heat setting of the mince with ingredients was done by steaming for 15 min. Green mussel mince @ 5, 10 and 15% were added to Pangasius mince and the product with 10% mince was found better in terms of acceptability.



Restructured nuggets from Pangasius-mussel

### Effect of washing cycle on the physical properties and lipid oxidation in restructured nuggets from Pangasius-mussel mince

Washing of Pangasius mince reduced fat content from 21.8% to 15.7%, 5.6% and 4.8% in single (SW), double (DW) and triple washed (TW) mince, respectively. Lipid oxidation analysis of the nuggets indicated a significant difference between SW and DW; while the difference between DW and TW was meagre. Addition of mussel mince had no influence on fat content and oxidation whereas it had a strong positive effect on hardness of final products from



SW and TW mince. The product incorporated with mussel mince was well accepted by the sensory panel. The “fatty odour” of the pangasius mince was markedly reduced after repeated washing. Addition of mussel mince further masked the odour of mince.

### Shrimp analogue product

An analogue product having shrimp shape and colour was prepared from tuna mince. Tuna mince was washed two times with chilled water in 1:4 ratio and screw pressed. The mince was ground with 2% salt, 5% corn starch and moulded in shrimp shape using a food grade plastic mould. The mould along with product was steam cooked for 20 min. Shrimp flavor extract from shell waste was added at 1% and 2% concentration for getting shrimp flavor. After cooking, the product was separated from the mould, battered, breaded and fried. The product with 2% shrimp flavor extract showed better shrimp flavor and acceptability.



Moulded fish mince



Fried product

### Effect of pomegranate extract on lipid oxidation in fishmeal

A study has been initiated for assessing the antioxidant effects of pomegranate peel extract in fishmeal to replace the use of synthetic additives. Fishmeal from under-utilized fishes was prepared by dry-rendering process and treated with 100 ppm BHA, 1 to 2% pomegranate concentrate (PGE) and oxidation stability compared with control. The samples were sealed in polythene packaging material and stored at ambient temperature. After three months of storage, control samples showed highest TBARS (1.458 mg MDA/kg), PV (6.33 MeqO<sub>2</sub>/kg) than treated samples. Fishmeal, with 1% PGE showed lowest TBARS followed by 2% PGE and 100 ppm BHA. PV was lowest in 2% PGE and 100 ppm BHA added samples.

### Incorporation of tuna protein hydrolysate as a functional ingredient in health drink

Tuna (*Euthynnus affinis*) protein hydrolysate @ 2.5-10% were incorporated into the standardized basic mix. Up to 10% was acceptable with slight detection of bitterness. The functional as well as antioxidative properties of basic mix improved with hydrolysate incorporation.

### Application of tuna protein hydrolysate as a natural antioxidant

Tuna red meat protein was hydrolysed using papain enzyme (0.5% w/w) for 45 min., and applied as an antioxidant in dressed sardine during ice storage. TBA studies indicated that dip treatment in 0.5% TPH solution significantly reduced ( $p < 0.05$ ) the oxidation in ice stored dressed sardine compared to control revealing FPH application as a natural antioxidant in foods.

### Preparation of low sodium dried fish products

Low sodium dried fish products were prepared by partial replacement of sodium chloride (30, 40 and 50%) by six different formulations of alternative no-sodium salt and spice mixtures. No significant ( $p \leq 0.05$ ) changes were observed in the sensory quality of catfish dried in both the methods pre-salted with a mixture of no-sodium salts by replacing sodium chloride up to 50% level.



Low sodium dried fish products

### Quality evaluation of fish nuggets incorporated with green tea extract

Fish nuggets were prepared from pinkperch mince with incorporation of salt, corn flour and green tea extract. Products were prepared by steam cooking and kept at chilled (4 °C) condition. BHT (0.01%) incorporated nuggets served as positive control. Results showed an increasing trend in TBA values during storage. However, sample containing green tea extract showed less TBA value (0.34-0.44 mg MDA/kg) than BHT-incorporated sample (0.42 - 0.80 mg MDA/kg) and control (0.82 – 2.14 mg MDA /kg). Based on the microbial analysis, control sample was rejected on 12<sup>th</sup> day compared to 17<sup>th</sup> day for green tea extracts and BHT-incorporated samples.

## Development of high value byproducts from fish and shellfish processing discards

### Optimization of gelatin from surimi processing waste

Optimized gelatin extraction conditions (0.2 M NaOH, 70 °C temperature for 3.10 h) from surimi processing waste using RSM with predicted gelatin yield of 15.8% compared to 16.5% in experimental yield. The extracted gelatin is rich in glycine followed by glutamic acid, proline and alanine with high intensity of  $\beta$ - and  $\alpha$ -chains as the major components.

### Fish protein hydrolysate preparation using papain

Fish protein hydrolysate preparation from cooked meat of *Pangasius* sp. using papain resulted in a better product with increased oxidation stability compared to FPH prepared from fresh meat.

### Gelatin from croaker head waste

Gelatin extracted from croaker head waste had bloom strength of 45.33 g with gelling and melting points at 11 and 20 °C, respectively. The fish head gelatin showed peptide band near the molecular weight of 116 and 97 kDa corresponding to  $\alpha$ 1 and  $\alpha$ 2 chains.

### Studies on carboxy methyl (CM)-chitosan

The properties of CM-chitosan as affected by the degree of deacetylation (DA) of native chitosan was evaluated. The yield of CM-chitosan was found to be increasing with increase in DA of chitosan, with a maximum yield for 90% DA. Degree of substitution showed a direct relationship with DA of chitosan. Viscosity values showed minimum variations with DA of chitosan. The solubility values showed distinct differences between the samples, with maximum value for DA 90% and above. Chitosan beads prepared from native chitosan indicated that beads with lower DA registered marginally lower hardness values on compression. Morphologically, beads with 78% showed visible flake deposition in SEM images, owing to the poor solubility of chitosan in acetic acid.

### Protein from tuna eye ball

Crystallin protein from tuna eye ball was isolated in phosphate buffer and separated to soluble cortex and insoluble nucleus portions and freeze dried for analyzing physico-chemical properties. The proximate composition of the components indicated negligible content (less than 0.5%) of fat and ash. The SDS-PAGE of separated components indicated the predominance of sub-units below 30kDa. Thermal denaturation profile of crystallin proteins as determined by DSC indicated higher thermal stability at freezing and above ambient temperature zone.

### Hydroxyapatite for dentistry

Hydroxyapatite (HAP) was functionalized for antibacterial properties and loaded onto chitosan matrix for dental cleansing applications. The formulation was applied as an emulsion based on an aqua-base medium as well as powder form. Among the two formulations, the powder form showed better antibacterial efficacy compared to aqua-base form and pure HAP powder. The functionalized aqua-base mouthwash indicated three log reduction in total plate count, whereas powder form indicated four log reduction in TPC on the applied surface compared to the microbial load in untreated surface. On the other hand, simple HAP powder resulted in only one log reduction in TPC.

### Melanin from cuttlefish ink

Melanin was isolated from cuttlefish ink and the yield of melanin obtained using selective precipitation method was about 30% on wet weight basis. The isolated melanin was insoluble in water at neutral and acid pH ranges, whereas it started dissolution above pH 8.5. Scanning and transmission electron microscopic images of freeze dried melanin indicated presence of melanin pigments inside melanosome vesicles. Isolated melanin showed broad absorption in the entire UV range with a narrow and lower absorption at visible range.

### Studies on protein hydrolysate

Optimized preparation of tuna protein hydrolysate by RSM and maximum yield obtained was 15.84%. Papain-derived tuna dark meat protein hydrolysate possessed desired functional properties. The microbial quality of tuna white meat hydrolysate was better than the red meat hydrolysate. Tuna meat hydrolysate were found to be superior to waste hydrolysate, whereas waste hydrolysates exhibited higher functional properties and less bitterness.

### Development of crackers from rohu roe

Fish protein hydrolysate i.e., spray dried rohu roe, spray dried rohu roe with gum, fish waste hydrolysate, rohu hydrolysate and collagen peptide @ 1, 2.5 and 5 percent in crackers revealed that collagen peptide-incorporated cracker was most preferred sensorily. Baking time-temperature combination of 180 °C for 9 min. or 190 °C for 8 min. was found optimum.

### Antioxidant properties of squilla protein hydrolysate

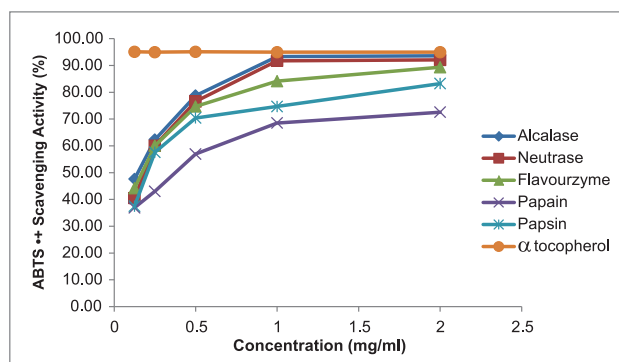
Protein hydrolysates were prepared from squilla using five protease namely alcalase from *Bacillus licheniformis*, neutrase from *Bacillus amyloliquefaciens*, flavourzyme from *Aspergillus oryzae*, papain from papaya and papsin from Porcine gastric mucosa. At the optimum condition, DH percentage was found to be 17.75%, 12.13%, 17.63%, 26.19% and 13.03% for alcalase, neutrase, flavourzyme, papain and pepsin, respectively. Yield of hydrolysates ranged from 4.46 to 6.53% and protein content ranged from 69.69±1.00 to 82.80±3.93%. Highest protein content was found in hydrolysate prepared from pepsin. Squilla hydrolysates produced using alcalase had higher scavenging ability and reducing power followed by pepsin, papain, neutrase and flavourzyme.

Squilla protein hydrolysate (SPH) prepared had eight essential amino acids and eight non-essential amino acids. Glycine, glutamic acid and aspartic acids were the major amino acids present in SPH.



Squilla

Squilla protein hydrolysate



Scavenging activity of squilla protein hydrolysate



Effect of SPH on lipid oxidation and quality changes of fish nuggets prepared from marine catfish (*Netuma thalassina*) mince during refrigerated storage was assessed. Peroxide value (PV) of control reached 19.2 meq of O<sub>2</sub> / kg of fat by the end of storage period whereas treated samples showed relatively lower PV values. After 10 days of storage, fish nuggets incorporated with SPH showed slightly lower TBARS value (mg MDA/Kg). However, there was no change in TBARS value in case of fish nuggets made with 1% ascorbic acid. The results of the study indicate that SPH is a promising alternative to replace harmful synthetic antioxidant in fishery products.



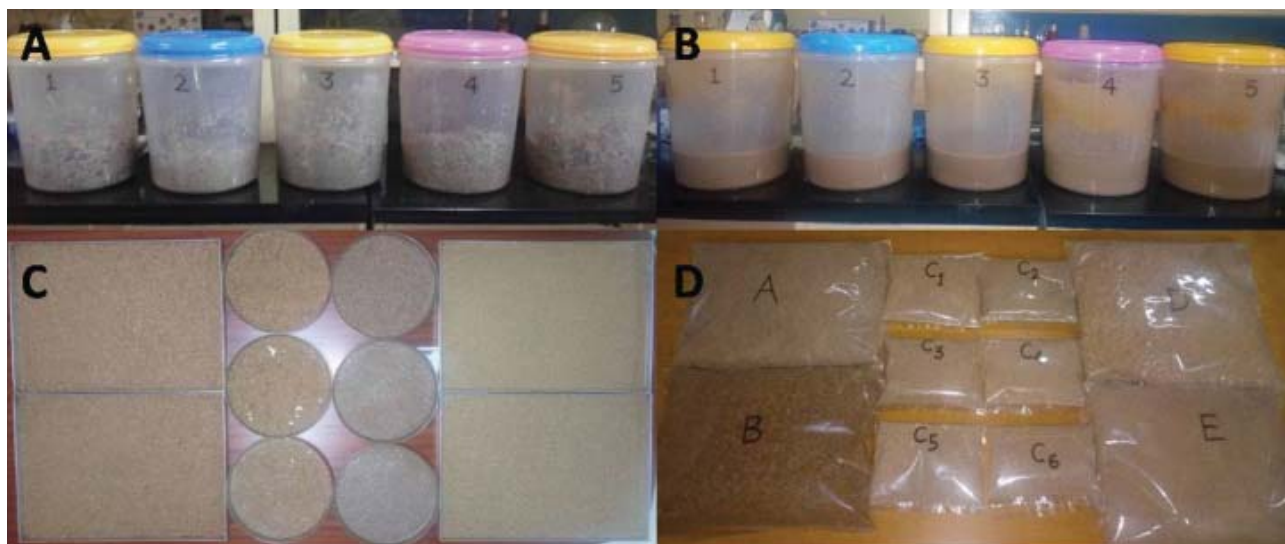
Fish nuggets in thermoform tray and fried fish nuggets

### Isolation and characterization of visceral proteases of fish from different habitats

Proteases from viscera of three different species namely, little tuna (*Euthynnus affinis*), catla (*Catla catla*) and tilapia (*Oreochromis mossambicus*) belonging to different habitats were isolated using different precipitation techniques such as acetone precipitation, ethanol precipitation and ammonium sulfate fractional precipitation and further characterized. Ammonium sulphate fractionated precipitation exhibited higher specific activity whereas acetone precipitated fractions exhibited higher recovery in all the fishes.

### Preparation of powdered silage using solar drying technique

Silage was prepared from small sized whole pinkperch (*Nemipterus japonicus*) using different combinations of acids (3% formic acid alone, combination of 1.5% each of formic acid and propionic acid, 3% propionic acid, 3% sulfuric



A. Fish silage before liquefaction, B. Fish silage after liquefaction, C. Fish silage mixed with bran for drying, D. Powdered dried fish silage

acid and 1.5% each of sulfuric acid and formic acid). Formic acid silage exhibited higher protein content among the different treatments. The liquid portion was subjected to solar drying after mixing with 30% wheat bran in order to facilitate easy transport. Slight variations in colour and moisture content of silage was observed as a function of storage period.

### **Fish Protein Hydrolysate (FPH) from tuna waste**

Little tuna skins and frame waste was utilized for preparation of protein hydrolysates using 1% papain. The hydrolysates were oven dried in order to make drying operations economical and evaluated for its functional and antioxidant properties. The FPH samples exhibited good functional as well as antioxidant properties.

### **Microencapsulation of fish oil with cuttlefish skin gelatin and chitosan**

Microencapsulation of fish oil was done by using cuttlefish skin gelatin, chitosan, and maltodextrin as a wall material. Moisture content of the fish oil encapsulates was 6.36% and showed encapsulation efficiency of 59.19%. Microencapsulated fish oil showed passable flowability with the Hausner Ratio of 1.32.  $L^*$ ,  $a^*$ ,  $b^*$  value of fish oil encapsulate was 74.25, 7.21 and 16.81, respectively.

### **Effect of chitosan and oregano essential oil on the stability of fish oil encapsulates**

Microencapsulation of fish oil was done by spray drying using chitosan, bovine gelatin and maltodextrin as a wall material. In order to study the effect of natural antioxidants on the fish oil encapsulates, oregano (*Origanum vulgare* L.) essential oil was added at 0.25% concentration. Microcapsules had a moisture content of 2.8–3.2%. Encapsulation efficiency of fish oil encapsulates ranged between 59.98–68.20%. SEM analysis of fish oil encapsulates showed spherical shape. Oxidative stability of encapsulates under accelerated condition (50 °C) indicated that encapsulates prepared with oregano essential oil had lower TBARS value than control sample during storage.

### **Utilization of fish protein hydrolysate for fish oil encapsulation**

Fish protein hydrolysates were prepared from pinkperch meat. Along with hydrolysate, maltodextrin and gum Arabic were also used as wall material for encapsulation. The emulsions were spray dried and physical properties of the encapsulated powder were evaluated. Oxidative stability of encapsulated powder under accelerated conditions showed an increasing trend in TBARS values during storage. However, microencapsulates containing fish protein hydrolysate had lower TBARS values than the control sample.

### **Chitosan marinade**

Fish marination using chitosan was carried out as chitosan requires low pH for maximum activity. Chitosan added tuna chunk marinades were microbiologically acceptable upto 66 days under refrigerated storage.



Fish marination

### **Properties of tuna white and red meat protein hydrolysates**

A comparative study of the properties of protein hydrolysates prepared from white meat and red meat of tuna (*Euthynnus affinis*) using 1% (w/w) papain for one hour was carried out. The protein content in tuna red meat was slightly higher than white meat, whereas the protein recovery was 42.14% from white meat and 36.87% from red meat on hydrolysis. Oil absorption capacity was higher for TRPH whereas foaming properties was higher for TWPH. DPPH radical scavenging activity, reducing power and metal chelating power was higher for TRPH compared to TWPH.

## Innovative product development for value addition, nutrient fortification and shelf life extension of farmed and wild freshwater and marine fish

### Fish mince using natural antioxidants

Effect of aqueous extracts of rosemary and thyme leaves in inhibiting accelerated lipid oxidation in fish oil-fortified fish mince was evaluated. Rosemary extract was found very effective and superior to thyme in inhibiting lipid oxidation as measured by PV and TBARS.

### Inhibition of melanosis in *Litopenaeus vannamei* using alternatives to metabisulphites

Shrimps were treated with sodium metabisulphite (SMS), EDTA with 0.5% sodium citrate (SC), pomegranate extract (PE) solution and control without any treatment and packed in polyethylene bags and stored in ice. The melanosis score at the end of 12 days were 8.7, 6.8, 7.9 and 6.4, respectively for control, SMS, EDTA+SC and PE treatments. In addition, PE reduced bacterial load and TVB-N generation followed by EDTA+SC combination during the storage period.

### Extraction of shrimp flavor

Shrimp flavor was extracted from the cephalothorax of *L. vannamei* through hydrolysis by ntrase enzyme. Corn starch was used as a binder for drying the extract. The flavor ingredient can be used for imparting shrimp flavor to restructured fish products. The dried powder imparted shrimp flavor to fish nuggets when added @ 2% of fish mince.



Shrimp flavor extracted in corn flour

### DHA fortified nutritional supplement

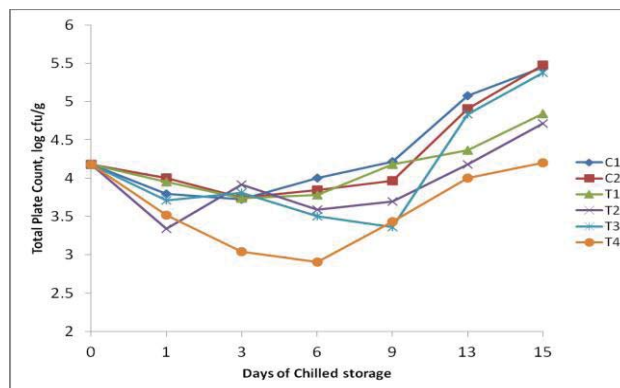


DHA fortified nutritional supplement

A nutritional supplement based on wheat flour, soy flour, gram flour, ground nut and cashew nut was prepared. Encapsulated DHA powder containing upto 7% DHA was added to the nutritional mix. 2% DHA powder showed better sensory acceptability after boiling the mix with milk. The product is vacuum packed and oxidative stability of the product with and without the presence of ascorbic acid indicated lower PV in ascorbic acid-incorporated samples after two months storage.

### Chilled storage of Pangasius fillets coated with plant oil-incorporated alginate gels

Pangasius (*Pangasianodon hypophthalmus*) fish fillets were coated with edible coating of Sodium alginate incorporated with 1% essential oils (clove leaf oil, clove bud oil, rosemary oil and thyme oil) for 1 min. and packed in pouches and stored under chilled conditions.



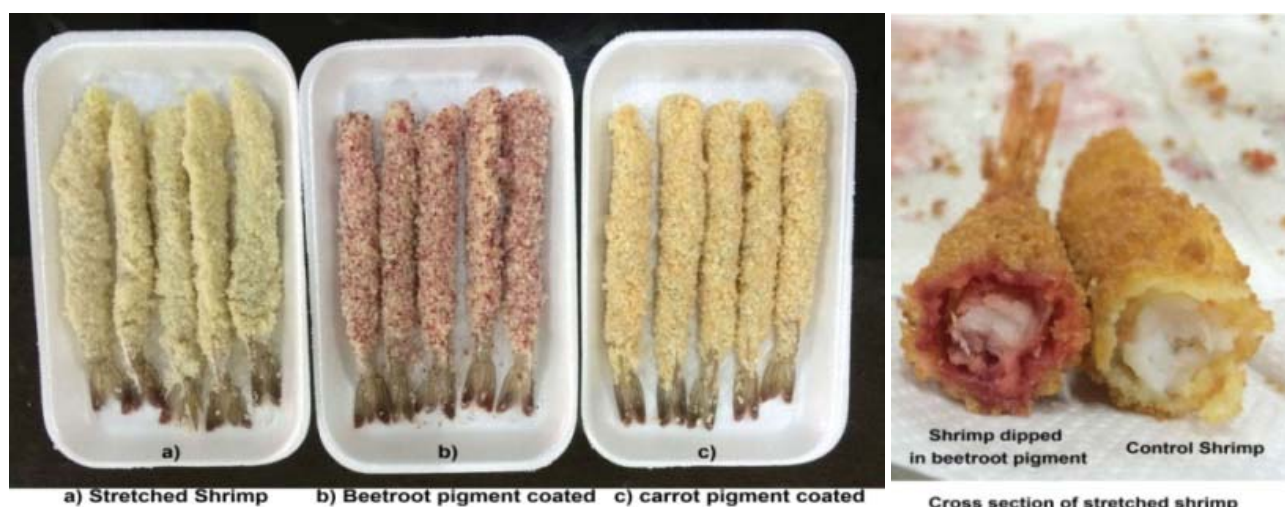
Changes in the Total Plate Count



The total plate count (TPC) of plant oil treated fillets were lower than the control fillets.  $H_2S$  producing bacteria showed an increasing trend in all samples but the increase was slower in thyme oil treated fillets. Among the different essential oils, inhibition of secondary oxidation as assessed by TBARS value followed the order; clove leaf oil > clove bud oil > thyme oil > rosemary oil.

### Bioactive pigment-fortified stretched shrimp

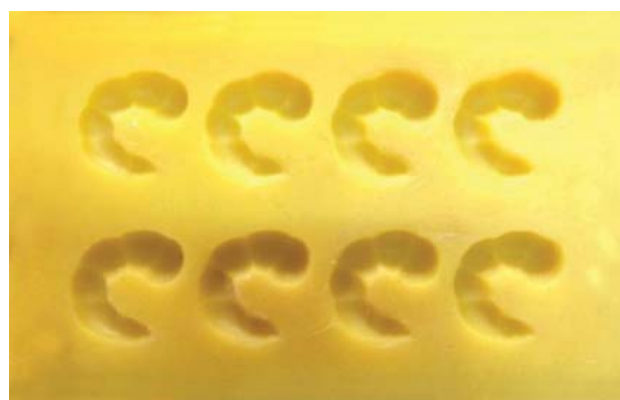
Natural pigments were extracted from beet root (*Beta vulgaris*) and carrot (*Daucus carota*; orange cultivar). The yield of pigment laden liquid for beet root and carrot was 73% (v/w) and 62% (v/w) respectively. These liquids, rich in natural pigments were sprayed on bread crumbs to impart colour to the crumbs. Vannamei shrimp were stretched using the CIFT-shrimp stretching mould and were dipped in batter. Control shrimps were breaded using commercially available bread crumbs. Beet root pigment and carrot pigment-laden liquids were added, separately to commercial bread crumbs @ 1, 2, 4, 8% v/w, and the results based on organoleptic evaluation (colour and taste) showed that beet root pigment at 4% v/w and carrot pigment at 8% v/w had better acceptability.



Stretched shrimp coated with vegetable pigments and stretched shrimp dipped directly in undiluted beet root pigment laden liquid

### Design of plastic mould for preparing shrimp analogues

The dimensions of the *L. vannamei* shrimp (40 count) shrimp were measured very accurately and was used as the prototype for engraving on the LDPE block. Computer numerical control router, a computer controlled cutting machine was used to engrave the shrimp shapes on the LDPE block. The shrimp analogue mould was easy to clean as it has a non-absorbent and non-porous surface and can withstand steam temperature. The mould finds use as template for making analogue shrimp products.



Plastic mould for preparing shrimp analogues

### Meat characteristics of white and brown shell *L. vannamei*

Meat composition and characteristics of the vannamei shrimp with different shell colour was analyzed. The results indicate that the white shell vannamei (regular) had higher content of sodium and calcium compared to brown shell vannamei indicating that mineral imbalance might be a reason for the difference in shell colour of vannamei.

The meat characteristics indicated by texture profile analysis showed that white shell vannamei was better in hardness, gumminess and chewiness compared to brown shell vannamei.



*L. vannamei* – brown colour (top), *L. vannamei* – regular white colour (bottom)

### Nutritional and physical properties of noodles incorporated with seaweed puree

Nutritional and physical properties of noodles prepared with and without green seaweed (*Ulva reticulata*) puree was evaluated. Addition of seaweed puree increased the crude fibre content of noodles. Higher water absorption was noticed in noodles with 20% seaweed puree, which led to softer and spongier textural intensities of the noodles. The results indicate that incorporation of green seaweed puree in noodles has positively influenced the flavour and fibre content.



*Ulva reticulata*



Noodles incorporated with seaweed puree

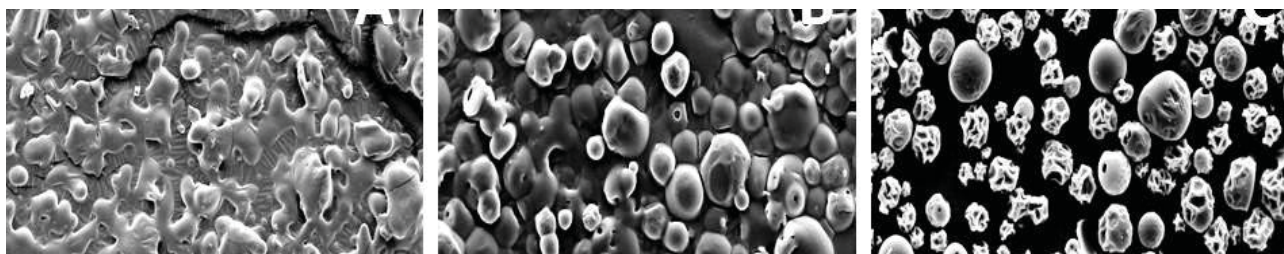
## Species specific technologies for the improved utilization of the fishery resources of Maharashtra region

### Bioactive and functional properties of FPH with and without addition of maltodextrin and gum Arabic

Pinkperch (*Nemipterus japonicus*) meat protein hydrolysates were prepared using 1% papain with and without addition of maltodextrin and gum Arabic as carrier agents in spray drying. DPPH free radical scavenging activity, reducing power and metal chelating activity of FPH samples without addition of maltodextrin and gum Arabic (Sample A) was higher when compared with the other (Sample B).

### Effect of drying techniques on FPH

Oven dried and spray dried FPH samples were compared using Scanning Electron Microscopy (SEM) analysis. Oven



Scanning Electron Microscopy images of FPH (Sample A, B and C)



dried FPH (Sample A) exhibited hydro-colloidal nature. Particles were more spherical in spray dried FPH (Sample B) compared to oven dried FPH. Spray dried samples with addition of maltodextrin and gum Arabic (Sample C) showed separated uniform sized particles with shrinkage resulting in reduced particle size. Differential Scanning Colourimetry analysis of FPH with (Sample B) and without addition of maltodextrin and gum Arabic (Sample A) was carried out which exhibited two degradation curves for Sample A and for Sample B there was only a single degradation curve.

### Enhancement of antimicrobial effect of chitosan with addition of FPH

Antimicrobial activity of FPH with and without addition of maltodextrin and gum arabic was evaluated. FPH alone did not exhibit antimicrobial activity but in combination with chitosan it exhibited antimicrobial activity against *B. cereus* and *E. coli*. Chitosan alone showed an inhibition zone with diameter of 17 mm against *E. coli* and FPH in combination with chitosan enhanced the antimicrobial activity to 24 mm inhibition zone against *E. coli*.

A. FPH + Chitosan, A1. FPH alone, B. FPH added with maltodextrin and gum arabic + Chitosan, B1. FPH added with maltodextrin and gum arabic, C. Chitosan alone



### Development of innovative value added product “shrimp sev puri” from tiny shrimps

“Shrimp sev puri” from tiny shrimps (*P. styliifera*) was developed by replacing potato filling with shrimp filling which was prepared using Chinese and Maharashtra region specific spice mixtures.



Shrimp sev puri from tiny shrimps

### Application of FPH in sweet corn vegetable soup

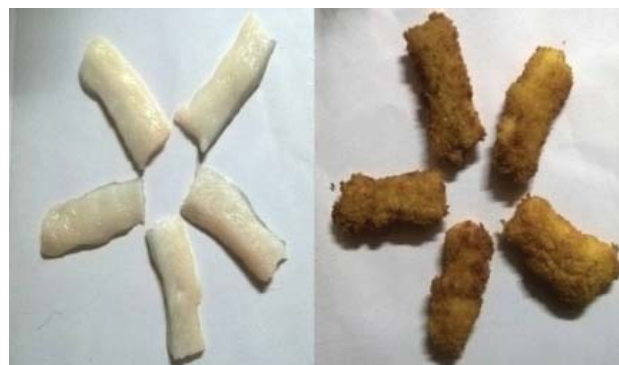
Sweet corn vegetable soup was fortified with FPH at 2, 3 and 4% in order to enrich with proteins and reduce the bitterness. Sweet corn vegetable soup effectively masked bitterness of FPH. Addition of maltodextrin and gum Arabic to FPH was more effective in masking bitterness at 4% concentration. Fish protein fortified soup powder could be considered as healthy diet as it is rich in proteins.

### Quality of onboard stored squid under slurry ice

Biochemical quality of squid stored in slurry ice onboard fishing vessel was evaluated. Lower values of pH, TMA and TVB-N were observed in slurry ice stored samples. Texture was better for slurry ice stored samples compared to conventional ice stored samples.

### Shelf life assessment of fish fingers from Bombay duck

Fish fingers were prepared from Bombay duck and quality characteristics were evaluated under chilled condition. An increasing trend in pH, TVB-N, FFA, PV and TBA values ( $p < 0.05$ ) were observed during storage and sensorily samples were acceptable upto 15 days.



Fish fingers from Bombay duck (Fresh and cooked)

### Quality of fish in retail markets

Biochemical quality of fishes collected from local fish market and super market at Navi Mumbai, Maharashtra were evaluated. Fishes collected from the local fish market had a higher TVB-N value and formaldehyde content than the permissible level. All the samples from retail fish market had an acceptable level of biochemical content except Bombay duck which showed higher formaldehyde content. All the samples from super market had higher formaldehyde content. It could be due to the intentional incorporation of formaldehyde in the fishes which should be avoided as it affects the consumer's health.

### Effect of chitosan coating and drying on the quality of Bombay duck

The dried Bombay duck had moisture content of 7 to 8%. Results showed that chitosan treated sample had less TVB-N and TBA value than untreated sample. Microbial analysis revealed that sample had acceptable level of total bacterial count during storage period and samples treated with chitosan had better sensory quality.



Bombay duck dried with various treatments

### Preparation of fish papad from croaker (*Johnius dussumieri*)

Standardization of process and ingredients for the preparation of fish papads from croaker was carried out. Upto 50% cooked fish was required for developing the fish flavor in papads. Papads were dried in an oven at a temperature of 50 °C for 15 min. and were further stored under room temperature and chilled conditions for evaluating their quality. Dried papads stored at room temperature had a shelf life of one week compared to one month under chilled condition.



Fish papad from croaker

### Standardization of process conditions for the development of fish cake

A study was carried out to optimize the process conditions for improving the textural properties of fish cake. Fish cake was prepared from water leached threadfin bream fish mince. The influence of various ingredients and processing steps on texture and colour of the product was assessed. Better whiteness for fish cake was observed for a process combination of 5 min. mixing and 30 min. steaming; and 10 min. mixing and 20 min. steaming.



# QUALITY ASSURANCE & MANAGEMENT



## Research projects handled

### Institute projects

- Risk assessment of emerging food-borne pathogens and chemical residues in aquatic systems
- Development of high value byproducts from fish and shellfish processing discards
- Development of standard processes and protocols for innovative products from aquatic resources, shelf life modelling and assessment of energy use
- Marine biomolecules - Characterization and utilization for nutraceutical, biomedical and industrial applications

### Externally funded projects

- Food safety interventions for women in fishery based micro-enterprises in coastal Kerala
- Characterization of harmful algal bloom along Indian coast
- National surveillance programme for aquatic animal diseases
- Development of bioplastic based sustainable nano-biocomposite food packaging - "Sustain Nanopack"

## Most significant achievements

- Exclusive presence of enterohaemorrhagic *Escherichia coli* O157:H7 and *Yersinia enterocolitica* in seafood sourced from local fish markets revealed cross contamination from animal meat. Among pathogens, highest prevalence was recorded for *E. coli* (25%), followed by *Salmonella* (18%), *Vibrio parahaemolyticus* (15%), *Listeria monocytogenes* (2%), *Aeromonas hydrophila* (1.2%) and *V. vulnificus* (0.87%).
- Progressive hazard profiling in the value chain of oil sardine (*Sardinella longiceps*) indicated one log increase in bacterial load (4.49-5.57 log cfu/g) subsequent to landing from the boat, through transportation and till it reached the retailer level in the market.
- In salted and dried fishery products, *Staphylococcus aureus* was detected as the major contaminating pathogen. A moderate level (23.8%) of the isolates were capable of producing enterotoxin.
- Hazard profiling of milkfish (*Chanos chanos*) from aquaculture grow-out ponds indicated high risk of histamine formation for the species in temperature abuse conditions.
- Application of lytic bacteriophages for control of *Salmonella* and *Listeria* in seafood processing was evaluated. A minimum exposure time of 2.5 hours was optimized to bring down surface contaminated *Salmonella* in tuna products by 6 logs and 5 logs for cooked clam meat.
- Recontamination potential of *Salmonella* in cooked and raw shrimp products was assessed. Higher recovery (67.04%) and higher survival (95-100%) of *Salmonella typhimurium* was recorded in cooked and frozen shrimp (*L. vannamei*) compared to raw product.
- Risk assessment of commercially available heat shucked clams indicated *E. coli*, *S. aureus* and *Salmonella* as potential hazards and suitable mitigation measures were developed.
- LC-MS/MS method for determination of 160 pesticides in fish and fishery products and simultaneous analysis of tetracycline and sulphonamide antibiotic residues in shrimp were developed.
- A multi-residue analysis of persistent organic pollutants in seaweeds was developed by ethylacetate extraction,



solid phase dispersive cleanup followed by GC MS/MS analysis. The micro-pollutants had 65-120% recovery by this method.

- Surveillance sampling and root-cause analysis of export rejections was carried out for hazards like *Salmonella*, Crystal violet, Coliform and *L. monocytogenes* for various seafood establishments and mitigation measures were suggested.
- Biogenic amine build up in high pressure treated tuna was modelled for predictive analysis during subsequent chilled storage conditions.

## Chief findings

### Institute projects

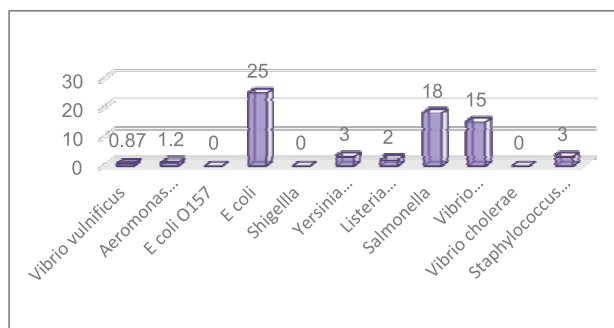
#### Risk assessment of emerging food-borne pathogens and chemical residues in aquatic systems

#### Risk assessment of emerging food-borne pathogens and chemical contaminants in seafood

Exclusive presence of enterohaemorrhagic *Escherichia coli* O157:H7 and *Yersinia enterocolitica* in seafood sourced from local fish markets revealed cross contamination from animal meat. Among pathogens, highest prevalence was recorded for *E. coli* (25%), followed by *Salmonella* (18%), *Vibrio parahaemolyticus* (15%), *Listeria monocytogenes* (2%), *Aeromonas hydrophila* (1.2%) and *V. vulnificus* (0.87%).

Dry fish samples of salted and non-salted types were collected from Ernakulam market and Alappuzha market (Vazhicherry market). Biochemical quality of samples based on water activity, moisture, sand and salt content were evaluated. Range of water activity of samples from Ernakulam market was 0.739–0.778. Moisture content of all the samples were above 40% and highest was in case of shark. Salt content was found in the range of 14.3922–21.2943%. Average sand content was 0.426%. Range of water activity of samples from Alappuzha market was 0.619–0.804. Most of the samples were improperly dried and stored unhygienically. Moisture content was found to be highest in case of tuna (mean 55%). Majority of the samples were having sand content above 1%. Salt content was found in the range of 16.49–23.11%. Presence of mercury (0.856 mg/kg) was observed in salt dried shark sample collected from Ernakulam market. Cadmium was found in the range of 0.011–0.305 mg/kg in 38% of samples. Presence of lead was detected in the range of 0.95–1.06 mg/kg in 6% of samples. APC, coagulase positive *S. aureus*, yeast and mould counts were analyzed. Aerobic plate count ranged from  $9.8 \times 10^3$  to  $3.3 \times 10^6$  cfu/g. Out of 21 samples, four were contaminated with Coagulase positive *S. aureus* ( $8.0 \times 10^1$  to  $6 \times 10^3$  cfu/g). Yeast and mould were present in all the samples ranging from  $4 \times 10^2$  to  $7.5 \times 10^3$  cfu/g. Pathogens like *Salmonella*, *Listeria monocytogenes*, *Vibrio cholerae* and *V. parahaemolyticus* were absent. Coagulase positive *S. aureus* isolates (n=25) obtained from the salted dried fishes, collected from the different markets of Ernakulam, Alappuzha and Kottayam districts of Kerala were tested for their enterotoxigenicity.

Fifty four samples which were procured from retail markets and aquaculture ponds were analyzed for *Yersinia* and *Aeromonas* species. Total 81 strains were isolated among which 13 strains were positive for *Yersinia* and four were found to be *Y. enterocolitica*. Total of 146 strains were isolated which revealed 69 isolates as *Aeromonas* spp. Three strains were positive for *Aeromonas hydrophila*. *Sardinella longiceps* procured from Pollathiyl harbor (Kollam) included fishing vessel, landing center, market, vehicles for transportation and



Food-borne pathogens prevalence in seafoods

retail markets. The total bacterial load was between  $3.1 \times 10^4$  to  $8 \times 10^5$  cfu/g with one log increase in supply chain. No *Y. enterocolitica* was detected in supply chain.

Assessment of water quality, heavy metal content and antibiotic residue level of milkfish farms of Njarackal, shrimp farms of Panangad and Mandapam in Tamil Nadu were carried out. Presence of chloramphenicol was found in *Litopenaeus vannamei* samples collected from Mandapam. A single LC-MS-MS method for analysis of antibiotic residues mainly sulphonamides (sulfadimethoxine, sulfadiazine, sulfamerazine, sulfamethazine, sulfamethizole and trimethoprim) and tetracyclines (oxytetracycline, tetracycline and chlorotetracycline) was developed.

### Progressive hazard profiling in the value chain of oil sardine

Progressive hazard profiling from landing centre to market in the value chain of oil sardine (*Sardinella longiceps*) was carried out. There was one log increase in bacterial load (4.49-5.57 log cfu/g) subsequent to landing from the boat, through transportation and till it reached the retailer level in the market. Similarly, there was cumulative increase in the load of Coliforms (<10 -210 cfu/g) and *E. coli* (<10 -10 cfu/g). There was complete absence of human pathogenic bacteria (*Salmonella*, *V. cholerae*, *V. parahaemolyticus*, *L. monocytogenes*, *Y. enterocolitica* and *S. aureus*) in any of the track points. Chemical hazard profiling along the value chain indicated that all the samples were in fresh and acceptable condition.



Collection of sample from landing market

### Hazard assessment of fresh and frozen fishes available in super markets of Kochi

Samples of fresh and frozen fishes belonging to different species were collected from the super markets of Kochi. Out of 31 fresh fishes analyzed 12.9% have APC above  $10^7$  cfu/g. Only 35% of the samples were less than  $5 \times 10^5$  cfu/g. The highest count of Coliforms observed was 2.79 log cfu/g. About 13% of the samples were contaminated with *E. coli*. Coagulase positive Staphylococci were detected in one sample and the count were less than 100 per g. Other pathogens such as *Salmonella*, *L. monocytogenes*, *V. parahemolyticus* and *V. cholerae* were not detected in any of the samples. In frozen fish available in super markets, the bacterial load was moderate (3.5-4.9 log cfu/g) and free from the other pathogens such as coagulase positive Staphylococci, *Salmonella*, *L. monocytogenes*, *V. parahemolyticus* and *V. cholerae*. The biochemical quality and chemical contamination (heavy metal and formaldehyde) profile of fresh and frozen fishes sold in super markets of Kochi was also assessed. A total of 45 samples were collected and 8% were found to be spoiled as indicated by biochemical indices. Histamine was found to be less than 10 ppm in all the samples analyzed. Levels of putrescine and cadaverine were highest in the samples of *Rastrelliger kanagurta* and *Lethrinus nebulosus*, respectively. Presence of lead (> 0.3 mg/kg) was found in 12% of samples. Cadmium was present in the range of 0.031-0.235 mg/kg in 38% of samples. Presence of lead was noticed in 13.33% of samples with a maximum of 0.864 ppm in case of *Nemipterus japonicus*. Formaldehyde was detected in the range of BDL –  $3.18 \pm 0.42$  mg/kg.

### Hazard profiling of milkfish from aquaculture grow-out ponds

Hazard profiling of milkfish (*Chanos chanos*) from aquaculture grow-out ponds was carried out. The mean bacterial load of milkfish observed was  $2.75 \times 10^5$  cfu/g. The load of Coliform and *E. coli* were below 10 cfu/g. The presumptive histamine formers were as high as  $3.8 \times 10^3$  cfu/g indicating possibility of development of histamine poisoning in temperature abuse conditions. The other pathogens like *Salmonella*, *E. coli* O157, *L. monocytogenes*, *V. cholerae* and *Y. enterocolitica* were absent. High content of lead and cadmium was found in case of sediment samples collected from milkfish farms of Njarackal.



### Recontamination potential of *Salmonella* in processed fishery products

The recontamination potential of cooked shrimp products with *Salmonella* was assessed. It was observed that there was higher recovery (67.04%) of *Salmonella typhimurium* in cooked shrimp (*L. vannamei*) compared to raw (62.98%) product. The survival of *Salmonella* in cooked shrimp subsequent to air blast freezing was unaffected, whereas there was 82.95% reduction in *Salmonella* in raw inoculated shrimp subsequent to freezing. Similarly, the percentage of *Salmonella* out of total bacterial load was higher (11.37%) in cooked samples compared to raw (7.23%) after seven days of cold storage (-20 °C). There was marginal decrease in counts after two month of cold storage indicating higher recolonization potential of *Salmonella* in processed fishery products.

### Growth kinetics and enterotoxin production of *Staphylococcus aureus* during drying

Growth and enterotoxin production potential of *S. aureus* during mechanical drying of anchovy (*Stolephorus commersoni*) was studied at different time intervals (0-8h) at different pre-inoculated concentrations ( $10^2$ - $10^9$  cfu/g) at a fixed exposure temperature of 30 °C. There was no enterotoxin production in anchovy samples pre-inoculated with  $10^2$  and  $10^3$  cells even after 8h although the *S. aureus* load increased to 3.3 log cfu/g and 5.41 logcfu/g respectively. Pre-inoculated levels of  $10^4$ ,  $10^5$ ,  $10^7$  and  $10^9$  showed enterotoxin production at 8<sup>th</sup> hr, 6<sup>th</sup> hr, 4<sup>th</sup> hr and 2<sup>nd</sup> hr, respectively, when the *S. aureus* count reached to 6 log cfu/g and APC of 8 log cfu/g. It was established from the study that enterotoxin production is initiated only when background load of *S. aureus* increases to  $10^6$  cfu/g.



Mechanically dried anchovy

### Validation of 3M Petrifilms

Suitability of films after 30 days of opening packs and stored at room temperature were evaluated. Validation of the Aerobic Plate Count films, Yeast and Mold count films were validated with IS 5402 and IS 5403 methods. Similarly, spiked recovery with fish and milk samples was also conducted using *E. coli* and *S. aureus* for APC Petrifilms and *Candida albicans*, *Saccharomyces cerevisiae* and *Aspergillus niger* for yeast and mold Petrifilms. Significantly higher count was obtained in APC Petrifilm in Stage I than IS 5402. No significant difference between methods were observed after 30 days (Stage II) but less APC was obtained in IS 5402 method. No significant difference in Stage I, but significant difference in methods after 30 days was observed for yeast and mold count from Petrifilms. Higher recovery (90-95%) was obtained in Petrifilms in spiked recovery studies compared to normal BIS method.

### Effect of sampling size on isolation of *Salmonella* from seafood

A comparative analysis was made on the effect of sampling size variation on isolation efficacy of *Salmonella* from seafood samples. Pangasius fillets were artificially contaminated with different concentrations of *Salmonella typhimurium* (10-100 no/g). As per USFDA *Salmonella* sampling plan, 15 individual samples (each weighing 100g) were drawn, from which again 25g each were composited to make 375g sample. Simultaneously, one sample unit of 25g was taken from each group of artificially contaminated Pangasius samples. Samples were further processed as per USFDA BAM protocol. The results indicated higher probability of isolation with USFDA *Salmonella* sampling protocol, when *Salmonella* load was  $\leq 10$  no/g. Easily identifiable typical colonies appeared on BSA, XLDA and HEA, when 375g composite samples was used. At higher contamination load (100/g and 1000/g), there was no significant difference in single sampling unit and composite sample. RV-BSA and TTB-HEA combinations were found to be more efficient in isolation of typical *Salmonella* colonies.

### Application of lytic bacteriophages for pathogen control in seafood

Application of lytic bacteriophages of *Salmonella* to tuna chunks could effectively bring down *Salmonella* load from  $10^6$  cfu/g to  $<0.3$  MPN/g. In artificially contaminated clam meat, some protection was observed as even after 2.5 hours exposure, *Salmonella* could survive and a count of 2.3 MPN/g could be recorded. Application of lytic bacteriophages of *Listeria* to tuna chunks could effectively bring down load of artificially contaminated *L. monocytogenes* by 6 logs after 2.5 hr exposure.

### Surveillance of *Listeria monocytogenes* in export consignments

Surveillance sampling was carried out in one seafood processing location subsequent to an alert issued by New Zealand Food Safety Authority for presence of *L. monocytogenes* and *Salmonella* in the exported frozen shrimp consignment. Random samples of raw material, water, surface swabs from conveyor belt, ice used for glazing and final product were taken. *L. monocytogenes* was detected in final product kept in cold storage. The verification of HACCP plan indicated the non-adherence to validated cooking time and temperature regime, which could have resulted in survival of *L. monocytogenes* in the final product. A stringent environmental sanitation regime was also suggested to avoid survival of pathogens in biofilms.

### Baseline screening for permitted additives in fish and fishery products

Baseline study was carried out to find the natural level of phosphate in shrimp. Fresh samples of *Litopenaeus vannamei* and *Penaeus monodon* were collected and analyzed using ICP-OES. Phosphorous content was found to be on an average 1850 and 2150 ppm respectively.

Impact of time and concentration of phosphate in shrimp was evaluated. Fresh, cultured tiger shrimps were used for the study. Samples were drawn at 2h, 4h, 8h, 10h, 12h and 24h, drained for 5 min. and evaluated for colour, texture, water holding capacity, salt intake, and phosphate influx. The proximate composition study indicated a moisture content of 76.38%, 18.64% protein, and 0.15% lipid content and 1.45% ash. During the colour analysis, maximum L\* values for 1% ( $47.80 \pm 0.17$ ), 2% ( $44.17 \pm 0.52$ ) and 3% ( $46.46 \pm 0.36$ ) treated samples were observed at 4h, 8h and 2h respectively. For hardness, maximum values was observed  $14.48 \pm 1.69$  N–8h,  $16.85 \pm 3.66$  N–2h, and  $12.87 \pm 2.69$  N–2h respectively for 1%, 2% and 3% STPP treated samples. The water holding capacity for treated samples was increased from  $10.80 \pm 0.86\%$  to  $20.14 \pm 0.55\%$ ,  $10.92 \pm 1.13\%$  to  $21.07 \pm 0.71\%$  and  $10.21 \pm 0.29\%$  to  $14.73 \pm 0.62\%$ , respectively for 1%, 2% and 3% STPP treated samples. For control, the water holding capacity was found to be  $10.53 \pm 0.23\%$ . The salt content was gradually increased in all the treatments. For control, the salt content was  $0.42 \pm 0.02$  and, for 1%, 2%, and 3% treated samples it was 1.25, 1.09 and 1.03 respectively at the end of the 24h. The influx of phosphate was within the limit for 1% treated samples (1632 to 1232 ppm), while in 2% and 3% treated samples, it was increased beyond the limit, (637- 3428 ppm and 2241 – 3900 ppm, respectively).



Before treatment



After treatment (12 hr) : ( Control, 1%, 2%, 3% STPP)

Effect of time and concentration of phosphate in shrimp

## Development of high value byproducts from fish and shellfish processing discards

### Antibacterial activity of biomaterial-based dental cleansing agents

Hydroxyapatite based dental cleansing agents prepared with various ingredients were tested for antibacterial activity using CLSI method. Initially, it was standardized with glass slides enriched with biofilms formed by incubation with artificial saliva. Finally it was tested with excised human tooth.

#### Expt I: Biofilm formed with artificial saliva on glass slides (2.5x7.5 cm) glass slides

	Before Cleansing	After Cleansing	
		Hydroxyapatite (HAp) powder	Functional HAp Beads (HAp+ Chitosan+Clove oil)
Bacterial Load	$(1.29 \pm 0.38) \times 10^6$ cfu/cm <sup>2</sup>	$(7.42 \pm 2.45) \times 10^5$ cfu/cm <sup>2</sup>	$(3.07 \pm 0.29) \times 10^2$ cfu/cm <sup>2</sup>
Log Reduction		0.24	3.62

#### Expt II: Biofilm formed with artificial saliva on extracted human tooth

	Before Cleansing	After Cleansing		
		Hydroxyapatite (HAp) powder	Functional HAp Beads (HAp+ Chitosan+Clove oil)	Functional HAp powder
Bacterial Load	$(3.2 \pm 1.5) \times 10^6$ cfu/tooth	$(5.25 \pm 2.3) \times 10^5$ cfu/tooth	$(1.91 \pm 0.23) \times 10^4$ cfu/tooth	$5.9 \times 10^2$ cfu/tooth
Log Reduction		0.78	2.22	3.73

### Characterization of melanin from cuttlefish ink

No antibacterial activity was observed for melanin extract. Higher content of Boron (77.81 ppm), Calcium (419.56 ppm), Copper (30.51 ppm), Iron (80.52 ppm) and Phosphorus (300.84 ppm) was observed.

### Preparation of chitosan beads and evaluation of its quality characteristics

The chitosan beads were prepared from four different degrees of deacetylated (DA) chitosan (78%, 86%, 90% and 94%). Chitosan beads of uniform size were selected and evaluated for its biosorbent efficacy using lead solution. About 1 g of chitosan beads were added to 50 ml of 10 ppm lead solution with six different pH (2, 4, 6, 8, 10 and 12) and kept for 4h. The filtrate was taken and analyzed in ICP-OES. Chitosan beads with 86% DA were found to have high sorption capacity (69%) at pH 8. At pH 2-4 all chitosan beads, except 94% DA, had shown a decreasing sorption capacity, while 94% DA had shown slightly increasing adsorption. From pH 4-8, the adsorption had increased in all types of chitosan beads, but remained almost similar at pH 8-10; pH 10 to 12 adsorption decreased suddenly, indicating the saturation point near about the pH 8.

### Efficiency of different grades of chitosan in water treatment

The quantity of chitosan and stirring time for effective removal of cadmium at neutral pH was optimized. Cadmium

reduction rate of 4.79% was found at 15 min. stirring time compared to 1.37% at 60 min. stirring time. At neutral pH cadmium level got reduced from 5 ppm to 311.8 ppb.

Efficiency of chitosan with various degree of deacetylation (78.2, 86.0, 90.2 and 94.2%) for removal of cadmium and lead was evaluated. Chitosan with 90.2% was found to be effective compared to others. Effective reduction of cadmium and lead from 5 ppm concentration to 95.5 ppb and 60.5 ppb, respectively was obtained with treatment using chitosan with 90.2% DA.

### Development of standard processes and protocols for innovative products from aquatic resources, shelf life modelling and assessment of energy use

#### Freshness assessment of milkfish during iced and refrigerated storage

Freshness assessment based on biogenic amine content of milkfish during iced and refrigerated storage was carried out. In the case of iced sample both putrescine and cadaverine showed an increasing trend and reached to maximum of 3.73 ppm and 19.1 ppm respectively on the day of sensory rejection (13<sup>th</sup> day). Presence of histamine was noticed from 6<sup>th</sup> day onwards and it reached to a maximum of 1.5 ppm on 13<sup>th</sup> day.

In the case of refrigerated sample both putrescine and cadaverine showed an increasing trend and reached maximum of 2.09 ppm and 16.05 ppm respectively on the day of sensory rejection (10<sup>th</sup> day). Presence of histamine was noticed from 3<sup>rd</sup> day onwards (0.153 ppm) and reached 1.54 ppm on 10<sup>th</sup> day of refrigerated storage. Presence of histamine formers was comparatively higher in case of refrigerated sample.

#### Biogenic amine formation and microbial quality of three spotted crab during iced and refrigerated condition

Assessed the changes in biochemical indices and formation of biogenic amines of ice stored and refrigerated three spotted crab *Portunus sanguinolentus*. Putrescine content increased to 1.39 (12<sup>th</sup> day) and 0.98 (8<sup>th</sup> day) ppm in case of iced and refrigerated sample respectively. Cadaverine content increased to 139 (12<sup>th</sup> day) and 98.2 (8<sup>th</sup> day) ppm in case of iced and refrigerated sample respectively. Histamine content increased to 0.075 (12<sup>th</sup> day) and 0.043 ppm (8<sup>th</sup> day) ppm in case of iced and refrigerated sample, respectively. Studies on mesophilic and psychrotrophic bacterial count revealed that the crab stored in the refrigerated condition was rejected on 6<sup>th</sup> day and ice stored on 12<sup>th</sup> day. Enterobacteriaceae and *Pseudomonas* counts reached 4.17 and 4.76 log cfu/g on the 6<sup>th</sup> day for refrigerated crab whereas it reached to 3.45 and 3.5 log cfu/g for ice stored crab on 12<sup>th</sup> day. H<sub>2</sub>S forming bacteria and histamine forming bacteria were less than 4 log cfu/g for crab stored in the refrigerated condition on 6<sup>th</sup> day and less than 3.5 log cfu/g for crab stored in iced condition on the day of rejection.

### Marine biomolecules – Characterization and utilization for nutraceutical, biomedical and industrial applications

#### Optimization of pasteurization conditions for seaweed-based beverage

Based on USFDA Juice HACCP regulation 21 CFR 120.24 (a) (NACMCF recommendation), the pasteurization conditions for seaweed-based beverage was carried out. As per the requirement, there has to be minimum, a 5-log<sub>10</sub> reduction of the most resistant microorganism of public health significance in the product. The pertinent organisms used in the present study were *Escherichia coli* O157:H7 and *Listeria monocytogenes*.

Parameter	Before Pasteurization	After Pasteurization	
		72 °C/6 sec	82 °C/6 sec
Total Bacterial Load	3.35 x10 <sup>3</sup> cfu/ml	8.0 x10 <sup>2</sup> cfu/ml	1.45 x10 <sup>1</sup> cfu/ml
Log Reduction		0.62	2.36





# MICROBIOLOGY FERMENTATION & BIOTECHNOLOGY



## Research projects handled

### Institute projects

- Molecular heterogeneity and bio-prospecting of aquatic and fish microbes for novel molecules and genes
- Development of standard processes and protocols for innovative products from aquatic resources, shelf life modelling and assessment of energy use
- Development of high value byproducts from fish and shellfish processing discards
- Innovative product development for value addition, nutrient fortification and shelf life extension of farmed and wild freshwater and marine fish
- Marine biomolecules – Characterization and utilization for nutraceutical, biomedical and industrial applications

### Externally funded projects

- Genetic diversity of *Clostridium botulinum* in seafoods and development of Lateral Flow Immuno Assay (LFIA) for toxinotyping
- National surveillance programme for aquatic animal diseases
- Assessment of myctophid resources in the Arabian Sea and development of harvest and post harvest technologies

## Most significant achievements

- Occurrence of *C. botulinum* was seen in 7% of the canned, ready to cook, fresh fish and fish products from retail markets.
- Incidence of *V. parahaemolyticus* which carry *tdh* gene, a marker for virulence was seen in commercial fish samples, water and sediment from aquaculture farms.
- About 62.5% of *V. cholerae* isolates were resistant to ampicillin (10µg), 37.5% to cefotaxime (30µg), and 12.5% to ceftriaxone (30µg) and nitrofurantoin (300µg). Thyme oil was effective in inhibiting cholera toxin gene positive *V. cholerae* followed by clove bud oil.
- A protocol was standardized for Pulse Field Gel Electrophoresis of *Vibrio parahaemolyticus* strains isolated from fish and fishery environments.
- MLST data of MRSA revealed that the strain SA635, MRSA7 and MRSA9 belonged to ST5.
- A new spa type of MRSA was identified and was assigned spa type t15669 in the RIDOM server.
- Genotyping of eight isolates of *Aeromonas* spp. from a fish disease outbreak in Mangalam dam, Thrissur District revealed a genotype of *Aer*<sup>+</sup>, *Alt*<sup>+</sup>, *Ast*<sup>+</sup>, *Act*<sup>+</sup>, *Ahp*<sup>-</sup>, *ascV*<sup>-</sup> and *aopB*.
- Antibiotic sensitivity profile of 12 MRSA cultures revealed that all the strains were multi-drug resistant (MDR). MDR of the strains ranged from three to eight classes of antibiotics. Two out of 18 Actinomycetes strains isolated from marine sediments were found to be active against MRSA ATCC 43300 by agar overlay method.
- ISP-2 medium along with sample treatment of dry heat and benzalkonium chloride and SDS with 6% yeast extract was best suited for isolation of Actinobacteria from marine sediments.



- The LD<sub>50</sub> value of 15 strains of *A. hydrophila* and nine strains each of *A. jandaei* and *A. veronii* isolated from farms with disease outbreak revealed that majority of the *A. hydrophila* strains are highly virulent in rohu fingerlings.
- Nineteen strains of *Bacillus* sp. were found to have the ability to inhibit fish and shrimp pathogens; *A. hydrophila*, *E. tarda*, *V. cholerae* and *V. vulnificus* by well diffusion test for use as probiotic in aquaculture farm.
- Microbial profiling of Hentek and Shidal, two fermented fish products was done.
- *V. cholerae* belonging to the pathogenic O139 serogroup was isolated from freshwater fish, *Catla catla* procured from a fish market in Visakhapatnam for the first time.
- Fish protein hydrolysates enhanced antimicrobial activity of chitosan against bacterial strains of *Escherichia coli* and *Bacillus cereus*. Similarly green tea extract exhibited high antimicrobial activity against *Brochothrix thermosphacta*, *Pseudomonas* species and *Bacillus cereus*.

## Chief findings

### Institute projects

#### Molecular heterogeneity and bio-prospecting of aquatic and fish microbes for novel molecules and genes

##### *Clostridium botulinum* in seafoods

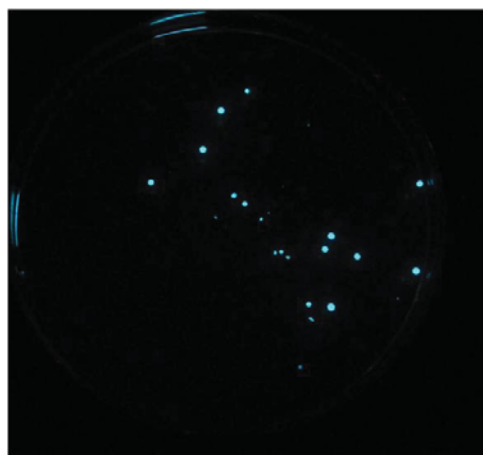
A total of 76 samples comprising of fish (fresh and ready to cook), shellfish (fresh oyster meat, shrimp, frozen shellfish and crustaceans shelled or not), fish products (canned fish, shrimp paste, prawn pickle, roasted shrimp, dried fish products, fish flakes/cutlet, crab stick, ready to cook and ready to eat fish products) were screened for the presence of *Clostridium botulinum* and five samples were found to carry *C. botulinum*.

##### Screening for *S. aureus* and *V. parahaemolyticus*

Seventy nine samples (fish, mud and water) collected from fish markets in Ernakulam and Alappuzha Districts of Kerala and Visakhapatnam in Andhra Pradesh revealed that 54% and 10% of the samples harbored *S. aureus* and MRSA, respectively. Out of 103 samples screened which included fish and shellfish from markets, water and sediment from aquaculture farms in Ernakulam, Thrissur and Alappuzha Districts for the presence of *V. parahaemolyticus*, 97 samples were positive. Three hundred and eighty three isolates of *V. parahaemolyticus* from fish and fishery environments were confirmed by PCR targeting *toxR* gene. Nine isolates were positive for *tdh* gene, a marker for virulence.

##### Screening of *L. vannamei* for *Vibrios*

Screening of *L. vannamei* post-larvae shrimp samples (n=5) from aquaculture farms (n=6) and markets (n=5) in Andhra Pradesh for the presence of *V. parahaemolyticus* causing EMS or AHPND showed that none of the samples harboured the bacteria. Out of 186 samples including fish and shellfish from markets, water and sediment from aquaculture farms in Ernakulam, Thrissur and Alappuzha Districts screened for the presence of *V. cholerae*, 24 samples were positive. Sixty four post-larvae and juveniles of shrimp from hatcheries and farms were screened for the presence of *V. harveyi* and isolates from two diseased shrimp farms were tentatively identified as *V. harveyi*.



Bio-luminescence from *Vibrio harveyi*

### Screening for *Listeria* and *Shigella*

One hundred and fifteen samples collected from retail fish markets of Kochi were screened for the presence of *Listeria monocytogenes* and none of the samples were positive for *L. monocytogenes*. Out of 40 *Listeria* sp. isolates from *Barracuda* sp. 38 isolates were found to be *L. innocua*. A total of 128 fish/shellfish samples from local fish markets, mud from aquaculture farm and water samples were screened for the presence of *Shigella* spp. Thirty presumptive *Shigella* isolates will be further confirmed by molecular and serological methods.

### Screening for other organisms

A total of 22 samples which included six farm water samples, seven sediment samples and nine farmed fish (rohu) samples were screened for *E. tarda*. Twenty nine isolates were identified as *E. tarda* by conventional biochemical tests and further confirmed by polymerase chain reaction assay targeted against *RpoS* gene.

### Screening for *Salmonella*

Out of total of 23 fish samples collected from different markets of Ernakulam district along with water samples from Marine Drive creek and Broadway creek screened for the presence of *Salmonella* confirmed its presence in black clam (*Villorita cyprinoides*), squid (*Loligo* sp.) and flatfish (*Cyanoglossus malabaricus*) were found to carry *Salmonella*.



### Antibacterial activity of spice oils

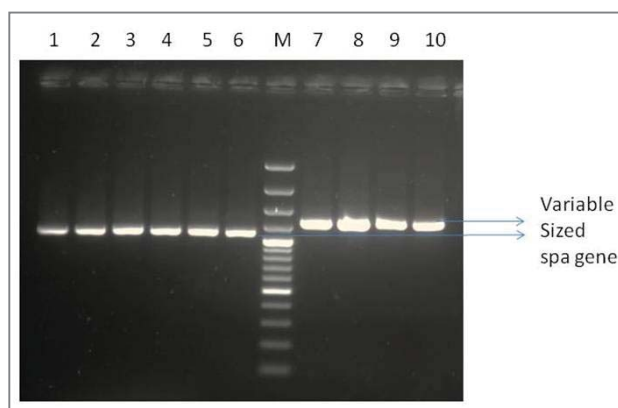
Antibacterial activity of oils from the leaves and buds of clove (*Eugenia caryophyllata*), flowering tops of rosemary (*Rosemarinus officianalis*) and dried seeds of thyme (*Trachyspermum ammi*) towards cholera toxin gene positive *V. cholerae* isolates (n=8) were tested by employing agar well diffusion method. Thyme oil (40 mm zone of inhibition) was most effective in inhibiting cholera toxin gene positive *V. cholerae* followed by clove bud oil (26.5 ± 5.2 mm zone of inhibition).

### Molecular typing of *Vibrios*

For molecular typing of *Vibrio parahaemolyticus* strains isolated from fish and fishery environments, a protocol was standardized for Pulse Field Gel Electrophoresis. Virulence analysis of 15 MRSA strains isolated from market samples revealed that none of the strains harbor *tsst* gene responsible for production of toxic shock syndrome toxin and *pvl* gene, a virulence marker which is often identified in CA-MRSA strains.

### Characterization of genetic diversity of MRSA

In order to characterize the genetic diversity of Methicillin Resistant *Staphylococcus aureus* (MRSA) population in fish and fishery environments, SPA typing and MLST were performed with seven housekeeping genes; *arc*, *aro*, *glp*, *gmk*, *pta*, *tpi* and *yqi*. The bioinformatic analysis of MLST data revealed that the strain SA635, MRSA7 and MRSA9 belonged to ST5. SPA typing of MRSA isolates revealed that strains were t007, t311, t121, t186 and non-typeable SPA ridom types. The orientation rearrangements were found among SPA gene of the non-typeable types. Clonal nature of MRSA isolates (strain designation MRSA3, MRSA4, MRSA6, MRSA9, MRSA13, MRSA19, MRSA23, MRSA26, MRSA28,



Whole gene *spa* of non-assignable MRSA

MRSA23 and MRSA34) revealed that MRSA34 belonged to t002-ST5; MRSA6 belonged to t334-ST5; MRSA9,19 and 23 belonged to t311-ST5, MRSA26 belonged to t311-ST88; MRSA 13 belonged to t711-ST6; MRSA28 belonged to t121-ST8; MRSA34 and 39 belonged to t186-ST88. Whole spa gene sequence analysis revealed that the one of the non-spa typable strain belonged to t711 and another one was a new spa type t15669. Antibiotic sensitivity profile of 12 MRSA cultures revealed that all the strains were multi-drug resistant (MDR) ranging from 3 to 8 classes of antibiotics.

### Genomic characterization of *V. cholerae*

Sixty six *V. cholerae* isolates from markets and aquaculture farms were positive for *V. cholerae* specific primer targeting *toxR* gene. Genomic characterization of *ctx* gene positive *V. cholerae* isolates (n=8) from fish and fishery environments revealed heterogeneity among isolates. All the *V. cholerae* isolates were positive for the *V. cholerae* specific PCR targeting *sodB* gene while 37.5% were positive for toxin co-regulated pilus (*tcp*, 453bp), zonula occludens toxin (*zot*, 947bp) and 50% for accessory cholera enterotoxin (*ace*, 316bp). 12.5% of the isolates belonged to serogroup O139 and 75% isolates belonged to O1 serogroup. 12.5% isolates belonged to nonO1-nonO139 serogroup.

### Phenotypic characterization of *V. cholerae*

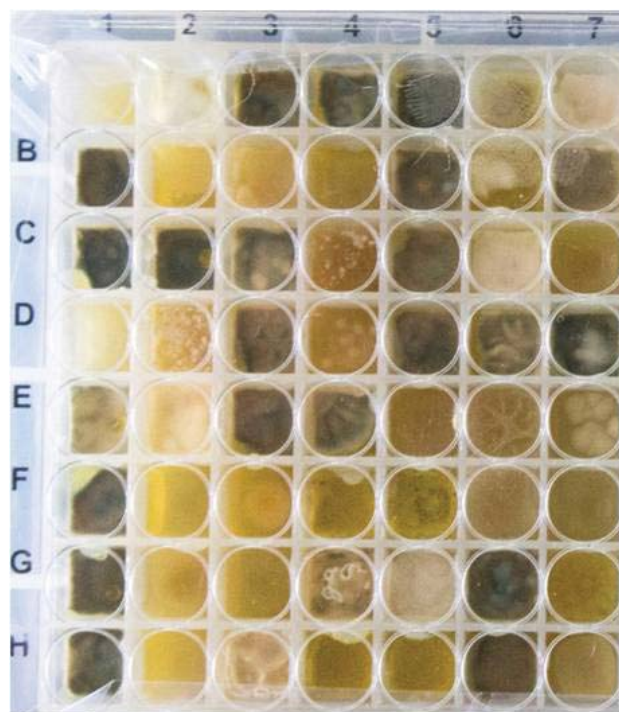
Phenotypic characterization of *V. cholerae* isolates from Visakhapatnam, Andhra Pradesh revealed that all the isolates were positive for gelatin liquefaction and exhibited haemolysis on blood agar but only 50% isolates showed caseinase activity. About 87.5% of the isolates showed lipolytic and DNase activity and 75% of the isolates showed amylolytic and chitinolytic activity. Studies on antibiotic susceptibility patterns of *V. cholerae* isolates from Visakhapatnam revealed that 62.5% of *V. cholerae* isolates were resistant to ampicillin (10µg), 37.5% isolates were resistant to cefotaxime (30µg), and 12.5% of the isolates were resistant to ceftriaxone (30µg) and nitrofurantoin (300µg). However, all the *V. cholerae* isolates were sensitive to 21 antibiotics.

### Isolation of Actinomycetes with anti bacterial activity

For isolation of Actinomycetes with antimicrobial activity, sediment samples from ocean floor (9°54'191"N; 76°08'088"E) were given six treatments and plated on to eight isolation media (IM1-IM8) in three different dilutions and incubated at 28 °C for four weeks. The best media for isolation of Actinobacteria from marine sediments was ISP-2 medium with sample treatment of dry heat and benzalkonium chloride and SDS with 6% yeast extract. Characterization of 250 isolates of Actinobacteria picked from different media for its biological properties are in progress.

Three marine sediments samples collected from different locations in Veraval (Gujarat) and five sediment samples collected from the mangrove ecosystem of Vashi (Maharashtra) were screened for the isolation of Actinobacteria by giving six treatments. Sediment samples from Veraval were plated on to IM1 to IM8 isolation media. A total of 24 numbers of Actinobacteria were isolated and purified for further analysis.

Bioinformatic analysis of ERIC PCR data of the eight *V. cholerae* isolates and 14 *E. tarda* isolates was done to assess the genetic heterogeneity. Cluster analysis carried out based on the unweighted pair group with arithmetic averages (UPGMA) using a position tolerance



High throughput culturing of Actinobacteria

of 1% showed dissimilarity indicating extensive genetic heterogeneity within the *V. cholerae* isolated from fish while *E. tarda* isolated from fish indicate low genetic heterogeneity.

### Genotyping of *Aeromonas*

Genotyping of 42 isolates of *Aeromonas* species from fish disease outbreak by PCR revealed that 10 isolates were negative for all the six virulence genes *Aer*, *Alt*, *Ast*, *Act*, *Ahp*, *ascV* and *aopB*. Ten isolates carried the *Aer* gene coding for aerolysin. Eight isolates from Palakuzha revealed *Aer*<sup>-</sup>, *Alt*<sup>+</sup>, *Ast*<sup>-</sup>, *Ac*<sup>-</sup>, *Ahp*<sup>-</sup>, *ascV*<sup>-</sup>, *aopB*<sup>-</sup> genotype while eight isolates from Mangalam dam exhibited *Aer*<sup>+</sup>, *Alt*<sup>+</sup>, *Ast*<sup>+</sup>, *Act*<sup>+</sup>, *Ahp*<sup>-</sup>, *ascV*<sup>-</sup> and *aopB* genotype.

### Detection of MBV and IHNV

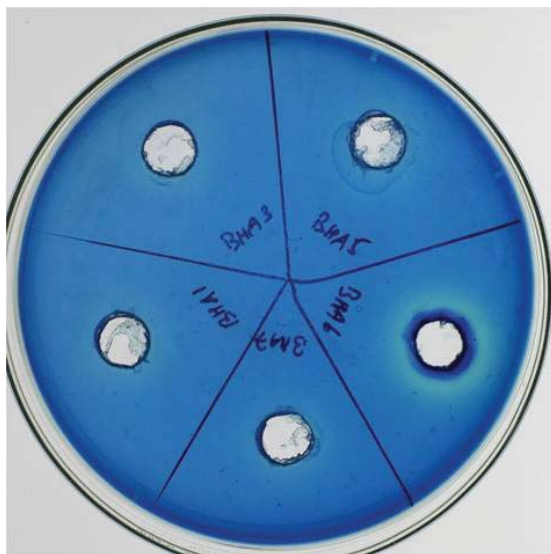
Microarray for detection of MBV and IHNV were attempted with four targets per virus. Hybridization was carried out using PCR amplified targets in hybridization buffer. Fluorescent signal from probe was improved by increasing the concentration of PCR product used for hybridization. *In vivo* virulence test of isolates of *Aeromonas* spp. showed that the LD<sub>50</sub> value of 15 strains of *A. hydrophila* and nine strains each of *A. jandaei* and *A. veronii* isolated from farms with disease outbreak ranged between 10<sup>2</sup>-10<sup>3</sup>, 10<sup>7</sup> and 10<sup>4</sup>-10<sup>5</sup> respectively in rohu fingerlings. In *E. tarda*, the LD<sub>50</sub> value ranged between 10<sup>4</sup>-10<sup>5</sup> in the *in vivo* virulence test of five strains of *E. tarda* from diseased fish.

### Production of recombinant chitinase

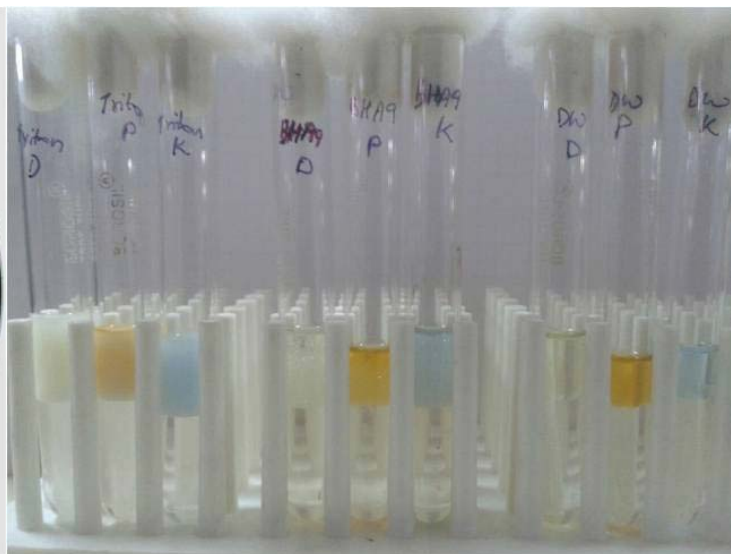
Using the cloned chitinase gene from *P. elgii*, production of recombinant chitinase enzyme in PET system was optimized to get soluble expressed protein with different induction conditions and highest level of soluble protein expression was obtained at 30 °C and at 4 hour after induction.

Twenty seven strains of *Bacillus* sp. were tested for their ability to inhibit fish and shrimp pathogens; *A. hydrophila*, *E. tarda*, *V. cholerae* and *V. vulnificus* by well diffusion test for use as probiotic in aquaculture farm. Nineteen strains were found to inhibit all the pathogens tested. The ABS profiles of the 19 strains were determined against 20 antibiotics and only eight strains were found to be sensitive to all the antibiotics tested. Eighteen Actinomycetes strains isolated from marine sediments were tested for its activity against MRSA ATCC 43300 by agar overlay method. Two of the Actinomycetes strains that gave maximum zone of inhibition were selected for further characterization.

Biosurfactant production by 15 bacterial isolates from aquaculture pond sediment samples were tested by emulsification index, oil spreading assay and formation of zone on CTAB agar. Six isolates showed high biosurfactant activity with EI (2.2 petrol – 20 sesame), oil spreading assay (0.3 cm sesame – 3 cm diesel).



Biosurfactant producing bacteria on CTAB agar



Emulsification index - Potential biosurfactant producing bacteria

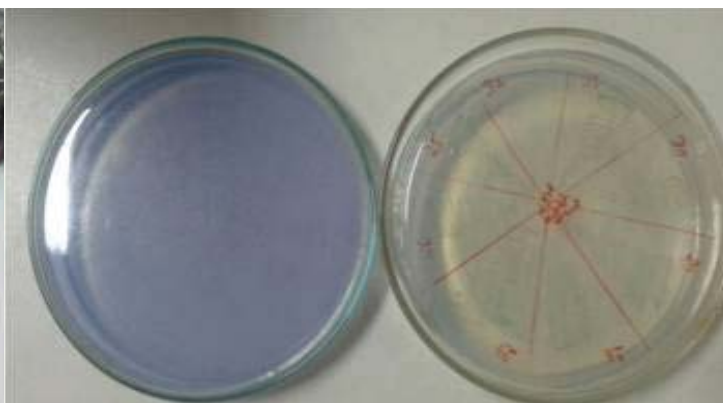


### Isolation of sulphur oxidizing bacteria

For addressing the problem of  $H_2S$  production in aquaculture ponds, sulphur oxidizing bacteria was isolated and growth conditions were optimized. Starkeys medium was used for optimization of growth of sulphur oxidizing bacteria from the aquaculture soil. The protocol was standardized for the estimation of  $H_2S$  from aquaculture water samples by using Iodometric and methylene blue Spectrophotometric methods.



Sulphur oxidizing bacteria in thiosulfate broth



Sulphur oxidizing bacteria in thiosulfate agar

### Microbiology of fermented fish products

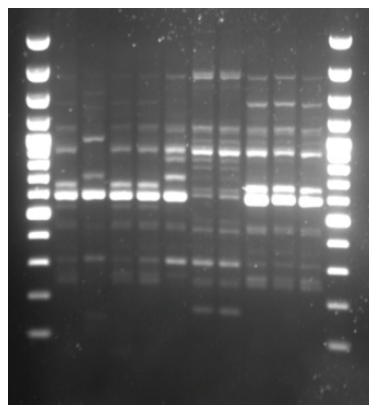
Microbiology of fermented fish products such as Shidol and Hentak were studied. Shidol, a fermented ready to eat fish product from Shillong, was analyzed for microbiological parameters at Kochi and Visakhapatnam. The counts of Lactic acid bacteria and anaerobic mesophilic bacteria were higher compared to total aerobic mesophilic bacterial count and their population was  $\geq 8.00 \log_{10}$  cfu/g. The counts of endospore-forming rods (*Bacillus* sp.), Faecal Streptococci, Staphylococci and yeast and mold were  $\geq 5 \log_{10}$  cfu/g. The indicator bacteria such as *E. coli*, *S. aureus* and pathogenic bacteria such as *L. monocytogenes*, *Salmonella* and *V. parahaemolyticus* were not detected. The microbial profile of Hentak revealed that counts of total aerobic bacteria, anaerobic bacteria, Faecal Streptococci, yeast and mold and LAB were  $\leq 5.0 \log_{10}$  cfu/g.



Shidol - A fermented fish product and its microbial diversity

### Studies on heterogeneity of cholera toxin gene positive *V. cholerae*

The heterogeneity of cholera toxin gene positive *V. cholerae* isolates (n=8) from fish and fishery environments was studied. 100% of the *V. cholerae* isolates were positive for the *V. cholerae* specific PCR targeting *sodB* gene. 37.5% of the *V. cholerae* isolates were positive for toxin co-regulated pilus, zonula occludens toxin and 50% of the *V. cholerae* isolates were positive for accessory cholera enterotoxin. 12.5% of the isolates belonged to serogroup O139 and 75% isolates belonged to O1 serogroup. 12.5% isolates belonged to nonO1-nonO139 serogroup. Except for gelatinolytic activity, differences were noticed in caseinase, lipolytic, amylolytic, DNase



ERIC PCR of cholera toxin gene positive *V. cholerae* isolated from fish



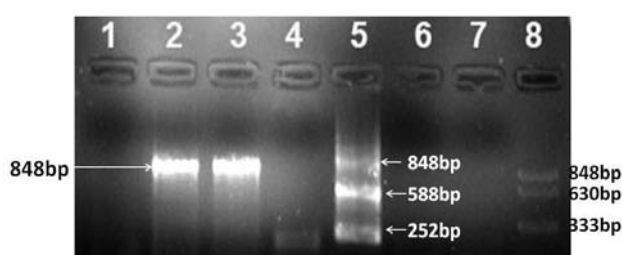
and chitinolytic activity of the *V. cholerae* isolates. However, all the *V. cholerae* isolates haemolyzed human RBC. The genetic heterogeneity of the *V. cholerae* isolates was tested by employing ERIC PCR and Cluster Analysis was carried out based on the un-weighted pair group with arithmetic averages (UPGMA) using a position tolerance of 1%. The results showed extensive dissimilarity among the *V. cholerae* isolated from fish. Even among the *V. cholerae* isolates that belonged to serogroup O1 the similarity ranged between 10 to 35%. The *V. cholerae* isolate belonging to serogroup O139 (isolate 10) was clustered with the *V. cholerae* O139 type culture. However, the *V. cholerae* isolates that belonged to nonO1-nonO139 serogroup was grouped as a separate entity.

### Antibacterial effect of plant oils on cholera toxin gene positive *V. cholerae*

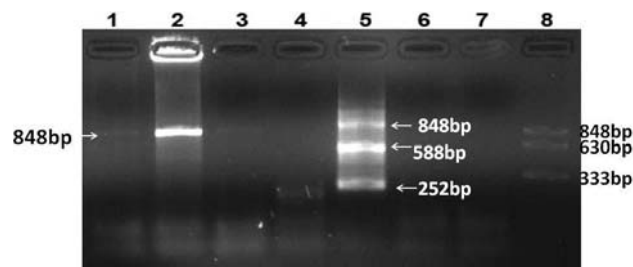
Oils from the leaves and buds of clove (*Eugenia caryophyllata*), flowering tops of rosemary (*Rosemarinus officianalis*) and dried seeds of thyme (*Trachyspermum ammi*) were tested for antibacterial activity towards cholera toxin gene positive *V. cholerae* isolates (n=8) employing agar well diffusion method. The results indicated that thyme oil (40 mm zone of inhibition) was effective in inhibiting cholera toxin gene positive *V. cholerae* followed by clove bud oil (26.5  $\pm$  5.2 mm zone of inhibition), clove leaf oil (25.6  $\pm$  5.2 mm) and rosemary oil (20.5  $\pm$  2 mm). The results suggest that use of thyme oil and clove oils in fish and fishery products may reduce the load of *V. cholerae*.

### Screening of *L. vannamei* shrimp samples for presence of EMS

Early Mortality Syndrome (EMS) or Acute Hepatopancreatic Necrosis Syndrome (AHPNS) in *Litopenaeus vannamei* shrimp is reported to have a bacterial aetiology by a specific strain of *Vibrio parahaemolyticus*. In this context, samples of *L. vannamei* post-larvae (n=5), shrimp samples from aquaculture farms (n=6; 18 DOC; weight 0.48 to 0.985g) and small sized shrimp samples from markets (n=5; weight 10 to 12.5g) in Andhra Pradesh were screened for the presence of EMS or AHPNS using the IQ 2000 AHPNS/EMS PCR-kit from M/s GeneReach, Biotechnology Corp., Taiwan. All the shrimp samples were found to be negative for the presence of EMS.



Lanes 1, 2, 3: Shrimp samples (-ve EMS result);  
Lane 4. Negative control (yeast tRNA);  
Lane 5. EMS positive standard; Lane 8. Marker



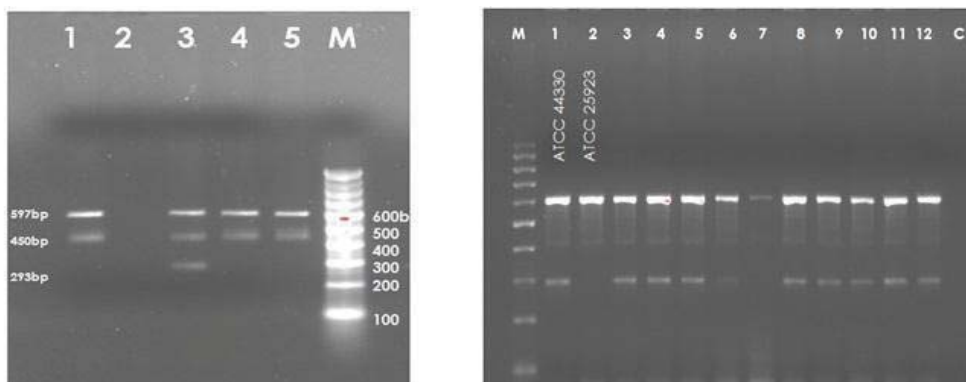
Lanes 1, 2, 3: Shrimp samples (-ve EMS result);  
Lane 4. Negative control (yeast tRNA);  
Lane 5. EMS positive standard; Lane 8. Marker

### Pathotyping of *E. coli* isolates

Methods were developed for pathotyping of *E. coli* isolates by using multiplex PCR for Enterotoxigenic (ETEC), Enteropathogenic (EPEC), Shiga toxin producing (STEC), Enteraggregative (EAgEC) and Enteroinvasive *E. coli* (EIEC) in seafood of Gujarat. A total of 14 isolates positive for ETEC (LT and ST genes of 321 and 186 bp), three EPEC (*eae* gene of 629 bp) and two were with STEC (*Stx1* gene of 894 bp) at 58-60 °C annealing temperature.

### Identification of MRSA

Multiplex PCR method was developed for the identification of multidrug resistant Methicillin-Resistant Staphylococci (MRSA) with *MecA*, *femA* and genus specific genes and it was found that 17.77% of them were MRSA in fish and fishery products in Gujarat. Complete molecular typing of emerging seafood pathogen, coagulase positive Methicillin Resistant Staphylococci was carried out and molecular source was traced.



Standardization of multiplex PCR amplification of MRSA isolates with genus specific primers (16SrRNA), *femA* and *mecA* gene

### Development of standard processes and protocols for innovative products from aquatic resources, shelf life modelling and assessment of energy use

Microbiology (TPC, VRBGA, PIA count) of GIFT tilapia stored under refrigerated and iced conditions were carried out on daily sampling basis for a period of two weeks. Fishes stored in refrigerated and iced conditions were microbiologically spoiled by 4<sup>th</sup> and 8<sup>th</sup> day respectively.

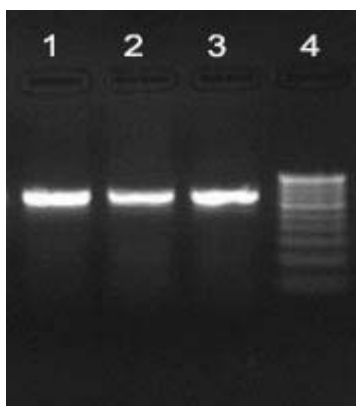
### Development of high value byproducts from fish and shellfish processing discards

Three thermotolerant protease producing *Bacillus* spp. were compared for fish protein hydrolysate in red meat of tuna. Fermentative hydrolysis was performed for 72h at 30 °C with three strains of *Bacillus* spp. There was no sufficient hydrolysate produced when inoculated *in situ* for fermentative hydrolysis of fish red meat suspension even after 72h. Offensive odours emanated from the product. But organism was able to grow in the red meat fish tuna waste.

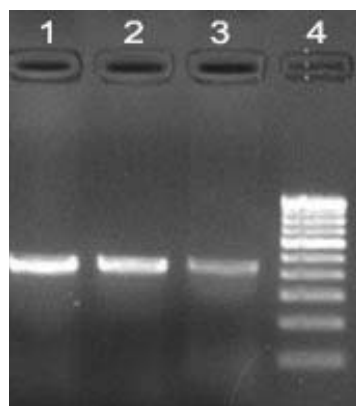
### Innovative product development for value addition, nutrient fortification and shelf life extension of farmed and wild freshwater and marine fish

#### Isolation of *Vibrio cholerae* O139 from freshwater fish at Visakhapatnam

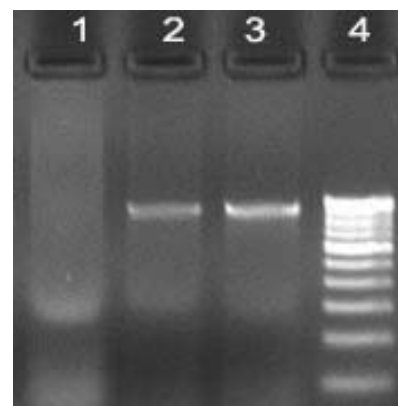
*V. cholerae* belonging to the pathogenic O139 serogroup was isolated from freshwater fish, *Catla catla* procured from a fish market in Visakhapatnam. This is the first report of detection of *V. cholerae* O139 from fish at Visakhapatnam. The *V. cholerae* O139 isolate was identified serologically using O139 antiserum and by using PCR targeting O139-rfb specific primers (449bp). The isolate was positive in *V. cholerae* species specific PCR (*sodB*, 248bp) and was also positive



PCR targeting *ctx* gene (777bp)



PCR targeting *tcp* gene (453bp)

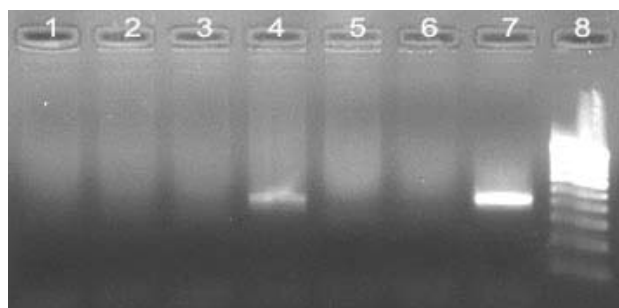


PCR targeting *zot* gene (947bp)

Lane 1. *V. cholerae* O139 isolate from *C. catla*, Lane 2. *V. cholerae* serogroup-O1 type culture,  
Lane 3. *V. cholerae* serogroup-O139 type culture, Lane 4. 100 bp marker

for many toxigenic factors viz., cholera toxin (*ctx*, 777bp), toxin co-regulated pilus (*tcp*, 453bp) and accessory cholera enterotoxin (*ace*, 316bp) but was negative for zonula occludens toxin (*zot*, 947bp).

The *V. cholerae* O139 isolate haemolyzed human RBC, was positive for proteolytic (gelatinase and caseinase), DNase, lipolytic, phosphatase, amylolytic and chitinolytic activity. The isolate was positive for indole, MR, VP, grew at salt concentrations of 3% and below, negative for esculin hydrolysis, H<sub>2</sub>S production and urease activity. The O139 isolate utilized glucose, sucrose, D-mannose, D-fructose, D-maltose monohydrate, D-mannitol and dulcitol but failed to utilize inositol, D-cellobiose, salicin, lactose, L-rhamnose monohydrate, melibiose, D-raffinose pentahydrate, D-arabitol, L-arabinose, D-arabinose, xylose, and erythritol.

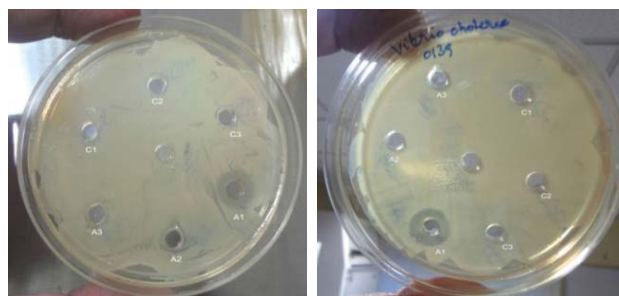


PCR targeting O139-rfb specific primers (amplicon size 449bp), Lane 1. Negative; Lanes 2, 3 and 5. *V. cholerae* isolates, Lane 4. *V. cholerae* O139 isolate from *C. catla*, Lane 6. *V. cholerae* serogroup-O1 type culture, Lane 7. *V. cholerae* serogroup-O139 type culture, Lane 8. 100 bp marker

## Marine biomolecules – Characterization and utilization for nutraceutical, biomedical and industrial applications

### Antibacterial activity of seaweeds

Acetone-chloroform extract of *Ulva lactuca*, *Gracilaria edulis* and *Sargassum* was tested for antibacterial activity against *Salmonella typhimurium*, *Morganella morganii*, *Escherichia coli*, *Vibrio cholerae* O1, *V. cholerae* O139, *Staphylococcus aureus* and *Listeria monocytogenes*. Sulfated polysaccharide prepared from *Ulva lactuca* was also tested for antibacterial activity. The first acetone extract (A1) of *U. lactuca* was greenish in colour indicating presence of the seaweed pigments. The order of antibacterial activity was *V. cholerae* O139 > *V. cholerae* O1 > *Staphylococcus aureus* > and *E. coli*. It did not showed any antibacterial activity against *Listeria monocytogenes*, *Salmonella typhimurium* and *Morganella morganii*. The acetone and chloroform extracts of *G. edulis* and *Sargassum* and the sulfated polysaccharide prepared from *U. lactuca* did not show antibacterial activity against any of these bacteria.

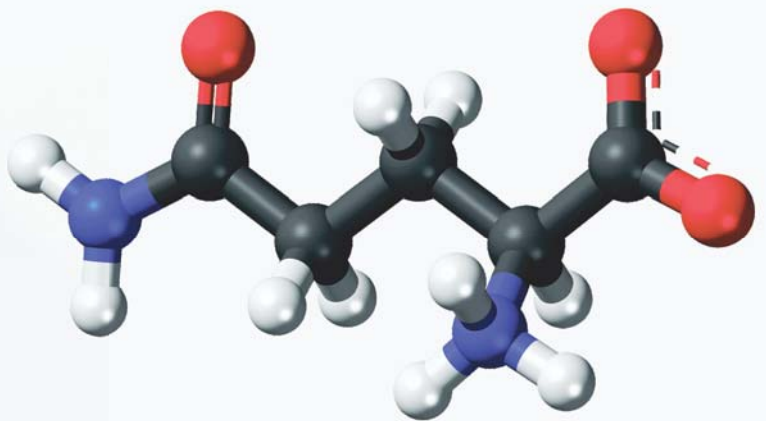


Acetone extract (A1) of *U. lactuca* showing antibacterial activity against *S. aureus*

Acetone extract (A1) of *U. lactuca* showing antibacterial activity against *V. cholerae* O139



# BIOCHEMISTRY & NUTRITION





## Research projects handled

### Institute projects

- Marine biomolecules – Characterization and utilization for nutraceutical, biomedical and industrial applications
- Risk assessment of emerging food-borne pathogens and chemical residues in aquatic systems

### Externally funded projects

- Nutrient profiling and evaluation of fish as a dietary component
- Assessment of myctophid resources in the Arabian Sea and development of harvest and post harvest technologies
- Extraction and purification of marine biomolecules and their derivatives for nutritional and industrial applications
- Exploration and assessment of demersal fishery resources along the continental slope (200-1200 m) of Indian EEZ and central Indian ocean
- Biomodulation of marine biopolymers for the preparation of biomaterials of healthcare importance

## Most significant achievements

- A process for microencapsulation of squalene by emulsification-spray drying technique was developed. A combination of maltodextrin and whey protein was found to be good for microencapsulation taking into consideration the high encapsulation efficiency (92%) and oxidative stability.
- Fruit juice was enriched with 30% Sargassum extract and its nutritional level was determined. Macroporous adsorbent resin, Sepabead 207 treatment did not affect the phytochemical composition and antioxidant activity of the extract.
- Iron and calcium-fortified fish soup powder was prepared by employing response surface methodology by varying the concentrations of starch and fish meat and nutritional evaluation was carried out.
- Proteoglycans extracted from *Scolidon* spp. cartilage was characterized and evaluated for their anti-proliferative activity against MCF-7 cell lines. Significant cytotoxic effect of 73% cell death was observed for 100 µg/ml treated sample.
- In anti-ulcer property studies of fish collagen against ethanol-HCl induced peptic ulcer in rats, partial resistance to denudation of the mucosal layer was observed in collagen treated group of rats, which could be due to the protective effect of collagen supplementation.
- Proteases were extracted from visceral waste of fish species from three different habitats. Marine fish proteases exhibited higher specific enzyme activity and recovery when compared with other habitat species.

## Chief findings

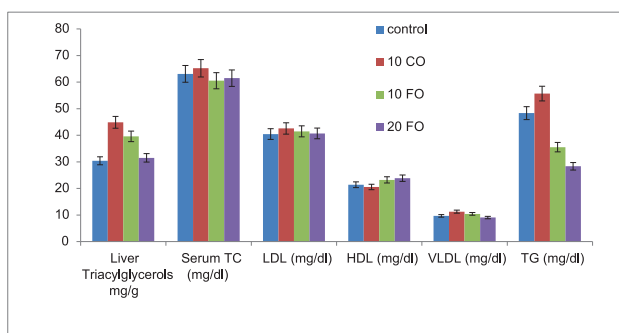
### Institute projects

#### Marine biomolecules - Characterization and utilization for nutraceutical, biomedical and industrial applications

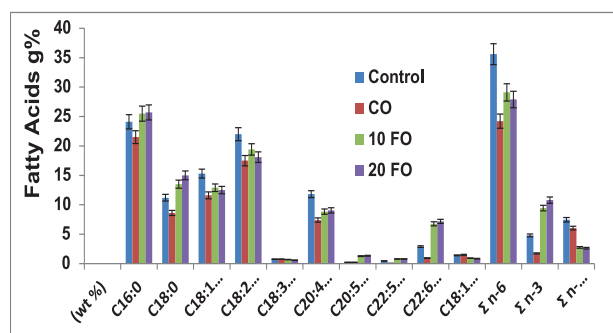
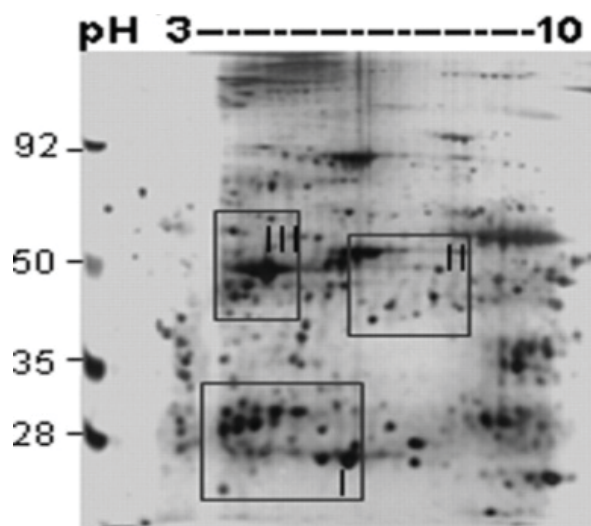
### Fish oil supplementation studies

Fish oil supplementation in albino rats reduced lipid parameters like triglycerides and LDL cholesterol. Fatty acid profile showed enhanced level of n-3 PUFA in fish oil-supplemented groups. RNA expression studies revealed a decrease in expression of fatty acid synthase mRNA in fish oil-supplemented group over control ground nut oil-fed group. Proteomics studies on liver cytosolic protein showed variation in intensities of spots between the fish oil-treated and control groups of rats.

Image of a 2-D electrophoresis performed on fish oil treated liver cytosolic protein. The highlighted portions indicate the areas where spots were intense with respect to control liver



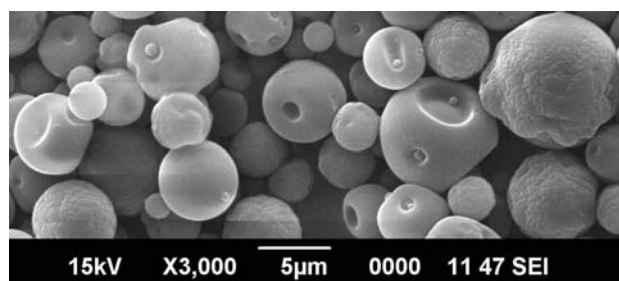
Lipid parameters in serum and liver of albino rats



Fatty acid profile of liver lipid of experimental rats

### Microencapsulation of squalene

A process for microencapsulation of squalene by emulsification-spray drying technique was developed. Chitosan as wall material as well as a surfactant biomaterial rendered poor protection from oxidative damage. A combination of maltodextrin and whey protein proved better for microencapsulation taking into consideration the higher encapsulation efficiency and oxidative stability.



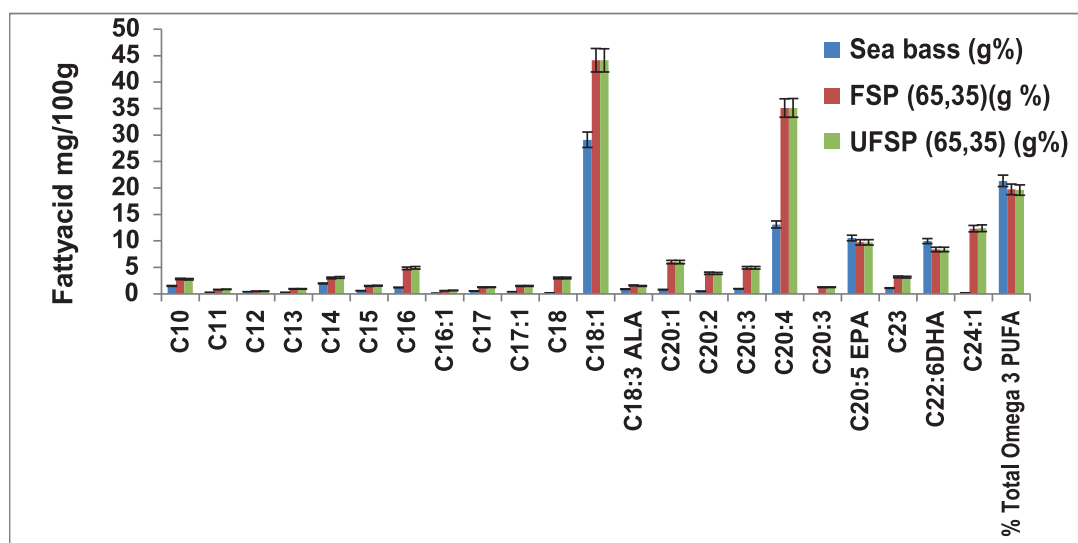
SEM image of microencapsulated squalene particles

### Fish soup powder

Iron and calcium-fortified fish soup powder was prepared by employing response surface methodology by varying the concentrations of starch and fish meat (protein content) and nutritional evaluation was conducted.

#### Different combinations of fish soup powder

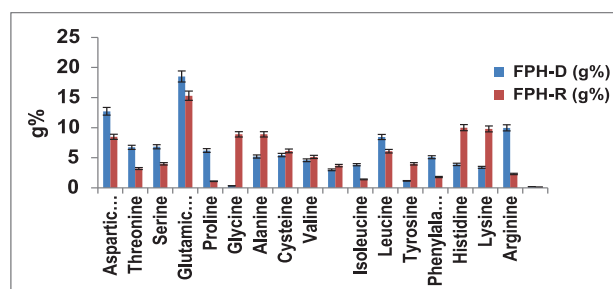
	Protein (%)	Starch (%)
Combination 1	80	20
Combination 2	75	25
Combination 3	70	30
Combination 4	65	35



Fatty acid composition of fortified and unfortified soup powder

### Fish protein hydrolysate from processing discards

Fish protein hydrolysates were prepared from fish byproducts, processing discards (FPH-D) and fish roe (FPH-R) prepared by sequential enzymatic hydrolysis using enzyme alcalase (1%). FPH-D and FPH-R exhibited good antioxidant activity as determined by DPPH, ABTS free radical scavenging activity and were found to be rich in essential amino acids and total phenolic compounds. Protein hydrolysates have a potential to be used as food supplements in nutraceutical and pharmaceutical industries. The hydrolysates showed good functional properties like protein solubility and fat absorption capacity that may allow for applications in the field of formulated food systems.



Amino acid composition of the hydrolysate from fish discards and roe of seabass

### Antioxidant activities of processing discards (FPH-D) and fish roe (FPH-R)

	DPPH radical scavenging activity	ABTS radical scavenging activity	Fe <sup>2+</sup> Ion chelating activity at 4 mg/ml
<b>FPH -D</b>	21.15±0.1% at 40 ug/ml	53.33±0.03% at 20 ug/ml	4.39±0.04%
<b>FPH -R</b>	39.26±0.14% at 40 ug/ml	62.22±0.04% at 20 ug/ml	3.88±0.06%

### Seaweed extract-enriched fruit juice

Fruit juice was enriched with up to 30% Sargassum extract without affecting the sensory properties of the juice. The resin treatment did not affect the phytochemical composition and antioxidant activity of the extract. Nutritional label of a filtered grape juice with 30% seaweed extract after pasteurization has been determined.

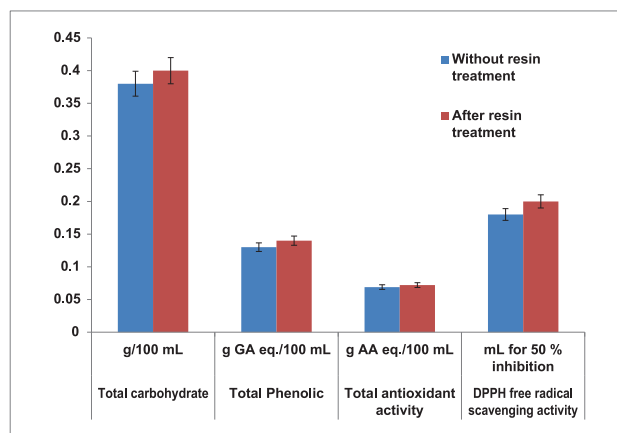
#### Nutritional label of grape juice with 30% seaweed extract

Protein (g/100 mL)	0.57
Carbohydrate (g/100 mL)	5.20
Lipid (g/100 mL)	0
Total phenolics (g GA eq./100 mL)	0.22
Total antioxidants (g AA eq./ 100 mL)	0.28
Sulphated polysaccharide (g/100 mL)	0.20
Sulphate content (g/100 mL)	0.30

### Extraction of seaweed phytochemicals

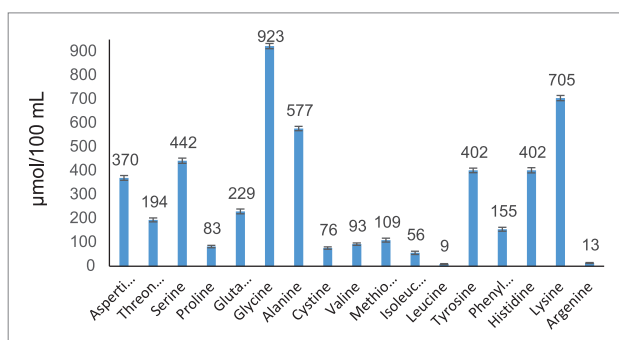
A procedure was optimized for seaweed phytochemicals by which higher amount of phenolics, sulphated polysaccharide and protein were extracted. Macroporous adsorbent resin, Sepabead 207 was used to remove the seaweed like smell.

Comparative profile of sargassum extract before and after passing through the Sepabead 207 resin column

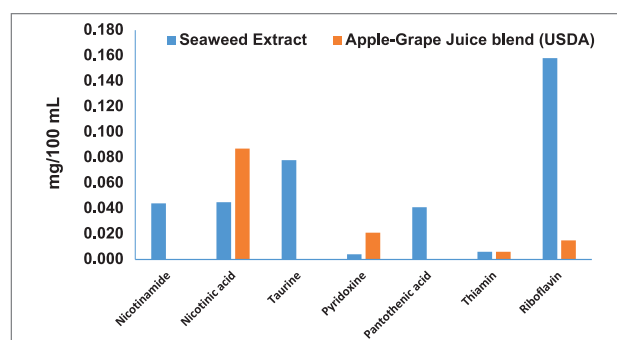


### Amino acid, water soluble vitamin and mineral profile of the treated seaweed extract

Different essential and non-essential amino acids were found to be present in appreciable quantity as shown in Figure. Water soluble B vitamins and taurine and various major and trace elements were estimated in the seaweed extract. The values were compared with that of an "Apple-Grape Juice blend" from USDA nutritional database. Significantly higher amount of Riboflavin, Pantothenic acid, calcium and iron were found in the seaweed extract. Taurine, a free amino acid with known nutraceutical properties were found in appreciable quantities in the seaweed extract.



Amino acid profile of the seaweed extract following resin treatment



Water soluble B vitamin and Taurine content in seaweed extract

### Preparation of gelatin hydrolysate from the skin of needle squid

Bioactive peptides are inactive in their original protein, and can be released to active form through hydrolysis by proteases. These peptides are reported to be involved in various biological functions such as anti-hypertension, immunomodulatory, antithrombotic, antioxidant, anticancer and antimicrobial activities, in addition to nutrient utilization. In the present work, gelatine was extracted from the skin of needle squid (*Doryteuthis sibogae*) and hydrolyzed using pepsin (37 °C, pH 4) with an enzyme substrate ratio of 1:20 (w:w) for 4 h. ABTS radical scavenging activity of gelatin hydrolysate expressed as mg vitamin C Equivalent Antioxidant Capacity (VCEAC)/g protein was  $31.23 \pm 0.5$ , which was only  $8.4 \pm 0.2$  for pure gelatin.

### Sulfated polysaccharides from seaweed

Sulfated polysaccharides were extracted from green seaweed, *Ulva lactuca*, *U. reticulata* and red seaweed, *Gracilaria edulis*. Functional properties, antioxidant (DPPH Free Radical-Scavenging Activity, Reducing Power

Sulfated polysaccharides from *U. reticulata* and *G. edulis*

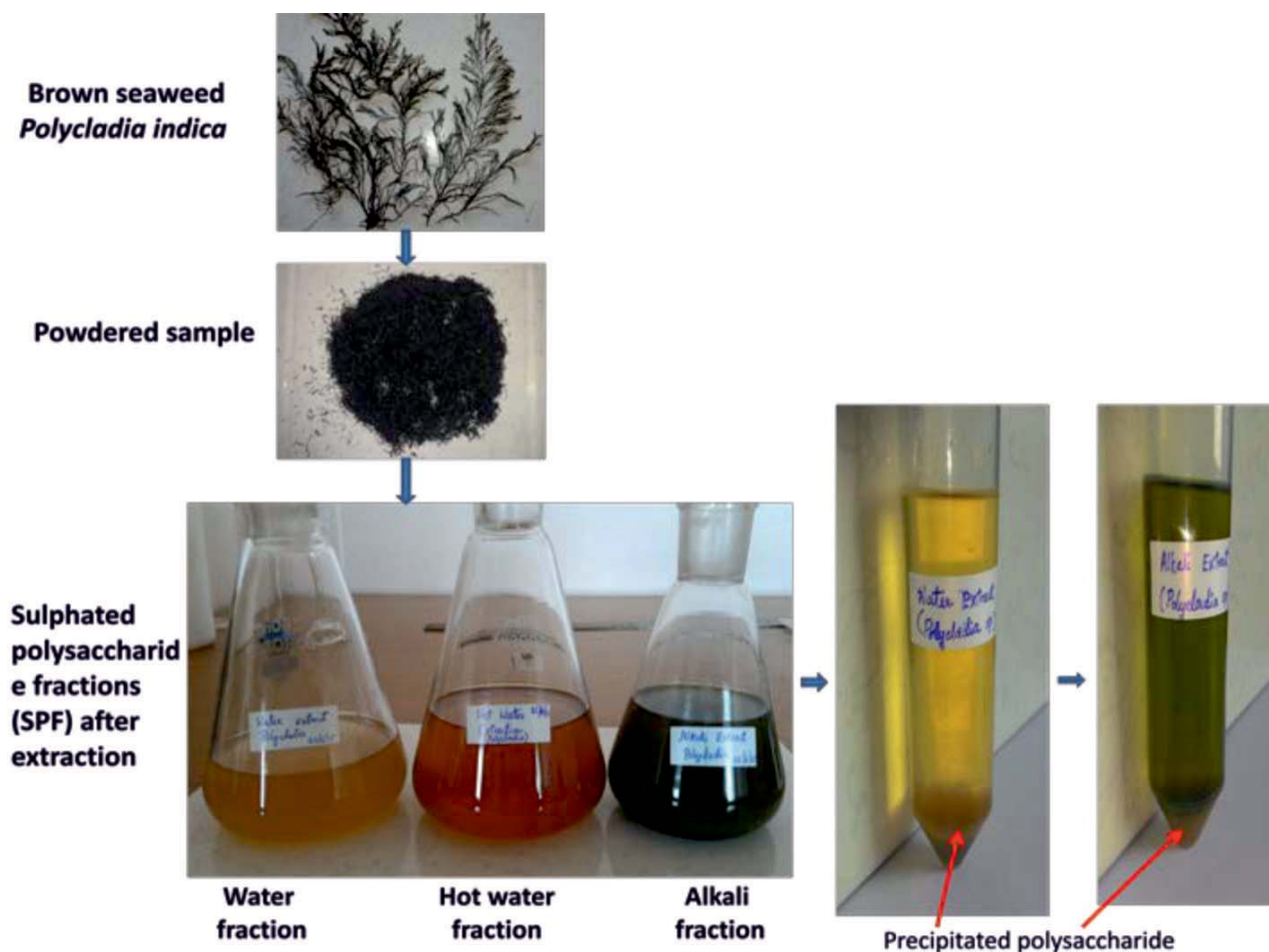




Assay and ABTS•+ Scavenging activity) and antimicrobial activity of sulfated polysaccharide were evaluated. Highest DPPH Free Radical-Scavenging Activity (65%) and Reducing Power (1.98) were found to be in sulfated polysaccharides extracted from *G. edulis* followed by sulfated polysaccharides from *U. lactuca*. Sulfated polysaccharides from seaweed exhibited strong ABTS•+ scavenging capacities and the inhibitory activity of sulfated polysaccharide from *G. edulis* on ABTS•+ reached  $86.74 \pm 1.02\%$  at a concentration of 2.0 mg/ml.

### Characterization of sulphated polysaccharides from brown seaweed

Three different methods viz. water, hot water and alkali extraction methods were compared in terms of yield percentage, antioxidant property, carbohydrate and sulphate content. Yield percentage and different antioxidant properties like total antioxidant activity, DPPH, ABTS, FRAP assay was done following standard protocols. The result indicates that there was no significant difference between the percentage yields obtained from water, hot water and alkali extraction method which were between 8.3 to 8.5%. The highest DPPH (radical scavenging) activity was obtained in alkali extract i.e 45% followed by water extract (40%) and hot water extract. The study revealed that among water, hot water and alkali extraction methods, alkali extraction method was best in terms of carbohydrate content and antioxidant property.



### Enzymatic lipid extraction from surimi waste: Comparison with other methods

The extractability and quality of oil from surimi waste was investigated. Fish oil extracted by wet rendering method showed high oil extractability and enzymatic-extracted oil exhibited high oil quality. The fatty acid analysis of heat-extracted lipid revealed high content of saturated fatty acid compared to unsaturated fatty acid. Palmitic acid was the major saturated fatty acid reported (56.9%).



Oil from surimi waste

## Risk assessment of emerging food-borne pathogens and chemical residues in aquatic systems

### Multi-residue analysis of persistent organic pollutants

Persistent organic pollutants in seaweeds are known to be indicators of micro-pollutants in marine and estuary environment. A sample preparation method involving ethyl acetate extraction and solid phase dispersive cleanup for GC MS/MS analysis of these micropollutants in seaweeds was developed and validated.

### Development of LC-MS/MS method for antibiotic analysis

Development of LC-MS/MS method for simultaneous analysis of three tetracycline and six sulphonamide antibiotic residues in shrimp was carried out. Five point calibration ranging from 5-25 µg/mL and 2.5-12.5 µg/mL were evaluated for linear response. Detailed method validation parameters are presented in Table.

#### Method validation parameters

Compounds	RT (Min)	Quantifier ion	Qualifier ion	LOQ (ng/mL)	Regression	r <sup>2</sup>
Sulphadiazine	11.19	251.0>92.1	251.0>108.1	0.30	Y=1.1e+004x	0.99
Sulphamerazine	11.75	265.0>92.1	265.0>108.2	0.20	Y=1.48e+004x	0.99
Sulphamethiazole	12.30	271.0>156	271.0>108.1	0.05	Y=4.19e+004x	0.99
Sulphamethiazine	12.16	279.1>124.1	279.1>92.2	0.29	Y=1.67e+004x	0.99
Trimethoprim	12.40	291.1>230.3	291.1>123.2	0.05	Y+4.04e+004x	0.99
Sulphadimethoxine	14.08	311.1>156.1	311.1>92.2	0.18	Y=2.45e+004x	0.99
Tetracycline	12.96	445.0>410.0	445.0>154.0	0.65	Y=3.29e+003x	0.99
Oxytetracycline	13.02	461.0>426.0	461.0>381.0	2.00	Y=1.94e+003x	0.99
Chlortetracycline	13.84	479.0>444.0	479.0>462.0	3.20	Y=930x	0.99

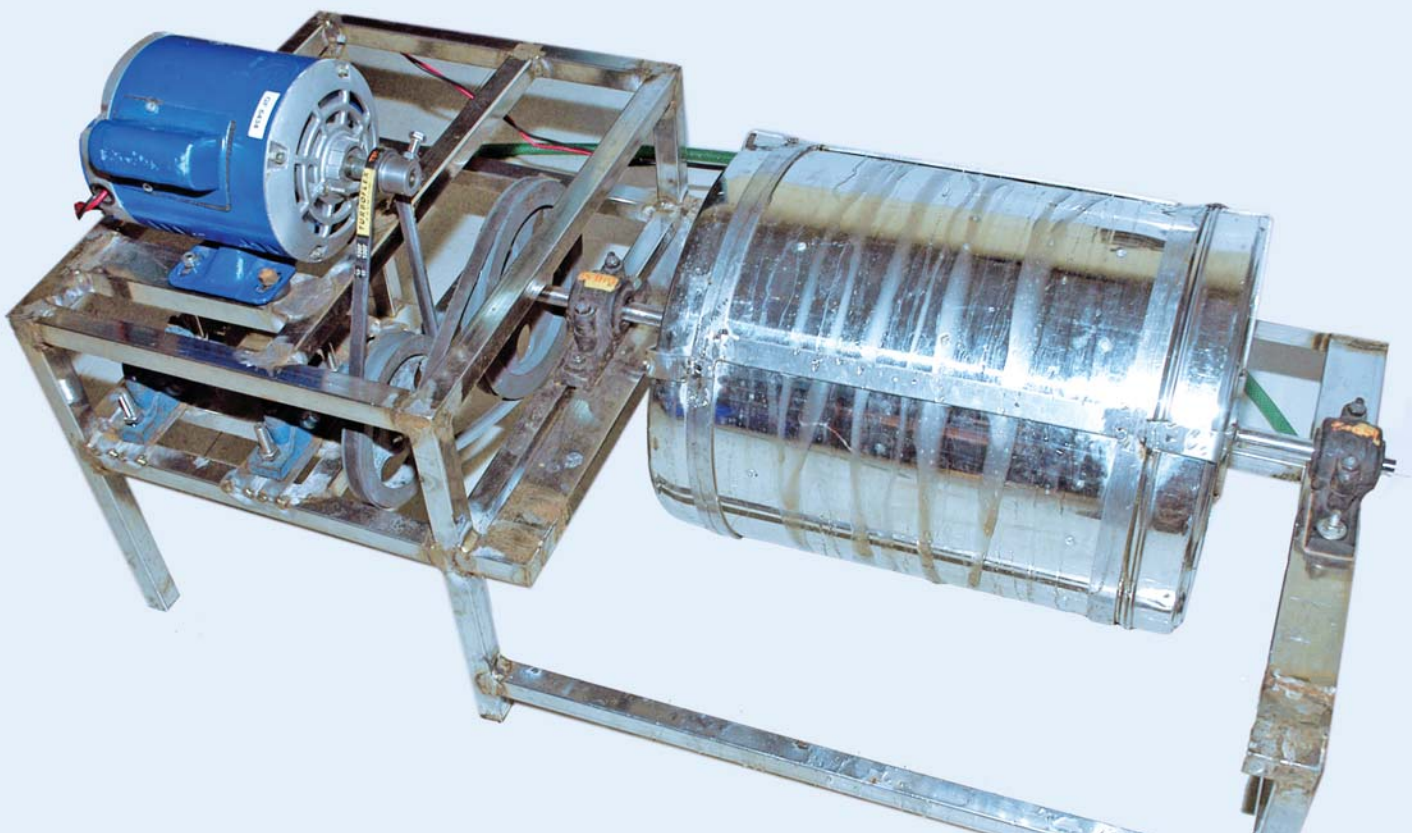




# CIFT SOLAR FISH DRYER



## ENGINEERING





## Research project handled

### Institute project

- Quality improvement of Indian fishing fleet and engineering interventions in post harvest sector

## Most significant achievements

- In order to establish and quantify significant variables (related to design and construction practices) affecting quality of fishing vessels, 12 aspects were finalized for detailed study based on an initial study conducted on 24 boats constructed from six boat yards in Kerala.
- Data base on varying size and power of boats, propeller fabrication and skill level of operatives were made.
- Designed and fabricated a prototype of dryer (10 kg capacity) with electrical backup.
- Fabricated a prototype of cutting machine for fresh and frozen fish.
- Based on the analysis of data collected from the validation of engines (January, 2015) and monitoring of the same makes on 12 vessels in field during the period (July 2015 - January, 2016), an engine validation method has been finalized and is under preparation for release.
- Numerous hull form designs that have been tested under commercial conditions are available with industry without any reasonable IP management system to benefit the traditional boat building industry. An IP management system is being devised.

## Chief findings

### Institute project

## Quality improvement of Indian fishing fleet and engineering interventions in post harvest sector

### Studies on boat design and construction practices

Based on an initial study conducted on 24 boats constructed from six boat-yards in Kerala at three leading fish hubs, viz., Munambam, Kollam and Kozhikode, 12 aspects were finalized for detailed study in order to establish and quantify significant variables (related to design and construction practices) affecting quality of fishing vessels under commercial operational environment.

Detailed data based on the 12 aspects has been collected from 38 boats of varying sizes and power under construction in 19 steel boatyards in the three main fishing hubs. Data from 21 vessels has already been completed. Data from another 57 vessels from the selected yards, similar to the ones which are under construction, but already in operation for varying time from one to six years are also being collected to study the maintenance issues and or component failures attributable to design and construction practices.

### Studies on propellers

Studies on design, specification, material selection, fabrication, finishing, quality control and power matching guidance followed by two propellers manufacturers (one in Kollam and one in Kozhikode) was initiated. Data for 87 propeller fabrication, on-board fitting and performance feedback were collected.

**Fabrication and utilization of electrical dryer and de-scaling machine**

A 10 kg capacity small prototype of dryer with electrical backup was fabricated. A prototype of cutting machine for fresh and frozen fish was also fabricated. Skill level data of 10 propeller fabricating personnel from two propeller manufacturing units were collected for analysis.

ICAR-CIFT solar dryers were utilized for commercial drying of prawn by M/s. HIC-ABF Special Foods, Aroor, Shri Abin, Kumbalangi and Shri Prasad, Cherthala. The dryer was also utilized for commercial drying of banana and other fruits and vegetables by an entrepreneur from Kollam.

The de-scaling machine (hand-operated) developed was handed over to an entrepreneur for commercial operation.

Small prototype of dryer with electrical backup







## EXTENSION INFORMATION & STATISTICS





## Research projects handled

### Institute projects

- Modelling studies for estimation of revenue-based capacity and valuation of selected fishing systems and fish supply chain analysis
- An assessment of the impact of S&T outputs of ICAR-CIFT on the socio-economic fabric of fisheries stakeholders
- Development of standard processes and protocols for innovative products from aquatic resources, shelf life modelling and assessment of energy use

### Externally funded projects

- Indigenous traditional knowledge (ITKs) in marine fisheries sector of Kerala: Documentation and analysis
- Assessing the role and impact of fisheries cooperatives in enhancing the livelihood and resource management capabilities of fisherfolk in India

## Most significant achievements

- The input and output indicators (quantitative and economical aspects) of trawl fisheries in Kerala were collected, covering three selected districts viz., Kozhikode, Ernakulam and Kollam from north, central and south regions, respectively.
- The fish supply chain analysis of domestic fish markets in Ernakulam revealed that the inter-market efficiency ranged from 3.11 to 3.46 and intra-market efficiency from 2.04 to 4.87.
- The constraint analysis of domestic fish markets indicated that poor road connectivity and absence of separate assemblage area for display are the major constraints
- The perception analysis of mechanized trawl owners of Visakhapatnam showed that majority of the fishermen had a neutral perception on availability of excess fishing fleets in the coast (75%) and increasing fishing pressure over the years (70%). The reason for excess capacity was entry of large number of fishing fleets into marine fisheries (35%) and indiscriminate use of high power engines (25%).
- Product-wise and activity-wise energy consumption of the seafood processing units showed that shrimp was the major product which consume high energy followed by cephalopods. The energy consumption is high for the cold storage activity (40%).

## Chief findings

### Institute projects

#### Modelling studies for estimation of revenue-based capacity and valuation of selected fishing systems and fish supply chain analysis

### Estimation of revenue-based fishing capacity in Kerala

The data for estimation of fishing capacity of trawl fisheries were collected from three selected districts viz., Kozhikode, Ernakulam and Kollam of Kerala. The details of input and output indicators (quantitative and economical aspects) relating to the fishing trips of trawlers were collected. The output indicators selected were species-wise landings per trip and catch value per trip.

### Fish supply chain at the domestic fish markets of Kerala

The supply chain analysis of domestic fish markets was carried out at three fish markets in Ernakulam. The basic infrastructure facilities, market chain and marketing efficiency of domestic fish markets were analyzed and compared. The marketing efficiency was estimated using the Shepherd's Marketing Efficiency Index (MFI). The marketing problems at the three markets were ranked based on Garrett Ranking Quotient. It was observed that the inter-market efficiency ranged from 3.11 to 3.46 and intra-market efficiency ranged from 2.04 to 4.87. It was



Interaction with the retailer at the Chambakkara fish market

### Marketing costs, marketing margin and marketing efficiency in the selected fish markets

Markets	Purchase price (₹)	Sale Price (₹)	Marketing margin (₹)	Marketing cost (₹)	Marketing efficiency index
<b>Market I (3.46)</b>					
Wholesaler	25.00	36.67	11.67	0.40	2.04
Retailer	48.00	60.00	20.00	0.32	4.87
<b>Market II (3.42)</b>					
Wholesaler	12.50	16.80	25.60	0.27	3.68
Retailer	0.83	1.04	27.95	0.12	3.15
<b>Market III (3.11)</b>					
Wholesaler	8.10	10.28	21.21	0.38	4.02
Retailer	0.65	0.92	29.35	0.15	2.19

### Ranking of constraints in fish markets in Ernakulam

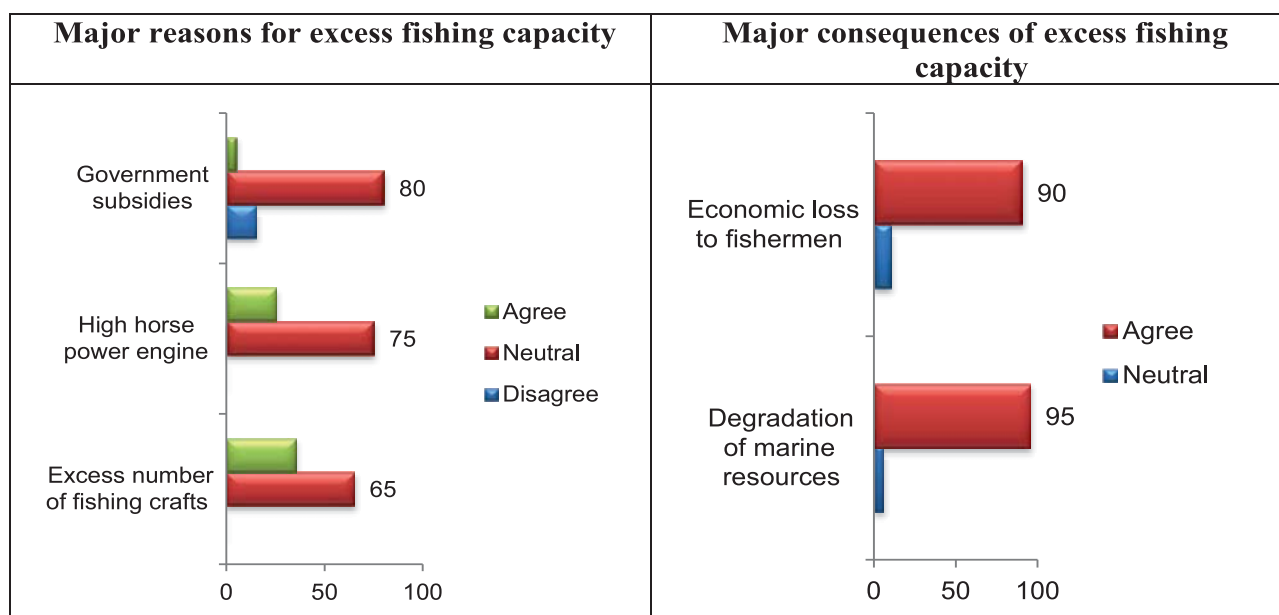
Constraints	Market I	Market II	Market III
Lack of clean water supply	IV	IV	V
Lack of cold storage facilities	III	II	III
Poor road connectivity	I	V	I
Lack of transport facilities	VIII	VIII	II
Lack of separate assemblage area	VII	I	VI
Domination of middlemen	V	VII	VII
Lack of drainage facilities	II	III	IV
Lack of preservation facilities	VI	VI	VIII

observed that retailers performed better (4.87) in Market I and wholesalers performed better (4.02) in Market III.

The constraint analysis of selected fish markets showed that poor road connectivity was the primary constraint at Market I and III, and absence of separate assemblage area for display of fish in Market II. Lack of proper drainage facilities, cold storage and drainage facilities were the other constraints affecting normal market functioning.

### Fishermen perception on fishing capacity utilization and its management

A study was undertaken among the mechanized boat owners in Visakhapatnam to understand their perception related to fishing capacity utilization and its management. Dimensions studied included socio-economic aspects, technology use details and perception regarding fishing capacity. Fishermen perception was measured under different dimensions viz; present scenario of capacity utilization in fisheries, major reasons for excessive fishing capacity, major consequences of excessive fishing capacity and adequacy of existing management measures.



Data collection at Visakhapatnam



Interaction with members of Mechanized Boat Owners Association at Visakhapatnam

### An assessment of the impact of S&T outputs of ICAR-CIFT on the socio-economic fabric of fisheries stakeholders

#### Assessment of impact of S&T

The S&T outputs of ICAR-CIFT for the past 20 years are documented (690 items). After assessing the nature of outputs, they were classified under different categories like new/improved – products, methods, processes, equipment,

materials, data base and policies. Further, an analysis of pattern of ToT programmes for past many years was done to fix the modes of technology transfer to be included under the project. They were finalized as media, trainings, demonstrations consultancies, diagnostic services and policy recommendations.

Developed measurement devices for i) Pre-field evaluation study of selected S&T outputs at Institute level and ii) Field level diagnostic studies and appraisal of impact of S&T outputs.

Major changes that happened in the selected socio-economic parameters of the fisheries sectors is also being documented parallel to the S&T output documentation for analysis. Divisia Tornqvist Index for studying Total Factor Productivity (TFP) of fishery was identified to assess the impact which encompasses the returns and technology components.

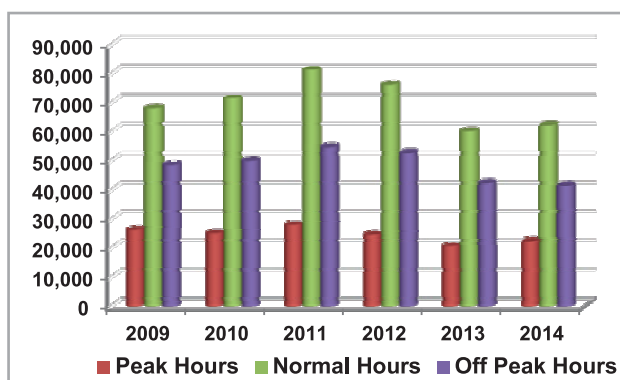
### Development of standard processes and protocols for innovative products from aquatic resources, shelf life modelling and assessment of energy use

#### Assessment of energy use pattern in the seafood processing unit at Kochi

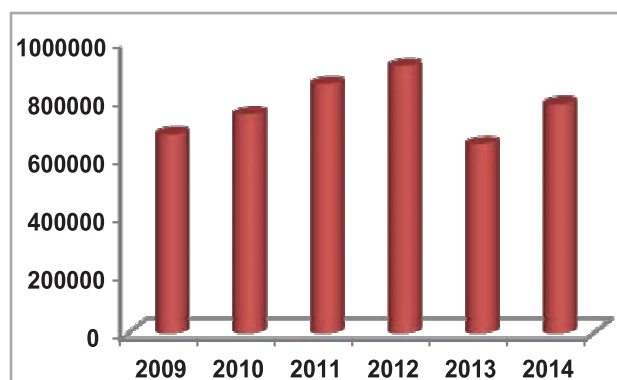
Under the project, a pilot study was carried out towards an intra-plant comparison of energy use pattern at seafood processing unit in Kochi. During 2014, the average annual energy consumption, energy cost and per unit energy cost of the unit was 42,137.33 KW units, ₹ 7, 84,258.50 and ₹ 18.61, respectively. The energy consumption and costs during the period 2009 and 2014 varied over the years, due to arrival of raw material and product demand.

The comparison of energy consumption between the period 2009 and 2014 showed that even though the current energy consumption was decreased by 11.23 per cent, there was an increase in energy cost by 15.30 per cent from the 2009 level. The average energy consumption of various products viz., shrimp, fish and other cephalopods was 85815.45, 12259.35 and 24518.70 kw units, respectively. The energy consumption was high for cold storage (16,854.93kw; 40%) followed by production (12,641.20kw; 30%), chilling (8,427.47kw; 20%) and other activities (4213.73kw; 10%).

The cost indices showed that energy cost indices was highest during August (120.97) and lowest during April. The coefficient of variation of cost indices was high compared to consumption indices.



Energy consumption - seafood processing units (kw)



Energy costs - seafood processing units (₹)

#### Seasonal variation indices of energy consumption and cost in a seafood processing unit

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
E <sub>Con.</sub> (KWH)	96.22	95.16	92.36	85.89	94.76	95.0	98.31	111.79	109.79	113.37	104.70	102.65
E <sub>Cost</sub> (Rs.)	97.19	95.85	88.67	84.83	96.97	92.0	109.29	120.97	112.34	109.93	93.43	98.53







# EXTERNALLY FUNDED PROJECTS





## Indian Council of Agricultural Research (ICAR) Projects

### Agri-business Incubation

Enrolled entrepreneurs as incubatees and imparted training on processing and value addition of fishery products.

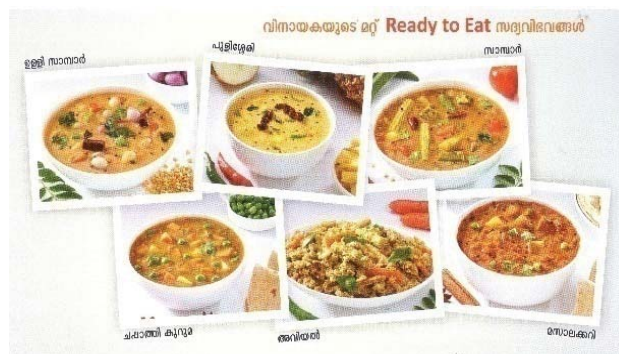
Transferred the technology for the production of Ready-To-Eat (RTE) food products to M/s Vinayaka Foods and Beverages, a part of M/s Vinayaka Caterers and Kalyana Mandapam, Kochi. A total of 13 food products like 'Palada Pradhanam' (rice based sweet dish), 'Pazha Pradhanam' (banana based sweet dish), 'Gothembu Pradhanam' (wheat based sweet dish), 'Parippu Pradhanam' (split pigeon pea or toor dal based sweet dish), 'Pal Payasam' (milk based sweet dish), 'Kurukku Kalan', 'Pulisheri', 'Puli Inji', 'Onion Sambar', 'Sadhya Sambar', 'Avial', 'Chappathi Kuruma' and 'Masala Curry' were perfected by ICAR-CIFT and are being produced in the HACCP complied and FSSAI approved processing unit at Eloor, Tripunithura, Kochi, which was inaugurated by Dr. S. Ayyappan, the then Secretary, Department of Agricultural Research and Education and Director General, ICAR, New Delhi in August 2015.



Inauguration of M/s Vinayaka Foods and Beverages, Kochi

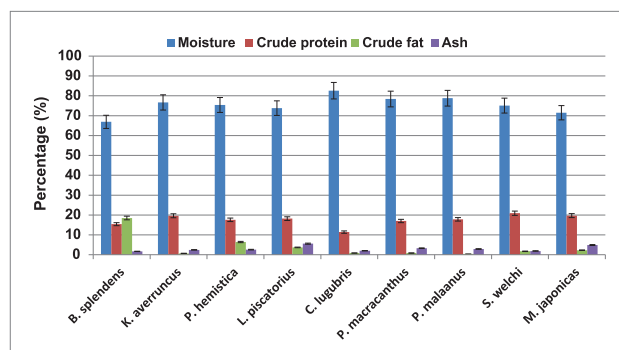


Product range of M/s Vinayaka Foods and Beverages, Kochi



### Nutrient profiling and evaluation of fish as a dietary component

Database on the biochemical composition, amino acid, macro mineral, micro-element, fatty acid and vitamin profiling of 14 deep-sea fishes viz. *Berix splendens*, *Kathetostoma averrencus*, *Pterigotrigla hemistica*, *Lophius piscatorius*, *Lophius vomerinus*, *Chascanopsetta lugubris*, *Priacanthus macracanthus*, *Mastigoteuthi flammea*, *Pseudorhombus malayanus*, *Satyrichthys welchi*, *Cynoglossus macrolepidotus*, *Myripristis japonicas*, *Idiacanthus atlanticus* and *Aristeus alcocki* and ten coastal fishes viz. *Metapenaeus dobsoni*, *Exocoetus monocirrhus*, *Decapterus russelli*, *Epinephelus diacanthus*, *Uroteuthis chinensis*, *Sepia pharaonis*, *Octopus* spp., *Parapenaeopsis*

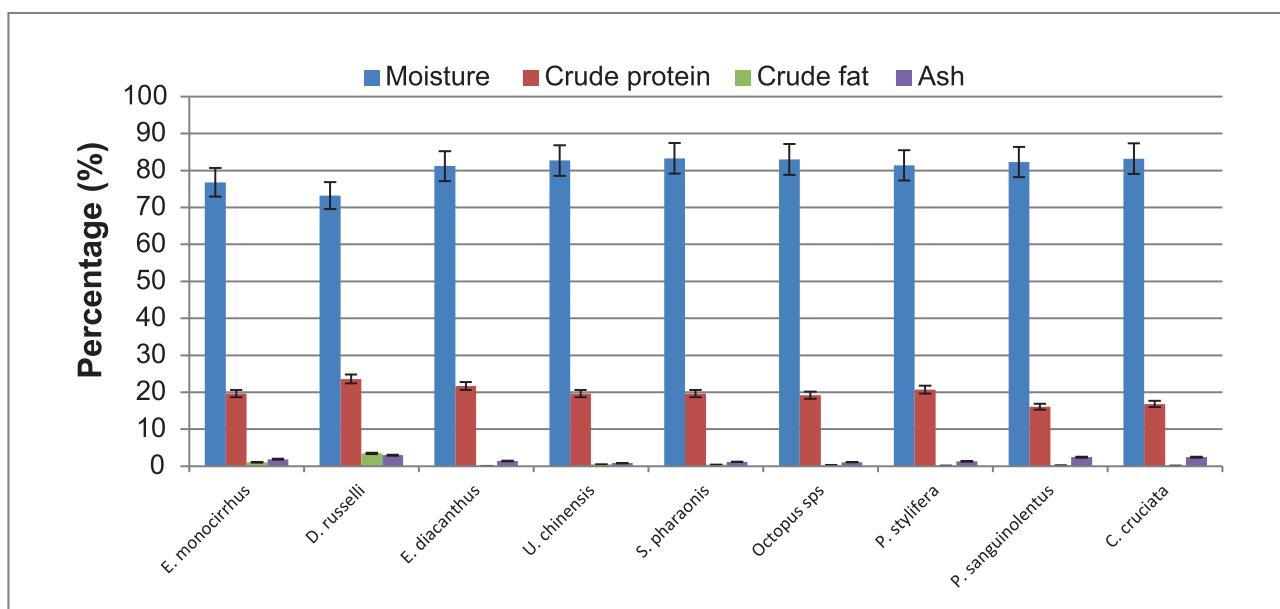


The proximate composition of deep sea fishes (g/100g)

\*Means values  $\pm$  S.D of determinations for triplicate samples



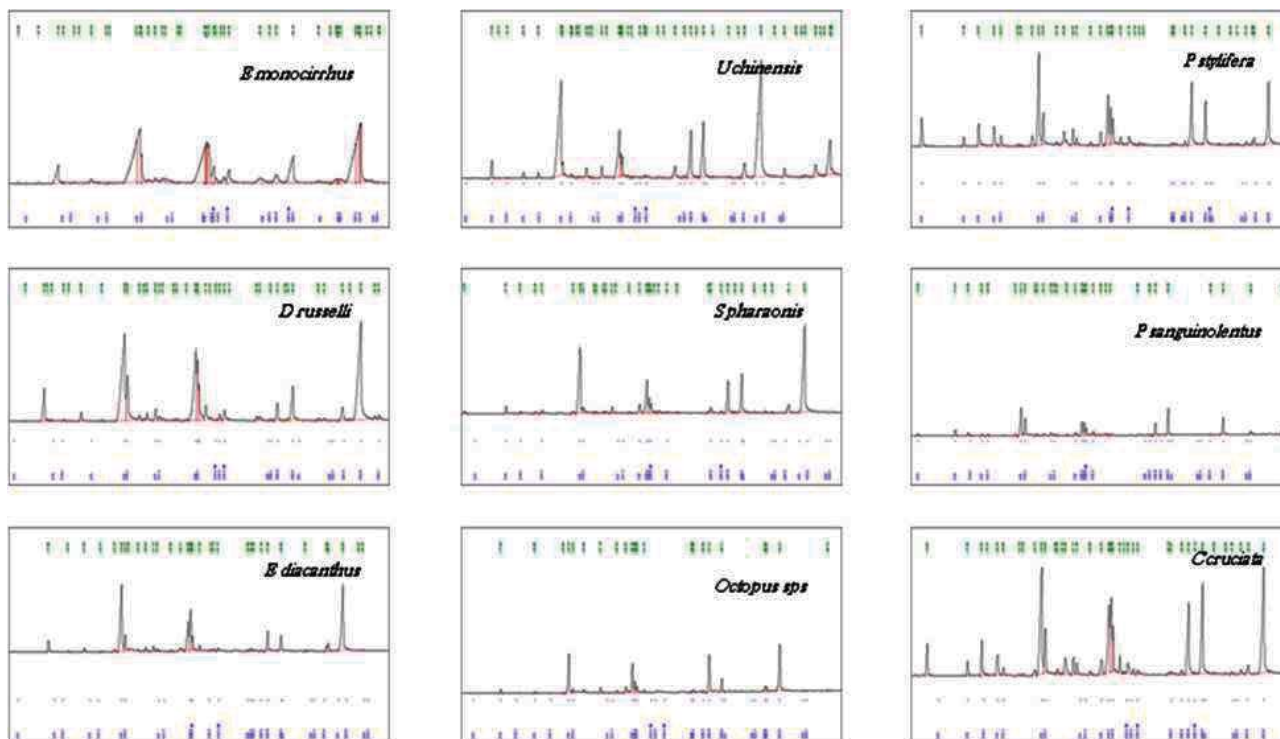
*stylifera*, *Portunus sanguinolentus* and *Charybdis cruciata* was prepared.



The proximate composition of coastal fishes (g/100g)

\*Means values  $\pm$  S.D of determinations for triplicate sample

Fatty acid profiling of fishes have indicated the presence of rich amount of EPA and DHA. These fatty acids are reported to have beneficial effects on foetal development, proper neuronal and cellular functions and healthy aging. Among all the deep sea fishes of interest, *A. alcocki* contains highest amount of polyunsaturated fatty acids (EPA and DHA).

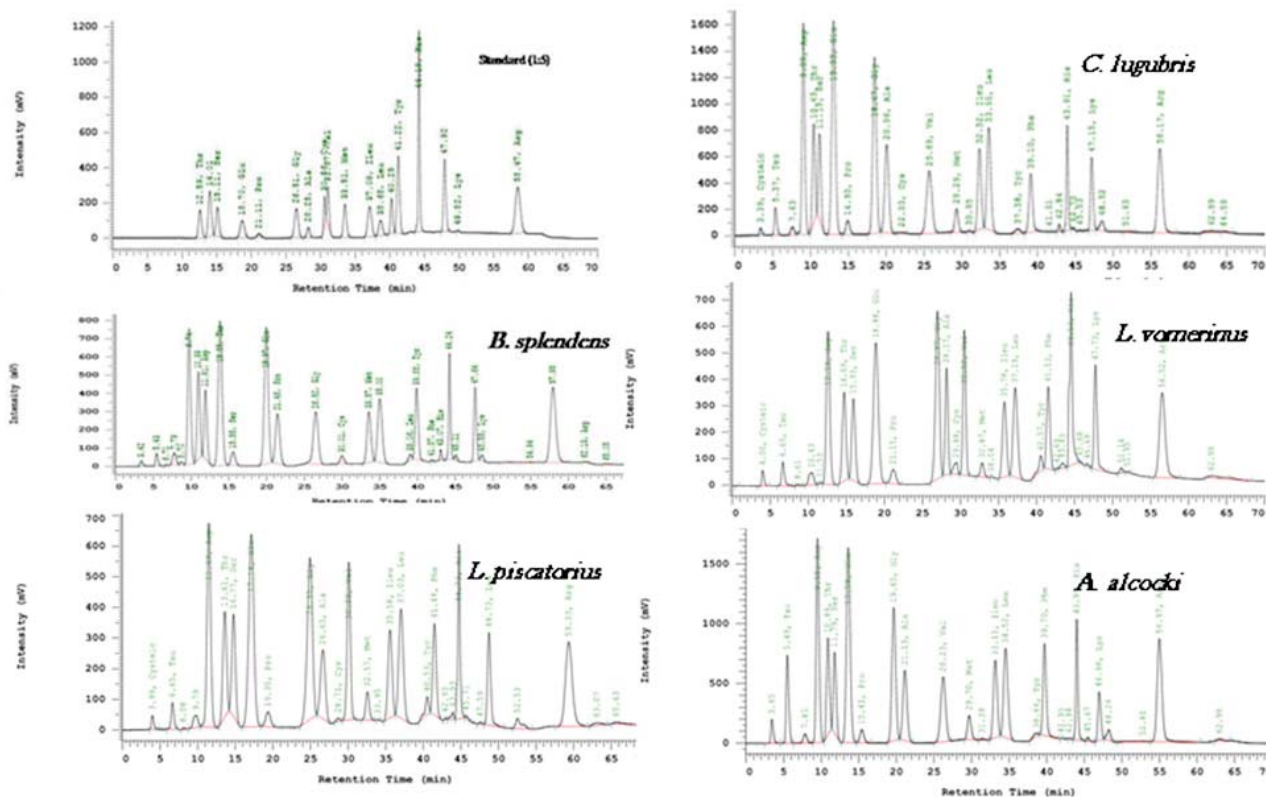


Chromatogram of gas chromatographic determination of fatty acid composition in coastal fishes



## Amino acid profiling of deep sea fishes and coastal fishes

Amino acid profiling of the meat extracted from deep sea fishes *B. splendens*, *L. vomerinus*, *L. piscatorius*, *C. lugubris*, *A. alcocki* and coastal fishes, *E. monocirrhus*, *D. russelli*, *E. diacanthus*, *U. chinensis*, *S. pharaonis*, *Octopus* sps., *P. stylifera*, *P. sanguinolentus* and *C. cruciata* was carried out.

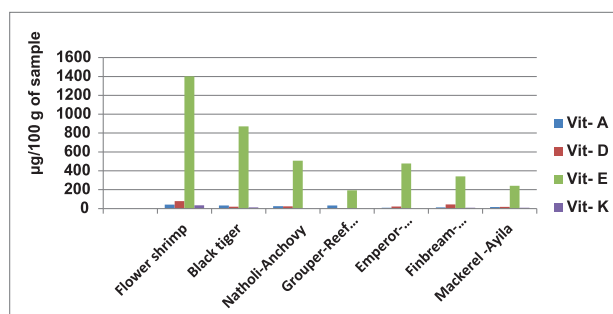


Amino acid profiling of deep sea fishes

## Validation of LC MS/MS method for water soluble vitamins in fish

Complete method validation and recovery studies were carried out for analysis of eight water soluble B vitamins in fish. Limit of quantification values ranged from 0.41-50 ng/g. Spike recovery studies using developed sample preparation protocol achieved more than 80% recovery in all the cases.

Water soluble vitamin content in fishes





## National Agricultural Science Fund (NASF) Project

### Green fishing systems for tropical seas

#### Construction of the green fishing vessel

The construction of the 19.75 m energy efficient fishing vessel, christened as *MFV Sagar Harita*, was completed at the Goa Shipyard Ltd., Goa. This new IR-Class combination fishing vessel has an array of novel features. The hull is made of marine grade steel and the cabin and wheel house is made of FRP to reduce weight, improve the carrying capacity and speed. The main engine power of 400 hp is 20% lower than comparable size vessels. The fishing gear handling equipment such as split trawl winch, long line hauler, setter and gillnet hauler were designed and installed onboard. Two RSW tanks (0° C to -10 °C) of 1 ton each capacity is also installed. The emergency lighting is provided by 400 watt solar power panel. Acoustic trawl telemetry system with under-water sensor is also fitted. Bilge keel, bulbous bow, Kort nozzle propeller, fuel monitoring system are other fuel saving features of the vessel.



MFV Sagar Harita

#### Studies on fuel consumption

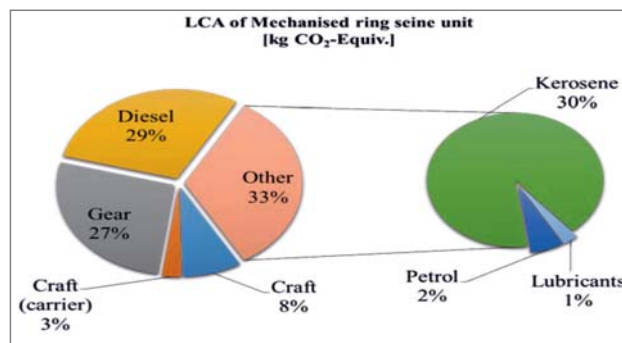
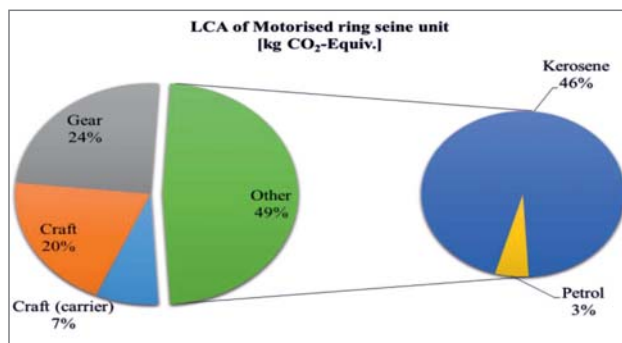
Tension meter was used to estimate the tension offered by two designs of trawl operated on-board FV Matsyakumari. A 27.0 m meter shrimp trawl and 33.0 m modified bottom trawl were used for estimating the changes in the tension at different speeds and also concomitant change in the fuel consumption pattern during trawling. The total tension offered by the gear increased from 8 KN to about 15 KN, when the speed was increased from 2.0 to 3.4 knots, while operating the 33.0 m shrimp trawl attached with BRD. The correlation between speed and fuel consumption showed a positive relationship with a correlation coefficient of 0.46, whereas the relationship between total tension and fuel consumption by the trawler showed a very high positive coefficient of 0.80, indicating significant increase in fuel consumption with increase in tension of the net.



Onboard experimentation using tension meter

#### LCA of ring seines

A comparative study was made between three different types of ring seine fishery (mechanized, motorized, motorized)

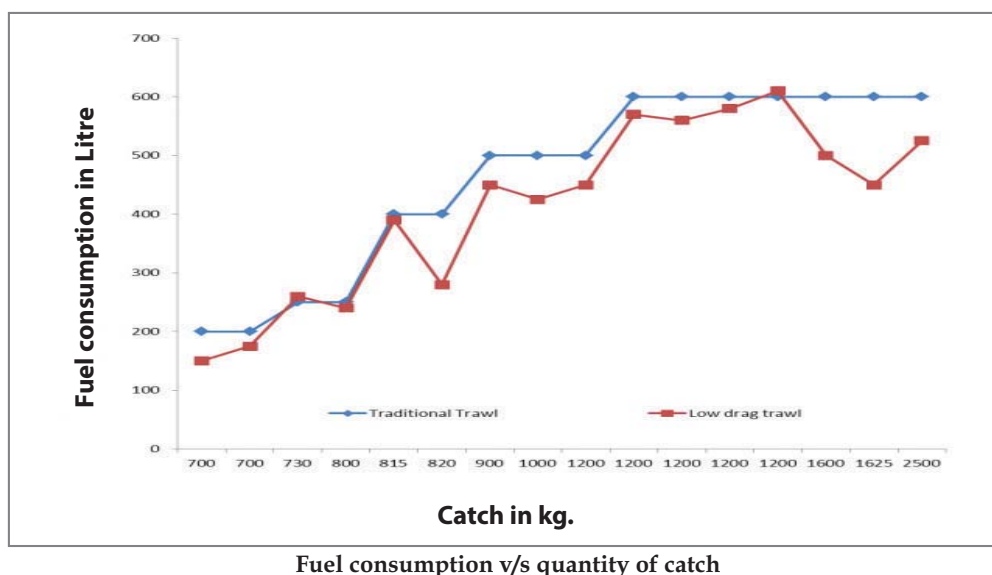


Percentage contribution of a motorized and mechanized ring seine fishing system in operation to carbon emission

and traditional ring seines) operated in the same geographical area and time to determine the environmental burden associated for the production of oil sardine. Fuel used for fishing contributed more than half of the total impacts in eight of the ten environmental impact categories analyzed. Motorized ring seine fleet was having higher impact when compared to mechanized ring seine fleet with a 24% higher value for Global Warming Potential.

### Field trials of low drag trawls

A low drag shrimp trawl (33 m head rope length) was developed by optimizing the cutting rate which helps in the reduction of drag. Eight operations were conducted using the gear off Kochi coast. Initial results of field trials in commercial trawlers operated at Munambam, Kerala showed a reduction of fuel by 2.5%.



### Field trials of gillnets with alternate materials

Fabrication of the experimental gillnets with new generation materials like Sapphire (7x3) and STAR (No. 8) was compared with nets made of Polyamide, (8x3) of mesh size 135 and 150 mm. One set of operation (10 hauls, Area: Kochi to Okha, lat long: 21038'17.4" N, 64051'27.0"E) was carried out. Tunas, dolphinfish, swordfishes and seerfishes in the size range of 70-150 cm dominated the catches. To facilitate multi-location testing, another set of experimental and control nets are fabricated and arrangements have been made for field trials on participatory mode through two fishermen societies (Association of Deep Sea going Artisanal Fishermen, AD SGAF and Fishermen Integral Development Organisation, FIDO) from Tamil Nadu.



Field trials of gillnets and catch



### Assessment of myctophid resources in Arabian Sea and development of harvest and post harvest technologies

#### FORV Sagar Sampada cruise

FORV Sagar Sampada Cruise No 344 spanning 22 days covered 36 stations located between 8° N to 5° S latitude and 73° to 65° E longitude. A total of 39 stations were covered during the cruise of which 17 were for CTD stations, nine were for MPN and 11 stations for mid water trawling. Fishing operations were conducted with Cosmos and 45 m mid-water nets using Thyborne otter board. Eleven fishery stations were covered during the cruise with a total fishing effort of 17.82 h, yielding a total catch of 132 kg with a CPUE of 7.40 kgs/hr comprised of finfishes, shellfishes, crustaceans, cephalopods and gastropods by 92% and myctophids by 8%. Eighteen species of myctophid species were identified.



*Lampanyctus ater*



*Bolinichthys distofax*



*Lampanyctus tenuiformes*



*Diaphus regain*



*Diaphus perspillatus*



*Diaphus lucidus*



*Diaphus garmanni*



*Diaphus fragilis*



*Diaphus flugens*



*Diaphus efflugens*



*Diaphus jensenii*



*Benthosema fibulatum*



*Benthosema pterotum*



*Myctophum spinosum*

Different species of myctophids caught in the experimental trawl net



Database of biochemical components of myctophid fishes was created and assessed. n-3 PUFA profiling of myctophid oil extracted from *Diaphus watasei* was carried out. Further profiling of n-3 polyunsaturated fatty acids of myctophid fish species available in Arabian Sea was done.

### Comparison of proximate composition in myctophids and anchovy

Species	Myctophid fishes				Anchovy
	<i>B. pterotum</i>	<i>B. fibulatum</i>	<i>D. jenseni</i>	<i>M. spinosum</i>	<i>S. commersonii</i>
Moisture	81.0±0.38 <sup>d</sup>	76.6±0.05 <sup>b</sup>	76.9±0.15 <sup>b</sup>	77.6±0.3 <sup>a</sup>	77.6±0.34 <sup>c</sup>
Protein	13.7±0.17 <sup>a</sup>	18.6±0.11 <sup>c</sup>	18.8±0.21 <sup>c</sup>	19.3±0.21 <sup>d</sup>	17.4±0.21 <sup>b</sup>
Fat	3.64±0.13 <sup>d</sup>	3.26±0.07 <sup>c</sup>	3.43±0.19 <sup>c,d</sup>	2.36±0.08 <sup>b</sup>	1.86±0.08 <sup>a</sup>
Ash	3±0.11 <sup>b</sup>	3.09±0.37 <sup>b</sup>	3±0.18 <sup>b</sup>	2.32±0.15 <sup>a</sup>	3.23±0.11 <sup>b</sup>

## Extraction and purification of marine bio-molecules and their derivatives for nutritional and industrial applications

### Characterization of collagen from various fishes

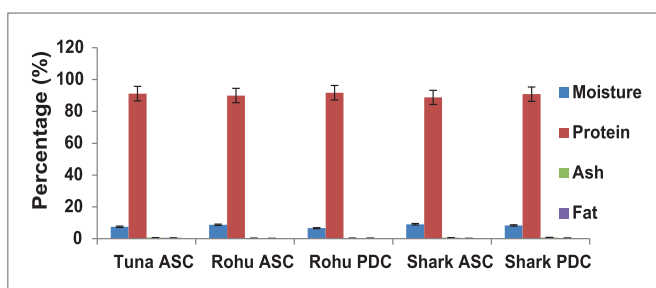
Collagen from the skin of Albacore tuna (*Thunnus alalunga*), Dogshark (*Scoliodon sorrakowah*), and Rohu (*Labeo rohita*) were isolated, yield estimated and characterized. Based on sodium dodecyl sulfate – polyacrylamide gel electrophoretic patterns and subunit compositions, all were identified to be Type 1 collagens and compared from calf skin Type 1 collagen.  $\alpha_1$ ,  $\alpha_2$  and  $\beta$  chains were the major components of these collagens.  $\gamma$  components were also found in lesser amounts in these collagens. While comparing these three species it was seen that Dogshark skin had good yield of collagen and it could serve as an alternative source of collagen for different applications.

### Yield of collagen from Albacore tuna (*Thunnus alalunga*), Dogshark (*Scoliodon sorrakowah*) and Rohu (*Labeo rohita*)

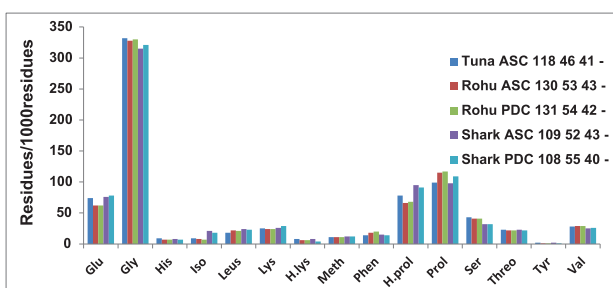
Collagen type	Yield
Tuna Skin ASC	13.97
Rohu skin ASC	4.13
Rohu skin PDC	3.68
Shark skin ASC	8.96
Shark skin PDC	7.68

### Proximate and amino acid analysis of collagens

Proximate analysis showed that all collagens had protein as a major constituent with trace amount of ash and fat. Amino acid analysis revealed that they contained glycine as a major amino acid with high contents of alanine, proline and hydroxyproline.



Proximate analysis of skin and their collagens from Albacore tuna, Dogshark and Rohu in percentages



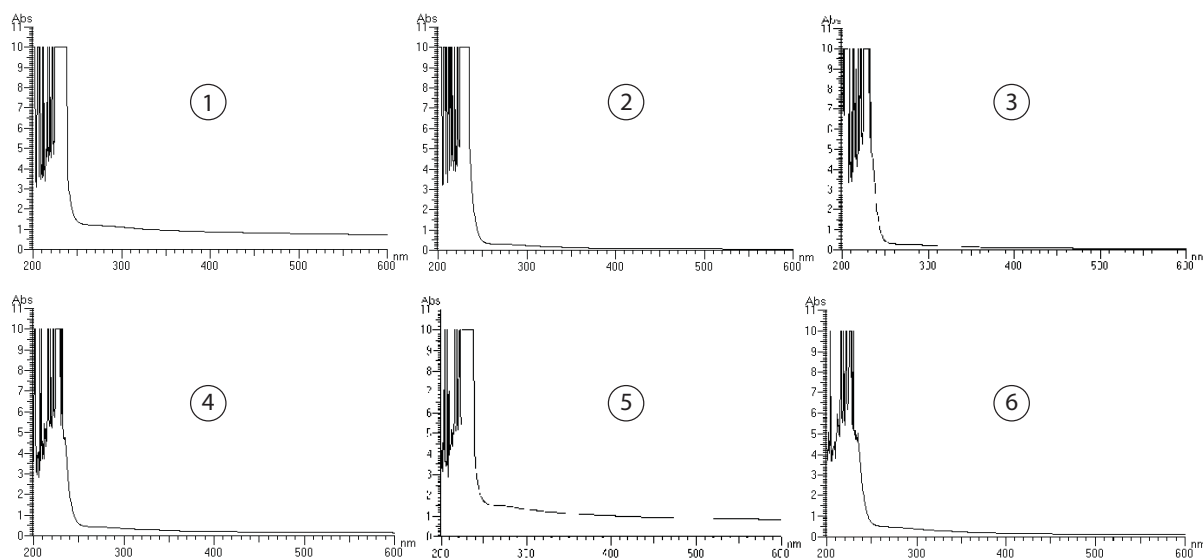
Amino acid composition of collagen (Residues /1000 residues)

Based on sodium dodecyl sulfate – polyacrylamide gel electrophoretic patterns and subunit compositions, all were identified to be Type 1 collagens and compared from calf skin Type 1 collagen.  $\alpha_1$ ,  $\alpha_2$  and  $\beta$  chains were the major components of these collagens.  $\gamma$  components were also found in lesser amounts of these collagens. While comparing

these three species, Dog shark skin had good yield of collagen and it could be served as an alternative source of collagen for different applications.

### Characterization of gelatin from various fishes

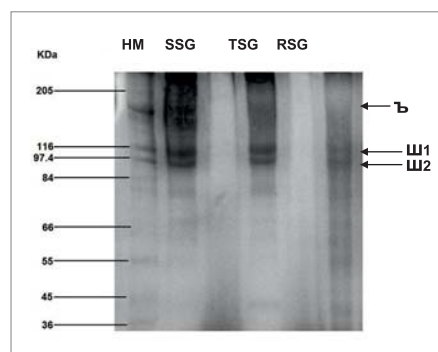
Dogshark (*Scoliodon sorrakowah*), Albacore tuna (*Thunnus alalunga*) and Rohu (*Labeo rohita*) skin was evaluated as a source of gelatin. The gelatin extracted from skin was characterized and its physico-chemical properties were examined. The skin of shark, tuna and rohu yielded 19.67%, 17.23% and 11.34% gelatin. Gelatin from the skin of Dogshark was found to have the highest gel strength (206.67 g) and thus was superior of the three.



Ultraviolet spectra of collagen samples 1. Pure collagen from calf skin, 2. Tuna ASC, 3. Rohu ASC, 4. Rohu PDC, 5. Shark ASC, 6. Shark PDC

Molecular weight, viscosity, colour, melting point, foaming capacity and stability, water holding capacity, fat binding capacity, and clarity of gelatin extracted from Dogshark were in general greater than those of the gelatin from tuna and rohu skin

Molecular weight pattern of of shark skin gelatin (SSG) and tuna skin gelatin (TSG) against high molecular weight marker (HM).



### Water holding capacity (WHC) and fat binding capacity (FBC) of SSG, RSG and TSG

Sample	WHC	FBC
SSG	255.67 ± 4.51	346.67 ± 5.51
RSG	163.00 ± 4.00	359.67 ± 29.19
TSG	214.00 ± 3.61	1.33 6.51

Present study indicated that Dogshark skin is a prospective alternative source to produce gelatin with desirable functional properties comparable to commercially available mammalian gelatins.

### Characterization of shark skin gelatin (SSG), rohu skin gelatin (RSG) and tuna skin gelatin (TSG)

Sample	Yield	Odour score	Transmittance	Viscosity	Bloom
SSG	19.67 ± 0.04	1.83 ± 0.29	44.80 ± 0.72	5.60 ± 0.10	206.67 ± 3.51
RSG	11.34 ± 0.03	2.17 ± 0.29	44.37 ± 0.59	2.50 ± 0.00	124.00 ± 3.61
TSG	17.23 ± 0.03	3.00 ± 0.00	35.53 ± 0.87	4.37 ± 0.06	177.67 ± 3.51

## Characterization of harmful algal bloom along Indian coast

### Ciguatera fish poisoning in Vizhinjam, Thiruvananthapuram, Kerala

Ciguatera Fish Poisoning (CFP), a human intoxication caused by the consumption of fish which bio-accumulate ciguatoxins (CTXs) was analyzed. Mouse bioassay was performed to establish the potential presence of ciguatoxins (CTXs) in the fish samples collected from Panachamoodu near Vizhinjam (8.3932° N, 77.0046° E), Thiruvananthapuram and to quantify it. The toxin-injected mice exhibited typical symptoms of ciguatera poisoning such as reduced locomotor activity, severe diarrhea, hind limb paralysis, gasping for air, breathing difficulty and finally death within 2hr. However, these symptoms were absent in control mice. The mouse toxicity of cooked and raw fish to cause intoxication has been reported to be 0.1 MU/g ( $=0.7 \text{ ng CTX}^{-1}/\text{g flesh}$ ) and 0.05 MU/g ( $=0.35 \text{ ng CTX}^{-1}/\text{g}$ ), respectively. The present study reveals the suspicious occurrence of CFP along the south-west coast of India. Though India has vast maritime area and consumes marine fishes in abundant quantity, there is paucity of data on cases concerning ciguatera fish poisoning. This could be probably due to lack of awareness about toxic fish or symptoms of CFP among public, avoiding consulting doctors or lack of knowledge among health professionals to recognize the disease. This study shows that the public are at risk of poisoning due to ciguateric fish as it cannot be distinguished based on taste, odour or appearance.



Fish sample collected from Vizhinjam, Thiruvananthapuram

*Lutjanus bohar*

### Incidence of paralytic shellfish toxin in *Villorita cyprinoides*

The toxin extractions were standardized and mouse bioassay was done as per AOAC (2012) extraction method. The toxins were found to be lethal after six hours and characterization is in progress with Q trap. Symptoms observed in mice due to paralytic shellfish poisoning when injected with the procured standard toxins were abnormal gait, stretching of hind legs and jumping, deep respiration, protrusion of eyes and finally death.

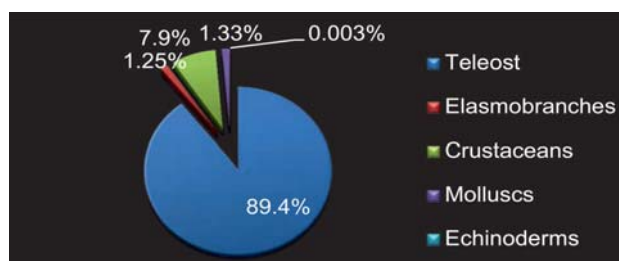


Clam sample used for analysis (*Villorita cyprinoides*)

## Exploration and assessment of demersal fishery resources along the continental slope (200-1200 m) of Indian EEZ and Central Indian Ocean

A total of eight trawling operations were carried out using High Opening Trawl (HOT) nets. All fishing operations were conducted at depths ranging from 200 m to 350 m covering the geographical area from Latitude 09° to 12°N and Longitude 73° to 75°E. The total

Percentage composition of various groups



catch of 2774.242 kg was landed with various groups of organisms from all the stations during the cruise. The catch composition dominated by teleost fishes (89%) followed by crustaceans (18%) and remaining composition was of Elasmobranches and Molluscs.

### Studies on biology and length - weight relationship of fishes

In the present study, *Neobythites analis* exhibited positive allometric growth, whereas most species like *Bythaelurus hispidus*, *Physiculus roseus*, *Glyptophidium oceanium*, *Bassogigas* sp., and *Bothus* sp. noticed negative allometric growth. *Cubiceps* sp. exhibited isometric growth. The values of condition factor 'K' recorded less than 0.80 for the species of *Bythaelurus hispidus*, *Glyptophidium oceanium* and *Neobythites analis* especially order Ophidiiformes species which were showing extremely poor fish, big head, narrow and thin body. Whereas K value recorded as 1.00 in some species like *Physiculus roseus* may be due to the long and thin body. In *Bothus* sp., K value was detected between 1.00 to 1.20 due to the fair and flat body. K value was between 1.20 to 1.40 in species such as *Bassogigas* sp., which denotes good and well proportioned fishes. Condition factor (K) value recorded as 1.40 to 1.60 in the species of *Cubiceps* sp. suggested excellent condition, and trophy class fishes.

### Food and feeding habitats

*Bythaelurus hispidus* has shown the maximum feeding intensity (20.5) followed by *Physiculus roseus* (19.7), *Cubiceps* sp. (5.89), *Glyptophidium oceanium* (3.8), *Neobythites analis* (0.2), *Bothus* sp. (0.2) and *Bassogigas* sp. (0). Feeding intensities were observed to be very low in deep-sea fishes and more than 80% of the stomachs are empty in the species of *Bassogigas* sp., *Bothus* sp., *Neobythites analis*, *Glyptophidium oceanium* and *Cubiceps* sp. Shrimps were the major food for most species such as *Bythaelurus hispidus* and *Physiculus roseus*.

### Degree of fullness of stomach and percentage of IRI

Species	n	Fullness of stomach (%)						Food items (% IRI)				
		Empty	Trace	¼ full	½ full	¾ full	Full	Fish	Shrimp	Crab	Cephalopods	Detritus
<i>Bythaelurus hispidus</i>	44	40.20	12.80	10.20	6.10	10.20	20.50	24.08	44.28	2.10	0.43	29.11
<i>Physiculus roseus</i>	40	60.40	8.20	2.40	4.10	5.20	19.70	18.95	38.24	8.90	6.40	27.51
<i>Glyptophidium oceanium</i>	18	80.20	8.50	2.00	3.20	2.30	3.80	12.31	18.42	2.40	0	66.87
<i>Bassogigas</i> sp.	12	90.20	5.20	1.80	1.60	1.20	0	53.21	30.24	11.32	1.18	4.05
<i>Neobythites analis</i>	18	93.90	2.10	1.30	1.60	0.90	0.20	54.20	6.20	1.10	0	38.50
<i>Cubiceps</i> sp.	220	44.31	18.47	13.54	8.24	9.55	5.89	35.70	49.31	10.65	4.34	0
<i>Bothus</i> sp.	80	93.90	2.10	1.30	1.60	0.90	0.20	87.80	8.90	2.10	0	1.20

### Reproductive biology of deepsea fishes

Studies are conducted on maturity stages of 25 deepsea species. Maturing gonads are dominant in *Bythaelurus hispidus* (32.61), followed *Neobythites analis* (28.61), *Glyptophidium oceanium* (27.28), *Bothus* sp. (26.21), *Cubiceps* sp. (20.95), *Physiculus roseus* (12.18) and *Bassogigas* sp. (10.34).

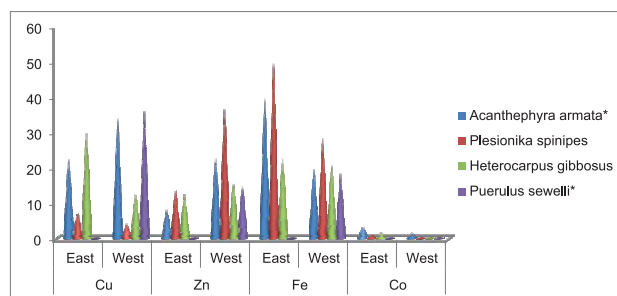


### Proximate composition and heavy metal accumulation of deepsea fishery resources

The proximate composition and heavy metal accumulation of the edible part of 13 demersal deepsea fish species viz., *Cubiceps bextri*, *Psenopsis cynea*, *Alepocephalus* sp., *B. caudimaculata*, *Beryx splendens*, *Neobycticus*, *Basogigus*, *Tricurus*, *Chelidoperca ivestigates*, *Neopinnula orientalis*, *Nemipterus*, *Lamprogrammus niger* and *Chascanopsetta lugubris* were studied.

### Analysis of deepsea Crustacean samples

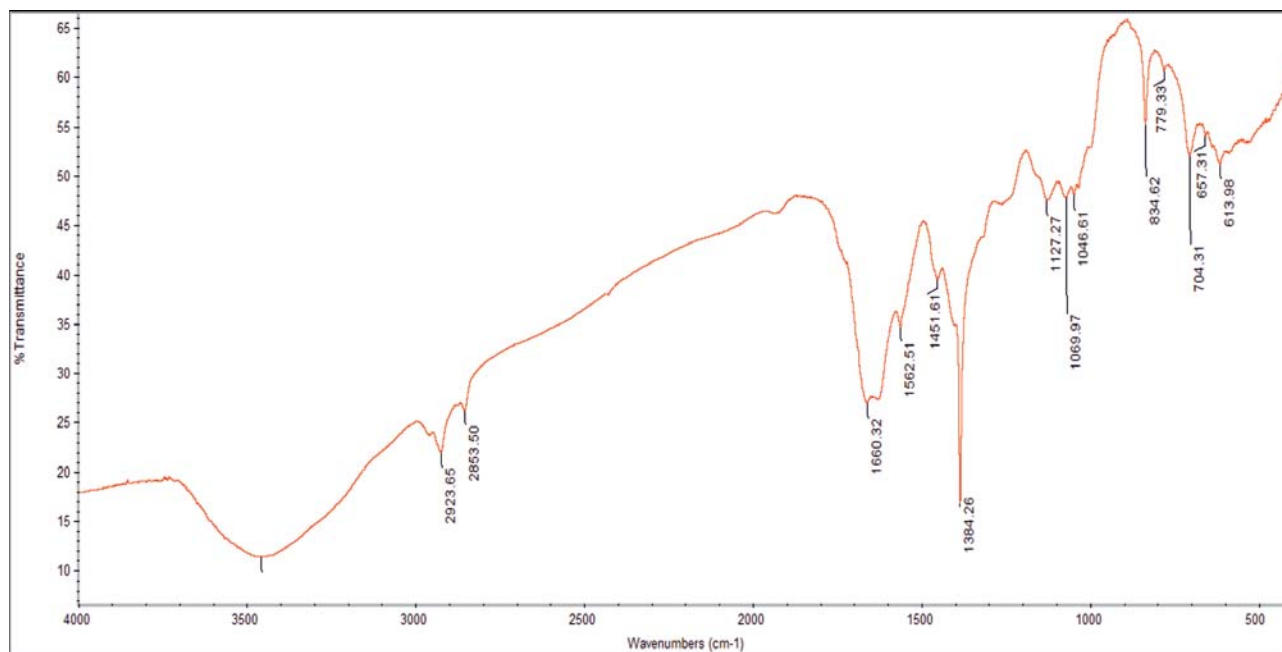
The Crustacean samples were collected from stations located in the east and west coast of India, during two deepsea cruises of FORV Sagar Sampada, at the depth of 900-1120 m (*Acantheephyra armata*), 280-380 m (*Heterocarpus gibbosus*), 250-400 m (*Plesionika spinipes*) and 300-380 m (*Puerulus sewelli*) using Expo and HSDT-CV (High Speed Demersal Trawl – Crustacean vessel) developed by the ICAR-CIFT.



Graphical representation of heavy metals (ppm) in deep-sea Crustaceans

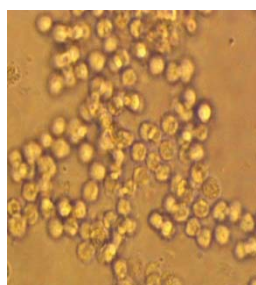
### Proteoglycans from important species

Proteoglycans extracted from *Scolidon* spp. cartilage was characterized and were evaluated for their anti-proliferative activity against MCF-7 cell lines. The IR absorption spectra of proteoglycans were read between 500 and 4000  $\text{cm}^{-1}$ . The spectra obtained for the proteoglycans from the shark cartilage is shown in Figure. Total amount of protein, carbohydrate, uronic acid and hexosamine present in 1g of shark cartilage extract was 4.8 mg, 0.902 mg, 0.95 mg and 0.601 mg, respectively.

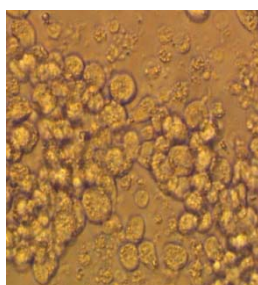


FTIR spectra of proteoglycan extracted from *Scolidon* sp.

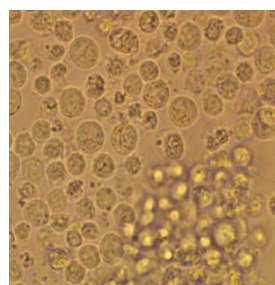
Cytotoxicity effect was determined by assessing the effect of the proteoglycans by MTT assay (3-(4, 5-dimethylthiazol-2-yl)-2, 5-diphenyltetrazolium bromide). Significant cytotoxic effect of 73% cell death was observed for 100  $\mu\text{g}/\text{ml}$  treated sample.



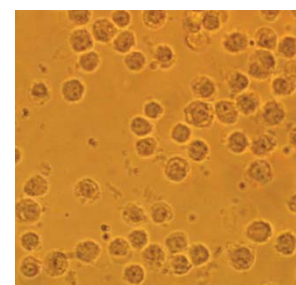
Control cells



25 µg/ml treated cells



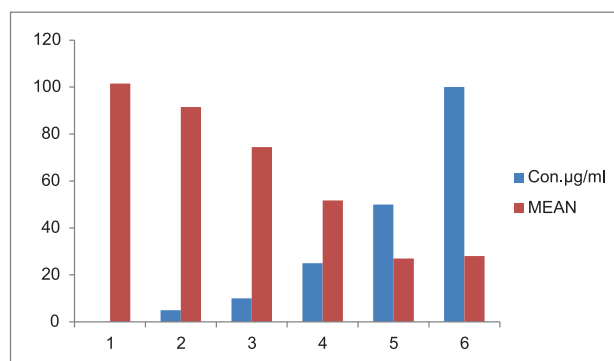
50 µg/ml treated cells



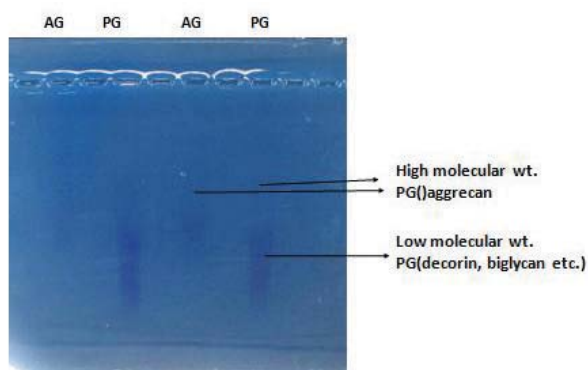
100 µg/ml treated cells

Cell cytotoxicity activity of proteoglycans extracted from *Scolidon* sp. on MCF - 7 cell lines

Proteoglycans were extracted from *Scolidon* spp. cartilage and their anti-proliferative activity against MCF-7 cell lines was evaluated. Cytotoxicity effect was determined by assessing the cytotoxic effect of the proteoglycans by MTT assay (3-(4, 5-dimethylthiazol-2-yl)-2, 5-diphenyltetrazolium bromide). Different concentrations such as 0, 5, 10, 25, 50 and 100 µg/ml were used for assessing anti-proliferative effect. Significant cytotoxic effect of 73% cell death was observed for 100 µg/ml treated sample.



Anti-proliferative activity against MCF - 7 cell lines. Different concentrations such as 0, 5, 10, 25, 50 and 100 µg/ml were used for assessing anti-proliferative effect



Agarose gel electrophoresis pattern of proteoglycans extracted from shark cartilage

For characterization of proteoglycans extracted and isolated from deep sea shark *Echinorhinus brucus*, a composite agarose/acrylamide gel based on its molecular weight was used. Cartilage tissue was extracted with 4 M guanidine-HCl, dialyzed against 6 M urea and freeze dried. Aliquots were electrophoresed directly into a composite gel.

### Studies on vanillic acid-grafted chitosan

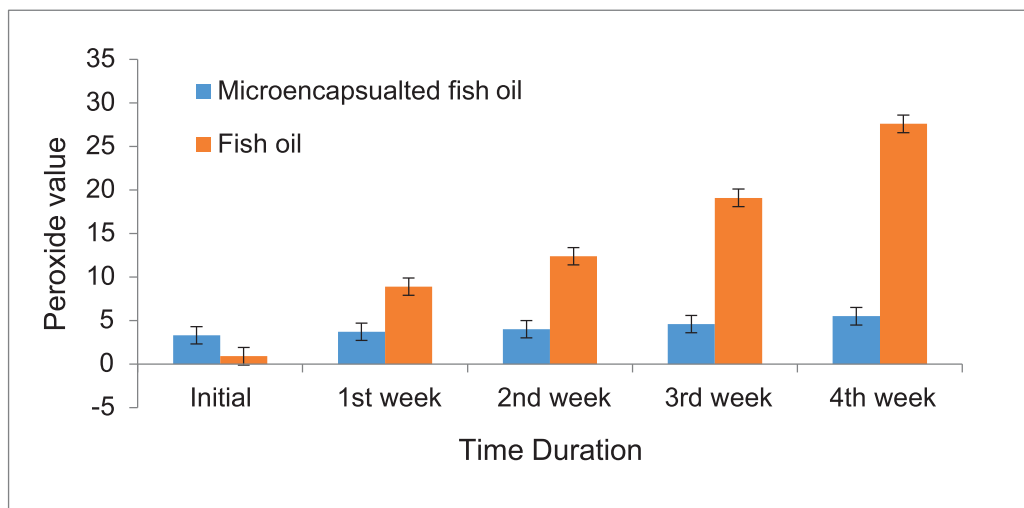
Vanillic acid-grafted chitosan alone showed significant emulsification ability. Emulsion stability index of chitosan and vanillic acid-grafted chitosan were determined.

#### Emulsion Stability Index of chitosan and vanillic acid-grafted chitosan

*In vitro* digestibility of the fish oil-loaded microparticles in terms of the amount of free fatty acid released from the emulsion by pancreatic lipase was 51.824 µmol/ml.

The encapsulated oil is little susceptible to lipid peroxidation as evidenced by the peroxide value of below 5 mmol/kg oil at the end of the 28<sup>th</sup> day compared to 27.6 mmol/kg oil for the un-encapsulated oil.

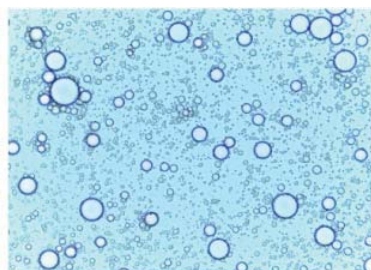
Concentration (%)	Emulsion Stability Index	
	Chitosan	Vanillic acid grafted chitosan
1.00	30.5	69.67
0.50	30.25	112.00
0.25	72.10	132.32



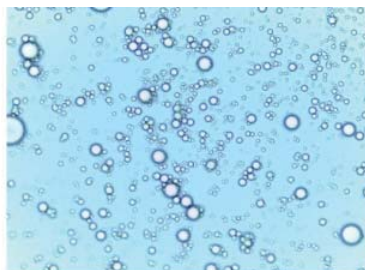
Peroxide value of sardine oil and microencapsulated sardine oil powder

### Development of sardine oil in water emulsion

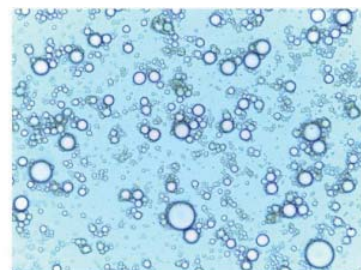
Sardine oil in water emulsion using vanillic acid-grafted chitosan and 0.1% Tween-20 as an emulsifying agent was developed. 0.1% Tween-20 showed best emulsion stability as evenly distributed small droplets without much coalescence were observed under light microscope. Yield of microencapsulated fish oil powder obtained by spray drying was 75%, moisture content was 2%, the mean particle size of fish oil powder was 551.4 nm and encapsulation efficiency of the spray dried powder obtained was 84.3%.



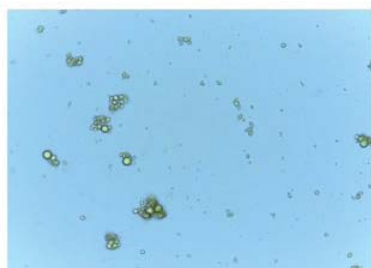
1.3% VAC + 5% Tween-20



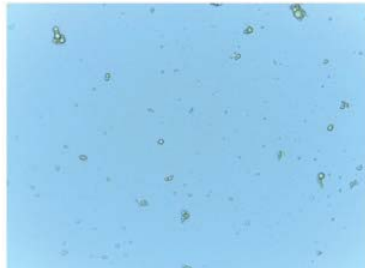
1.3% VAC + 2% Tween-20



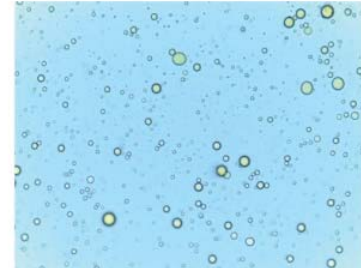
1.3% VAC + 1% Tween-20



1.3% VAC + 0.5% Tween-20



1.3% VAC + 0.25% Tween-20



1.3% VAC + 0.1% Tween-20

Emulsion stability observed under light microscope



## Department of Biotechnology (DBT) Projects

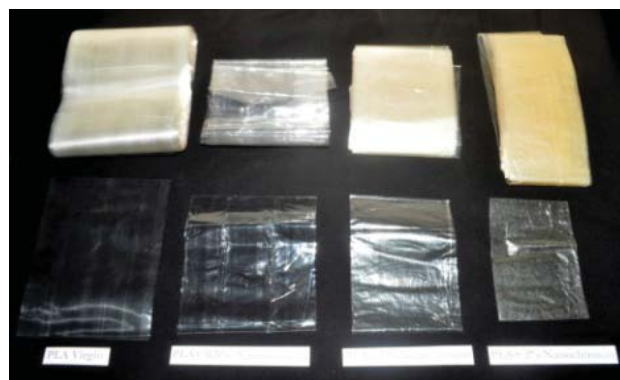
### Development of bioplastic based sustainable nano-biocomposite food packaging - "Sustain Nano-Pack"

#### Development of biodegradable nano composite

Biodegradable nano composite antimicrobial films was developed using nanochitosan (NC) (0.5, 1 and 2%) with polylactic acid (PLA) by solvent casting method. Oxygen and water vapour transmission of films with 0.5% nanochitosan was superior compared to other films. PLA/NC films showed antimicrobial properties against aerobic micro organisms. Quality of prawns (*Fenneropenaeus indicus*) packed in biodegradable film with 1% NC exhibited better keeping quality under chilled storage condition.



Virgin PLA and PLA/nanochitosan cast films in different concentrations



Virgin PLA and PLA/nanochitosan blown films in different concentrations



Virgin PLA and extruded granules of PLA/nanochitosan in different concentrations

#### Biodegradable films

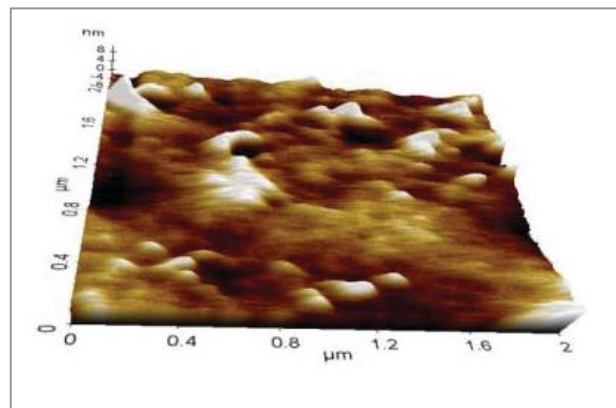
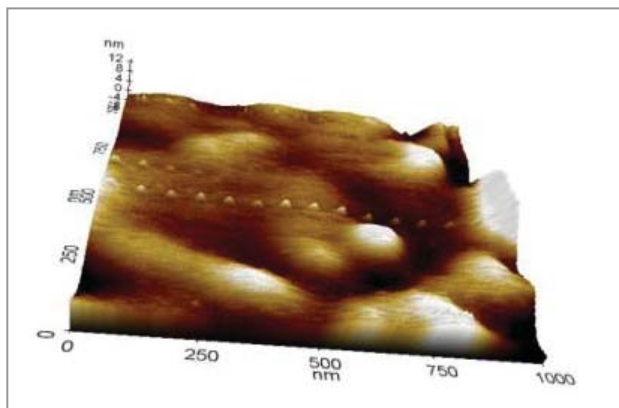
Biodegradable films incorporating nanoclay, montmorillonite (MMT) at 0.5, 1 and 2% with polylactic acid (PLA) was developed to enhance the properties of the film. PLA/MMT films provided better mechanical properties when compared to virgin PLA film. The films developed had good antimicrobial activity against food pathogens. Fresh fish packed with the developed film retained better microbial and biochemical quality in different PLA/nanoclay films compared to virgin PLA and LDPE films.

Packaging films prepared with nanochitosan (0.5%, 1.0% and 2.0%) and Polylactic acid (PLA) were evaluated for extension of chilled storage life of peeled and deveined *Litopenaeus vannamei*. Microbiological indices like Aerobic Plate Count, Enterobacteriaceae count, *Pseudomonas*



Virgin PLA, nanoclay and extruded granules of PLA/MMT in different concentrations

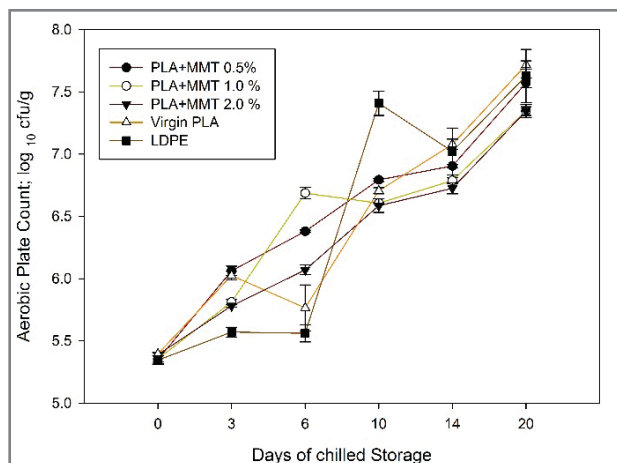




AFM images of virgin PLA and 1% PLA/MMT films

count and *Brochothrix thermosphacta* count were monitored for entire duration of storage life. Although incorporation of 1% nanochitosan reduced growth of most of the spoilage flora, no significant difference was observed among microbial indices of samples with different packaging films. Incorporation of higher concentration of nanochitosan with PLA was found to distort the film characteristics and thereby accelerate spoilage during chilled storage.

In another study, packaging films prepared with nanoclay MMT (0.5%, 1.0% and 2.0%) and PLA were evaluated for extension of chilled storage life of Mahi Mahi (*Coryphaena hippurus*) fillets. The acceptable limit of  $10^7$  cfu/g APC crossed on 9<sup>th</sup>, 14<sup>th</sup>, 15<sup>th</sup> 16<sup>th</sup> and 15<sup>th</sup> day of chilled storage for virgin LDPE, virgin PLA, PLA+MMT 0.5%, PLA+MMT 1.0% and PLA+MMT 2.0%, respectively. Lower increment in Enterobacteriaceae count, Pseudomonas count and *B. thermosphacta* count were observed in PLA+MMT 2.0% films compared to other films.



Extension of chilled storage life of Mahi Mahi

### Genetic diversity of *Clostridium botulinum* in seafoods and development of Lateral Flow Immuno Assay (LFIA) for toxinotyping

Surveys were undertaken in major cities in India to collect various packed fish products for *C. botulinum*



Fish and fish products screened

*C. botulinum* colonies on TSGY agar

contamination. A total of 94 food samples comprising of ready to eat (23), ready to cook (49) and fresh fish samples (22) from retail outlets and super market of major cities in India including Kochi, Bengaluru, Chennai, Veraval, Mumbai, Visakhapatnam and Delhi were screened. Eight fish product samples were found to be positive in mouse bioassay and showed protection in toxin neutralization tests. Efforts are being made to isolate *C. botulinum* from positive samples and to determine the genetic biodiversity of the food-borne

pathogen *C. botulinum*. Typical *C. botulinum* colonies on TSGYA exhibited surface iridescence (pearly layer) covering both the zone of precipitation and the halo of clearing around the colony as seen by reflected light. Out of 190 presumptive *C. botulinum* isolates eight were confirmed positive and nine were toxic in mouse bioassay. Mouse bioassay and 16S rRNA sequence analysis of two samples confirmed them as *C. botulinum* Type B.



### Department of Science and Technology (DST) Project

#### Food safety interventions for women in fishery based micro-enterprises in coastal Kerala

Under the project nine self help groups from three coastal districts of Kerala viz; Ernakulam, Alappuzha and Kasaragod were selected. The quality of seafood procured from microenterprise units were analyzed by physical, chemical and microbiological parameters and it was found that the quality can be improved by adopting scientific practices. The hygiene and sanitary conditions of the microenterprise units were evaluated using traditional methods and using modern hygiene monitoring system. Under the project an initiative was made to study the formation of biofilms in fish contact surfaces like weighing balance and basins used in the microenterprise units. The heavy metal contaminations in fishes collected from microenterprise units were also studied. Awareness campaigns were conducted on the importance of hand hygiene in seafood processing and food-borne diseases and on food-borne illness, preventive measures and treatment. A survey and training was also conducted on 'Hygiene and sanitation' under the project. The study could introduce improvements in the existing practices for ensuring quality and safety of seafoods handled by the microenterprise units through better scientific and management practices. A strategy for developing policy decisions in food safety by augmenting the role of women in fisheries for assuring quality could be formulated



Dr. Femeena Hassan, Principal Investigator of the project interacting with the stakeholders



### Ministry of Food Processing Industries (MoFP) Project

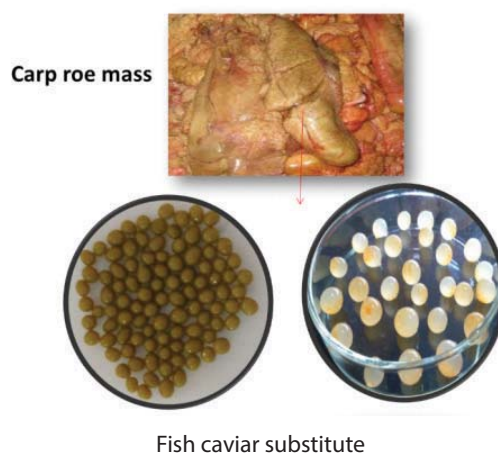
#### Use of natural resins and gums for preservation and value addition of fishery products

Ready to eat foods, a high satiety shrimp flavored jelly noodles was developed by cold gelation method. Microbiologically the shelf life of jelly noodles was estimated to be 17 days. Texturally, the jelly noodles exhibited a low hardness value which was attributed to its soft and gel like texture. The springiness of jelly noodles was low which indicates that the gel is soft and breaks down easily during mastication while the adhesiveness values indicated that the noodles were less sticky.



Ready to eat jelly fish noodles

Fish caviar substitute was formulated by reconstituting dehydrated carp roe by reverse spherification technique. The caviar mimetic was shelf stable under chill storage for a period of 16 days after which deteriorative changes were observed. The addition of oregano extract retarded lipid oxidation process in the beads. However textural data revealed that the beads were much softer compared to control beads. Structural characterization was done using Scanning Electron Microscopy of the freeze dried beads which indicated presence of a honey-comb like structure in control beads which was absent in oregano extract treated beads attributing to the lower hardness in oregano extract treated beads.

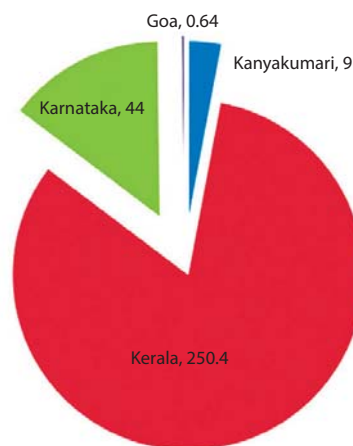


### Coconut Development Board (CDB) Project

#### Techno-economic feasibility of coconut wood canoes for small scale fisheries sector in the south west coast of India and Lakshadweep

##### Assessment of availability of coconut wood for boat building in the south west cost of India

A study was carried out in the states of Tamil Nadu (Kanyakumari district), Kerala, Karnataka and Goa for assessing availability of coconut wood. After assessing availability of coconut wood a multi-stage random sampling design was used for selection of the regions for undertaking the survey. The survey revealed that among these states, the availability of aged (above 60 years) coconut palms was maximum in Kerala and lowest in Goa. In Karnataka religious beliefs prevent people from culling coconut palm. The total quantity ( $m^3$ ) of coconut wood available from the total numbers of available palms (123.86 lakh palms) is about 37.16 lakh  $m^3$ .



Total number of >60 year palms (In lakhs)

##### Dimensional stability and mechanical properties of treated and untreated coconut wood

The dimensional stability was measured by estimating water absorption (WA), volumetric swelling coefficient (S), anti-swell efficiency (ASE) and water repellency effectiveness (WRE) as per Rowell and Elis 1978. The WA of CCB treated panels were slightly lower than that of untreated panels, while dual preservative treatment improved the WRE and ASE. Analysis of compressive stress at maximum load (CS at ML) showed that no significant difference existed between the treated (CCB and CNSL) and control samples. The samples treated with CCB+CNSL showed 28% increase in the CS at Maximum Load.



### Water absorption (WA), Volumetric swelling coefficient (S), Anti-swell efficiency (ASE) and Water repellency effectiveness (WRE) of coconut wood panels

Treatment	WA (%)	S (%)	WRE (%)	ASC (%)
Control (untreated)	30.89 ± 2.64	14.58 ± 3.44	—	—
CCB	27.39 ± 1.64	10.74 ± 1.60	11.33 ± 5.30	23.61 ± 11.07
CNSL	15.04 ± 2.35	11.14 ± 1.86	51.3 ± 7.62	26.32 ± 12.78
CCB+CNSL	15.77 ± .538	10.39 ± 1.61	48.95 ± 1.74	28.77 ± 10.82

### Bioaccumulation of CCB and CCA in *Oreochromis mossambicus*

The Bio Concentration Factor (BCF) for copper, chromium, arsenic and boron in various tissues viz. liver, gills, gonads and muscle of *Oreochromis mossambicus* exposed to different treatment type showed that BCF of boron is low compared to the other metals like Cu and Cr. In both CCA and CCB treated panels, the high accumulation of Cu and Cr was observed in fish muscle and the observed pattern was liver > gonad > gill > muscle. The concentration of boron present in the fish sample exposed in CCB treated panels were in the following pattern, liver > gonad > gill > muscle.



Dissected *Oreochromis mossambicus*

### Construction of canoe and initiation of field trials

Two canoes of dimensions 9.0 m L<sub>OA</sub>, 1.50 m breadth and 0.70 m depth were constructed for gillnetting, seining etc. for the artisanal sector. The canoes were handed over to Kannamali-Cheriakadavu Fisheries Development Welfare Co-operative Society and Chellanam-Kandakkadavu Fisher men Welfare Co-operative Society for conducting field trials.



Dignitaries in coconut wood canoe



Coconut wood canoe under field testing

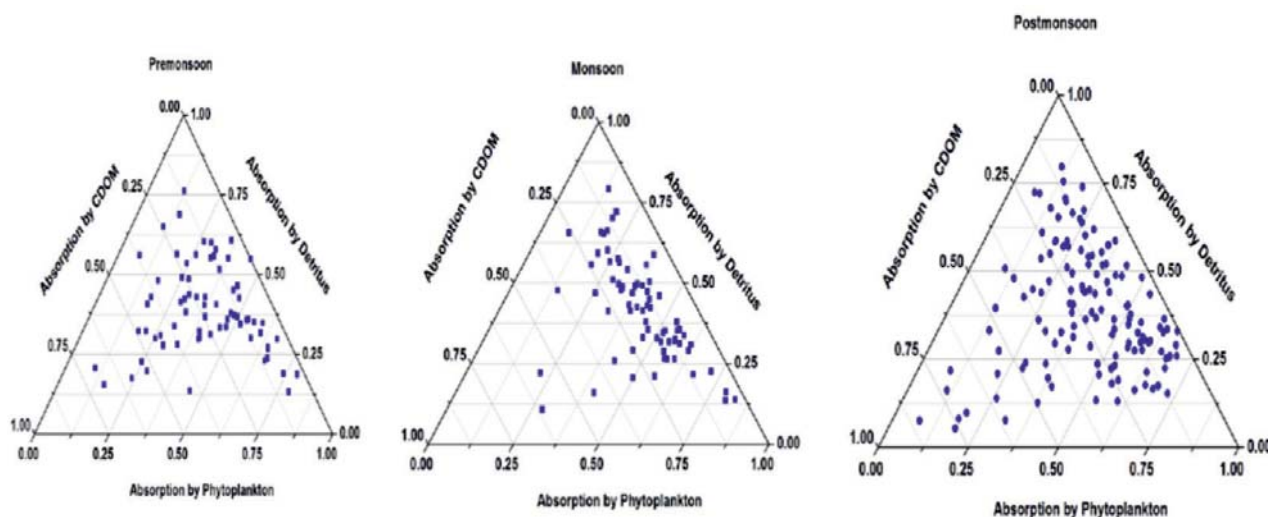




## Retrieval of phytoplankton biomass and associated optical constituents based on long term bio-optical studies

### Absorption of optically active substances along offshore waters of Kochi

The contribution of Optically Active Substances (OAS) towards total absorption was analyzed for the pre and post monsoon seasons. The contribution of CDOM was less than 25% towards total absorption which increased to 25-100% during the post-monsoon season. CDOM, phytoplankton and detritus contributed equally to the total absorption during the pre-monsoon season. Reduced concentration of CDOM during monsoon was due to the diluted terrigenous flux and an elevated concentration of CDOM during post-monsoon was due to the freshwater discharge, disintegration of chlorophyll-a, and resuspension of sediments.



Ternary diagram representing percentile contribution of CDOM, detritus and phytoplankton to total absorption in pre-monsoon, monsoon and post-monsoon

### Inter-annual variability of chlorophyll-a along off-shore waters off Kochi

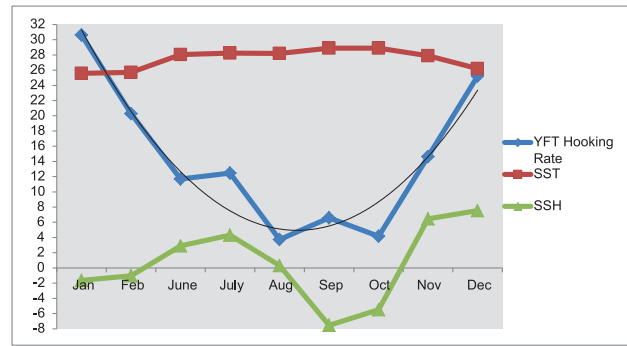
Chlorophyll-a variation along the off-shore waters off Kochi was analyzed for a period of five years. A polynomial trend line was derived.

## Validation of tuna advisories off east coast

### Impact of Sea Surface Temperature (SST) and Sea Surface Height anomaly (SSHa) on Yellowfin tuna catch

SST and SSHa were most important environmental parameters used by long line fishermen to locate good fishing areas. Pelagic fish such as Yellowfin tuna (*Thunnus albacores*), skipjack tuna (*Katsuwonus pelamis*), striped marlin (*Tetrapturus audax*) and swordfish (*Xiphias gladius*) have preferences for waters with certain temperature range. SST data were generated from Advanced Very High Resolution Radiometer (AVHRR) sensor on-board the National Oceanic and Atmospheric Administration (NOAA-18 and 19) and Metop1 and 2 satellites and SSHa data generated from JASON satellite. Both SST and SSHa were collected and distributed by Indian National Centre for Ocean Information Services (INCOIS), Hyderabad. The hooking rate of Yellowfin tuna from 2012 and 2013 were cumulated to monthly means of January to December. The hooking rates of Yellowfin tuna were very high during December to February.

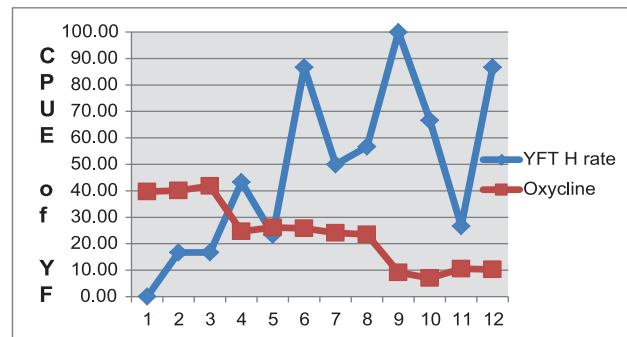
Low CPUE values were observed mainly during August to October. Most of the catches were observed when Sea Surface Temperature is between 25 °C to 29 °C and SSHa were -8 Meters to +8 Meters. Highest hooking rate of Yellowfin tuna were observed when Sea Surface Temperature between 25 °C to 27 °C and SSHa between -1 to -2 Meters and 6 to 8 Meters.



Correlation of Yellowfin tuna catch with SST and SSHa

### Impact of oxycline depth on Yellowfin tuna

SSH and Oxycline Depth were collected and distributed by Indian National Centre for Ocean Information Services (INCOIS), Hyderabad. The hooking rate of Yellowfin tuna (*Thannus albacares*) were measured based on the distance (in meters) between hooking depth and oxycline depth. The hooking rate of Yellowfin tuna was inversely proportional to the oxycline depth. When the distance between hooking depth and oxycline was more, the hooking rate was less and *vice versa*. At 35 to 45 meter of distance between hooking depth and oxycline depth, the hooking rate was 10 to 26 individuals per 1000 hooks. When the distance between hooking depth and oxycline depth was 9 to 11M, the hooking rate of Yellowfin tuna was found to be 40 to 100 individual per 1000 hooks.

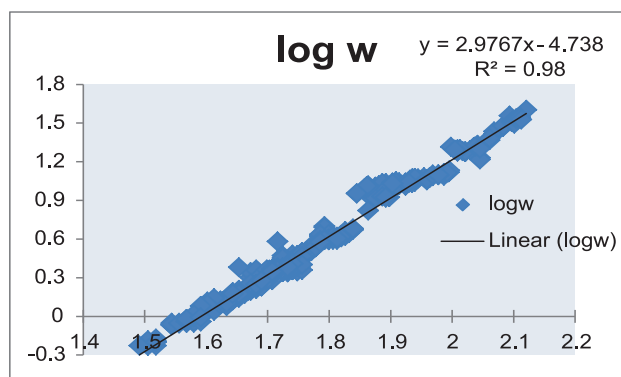


Correlation between Yellowfin tuna hooking rate and oxycline

### Length and weight relationship of Yellowfin tuna

Pooled length frequency distribution of 458 nos. Yellowfin tuna (*Thannus albacares*) individuals collected during June, 2015 to March, 2016 from commercial hook and line operators in and around Visakhapatnam coast were analyzed for length and weight relationship. The fork length (FL) ranged between 310 mm to 1320 mm with a mean fork length of 610.19 mm for total fish sampled. Length frequency histogram showed that more than 50% (232 individuals) belonged to the size of 440 mm to 570 mm.

The weight ranged between 589 g to 36,090 g with a mean weight of 5,380 g. The length and weight relationship was represented by potential equation  $W=0.0002384 L^{2.9896}$ .  $R^2=0.9516$  whose log-transformed version is  $r=0.98$ . Here "a" value is 0.0002384 and b value of Yellowfin tuna was 2.9896 which showed that the value is >3 indicating a slight tendency to negative allometric growth.



Log transformed data of Yellowfin tuna

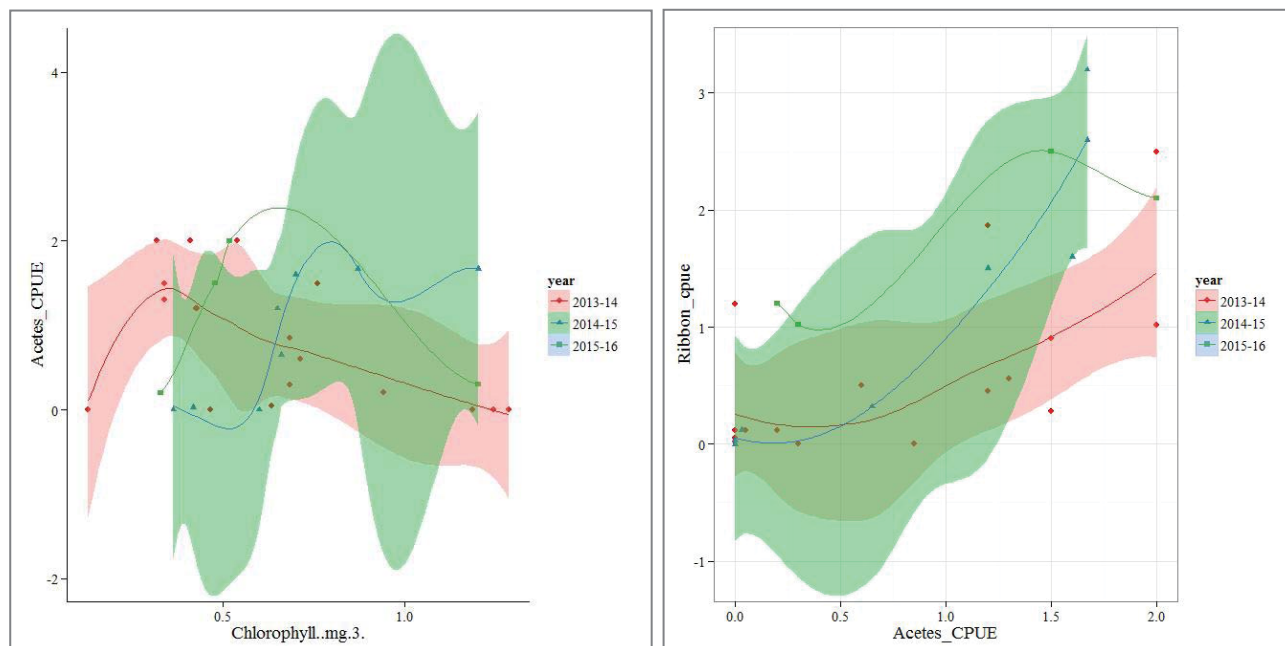


Measurement of length / weight at fishing harbour

### Studies on the ecological linkages between plankton production and *Acetes* sp. abundance along Gujarat coast

The relationship between *Acetes* sp. abundance, chlorophyll and nutrients along coastal waters off Veraval was analyzed by utilizing the data for three years (2013-2015) using GLM. The concentration of chlorophyll and temperature were significantly ( $p < 0.05$ ) correlated with the abundance of *Acetes* sp.

The analysis of gut content in major commercial species showed that digested material, followed by *Acetes* sp. contributed the most (in terms of weight). Out of the 12 species studied, 10 had substantial quantities of *Acetes* in their guts. There was significant correlation between the CPUE of *T. lepturus* and *O. cuvieri* catches.



### Indigenous traditional knowledge (ITKs) in marine fisheries sector of Kerala: Documentation and analysis

#### Desk study

Desk-based review of literature on Indigenous Traditional Knowledge (ITK) in agriculture and fisheries was conducted to get an understanding of the general folklore and ITK of agricultural and fishing sectors and the approaches and methodology to be followed for documenting ITKs.

#### Field survey and field level workshops

Based on the pilot survey in Ernakulam and Thrissur districts, interview schedules were prepared with open ended questions. The schedule included the following aspects: Characteristics of the respondent; Details regarding fishing systems; Indigenous ecological knowledge about fish catching and their availability; Influence of physical and chemical parameters on fish availability; Prediction of natural hazards and Beliefs and practices. During the period 2015-2016, field level surveys were conducted in five coastal districts of Kerala viz.; Ernakulam, Thrissur, Alappuzha, Kollam and Kozhikode. Key informant interviews, focus group discussions and snow balling techniques were used to collect data. Six field level workshops in Ernakulam, Thrissur and Alappuzha districts were also conducted as a part of documentation and dissemination of indigenous traditional knowledge in marine fisheries sector of Kerala. Major ITKs with reference to fishing craft and gear, currents and winds, tides,



fish shoal identification, stars and constellations and climate were documented through field surveys and field level workshops.



Data collection Indigenous traditional knowledge in marine fisheries





## UNDP-Global Environment Facility Project

### Demonstration and field testing of bycatch reduction and juvenile excluder devices along Sindhudurg district, Maharashtra

#### Training and awareness programmes

A total of 27 programmes were conducted which included the training on fabrication of square mesh codends and awareness on reduction of bycatch during trawling operations. A total of 347 fishermen including vessel owners and community leaders attended the programmes.



Training in square mesh fabrication

#### Comparative experiment trials



Location of experimental fishing carried out onboard commercial trawlers

A total of 140 and 141 experimental hauls using diamond and square mesh codends, respectively were carried out on-board commercial trawlers along Sindhudurg District. The average CPUE in the square mesh codend was 18.0 kg/h and the escapement from the codend was 3.18 kg/h with a normalized value of INR 7.0. The value of the total escapement during a day (3 hauls) was calculated as INR 210.

#### Distribution of square mesh codends

Fabricated square mesh codends were distributed to all trawlers (Total - 317 nos.) operating in the region and more than 50% of the trawlers are using square mesh codends in the region.



## National Fisheries Development Board (NFDB) Project

### National surveillance programme for aquatic animal diseases

Baseline data were collected from 62 farms and fish disease surveillance was carried out in these farms. In 406 finfish samples, gills, kidney and spleen were screened for OIE (World Organization for Animal Health) listed viruses KH Virus and SVC Virus and all the samples were negative. In 138 shellfish samples, hepatopancreas, pleopod and gills were screened for OIE listed viruses White Spot Syndrome Virus, Hepatopancreatic Parvo Virus, Monodon Baculo Virus, Infectious Hypodermal Haematopoietic Necro Virus, Yellow Head Virus and TSV by nested PCR as recommended by OIE, 32 samples were positive for WSSV, eight samples were positive for MBV, four samples were positive for HPV. YHV and TSV could not be detected in any of the samples.

Surveillance was carried out for diseases such as Enterocytozoon Hepatopenaei and Acute Hepato Pancreatic Necrosis Disease by PCR assay and histopathological tests. 126 Shrimp samples were collected from 18 farms located at Thrissur and Alappuzha districts and screened for EHP and AHPND. All the farms selected were free from EHP and AHPND. The water quality parameters of all the selected farms were analyzed.

Five disease outbreak cases (one fish farm and four shrimp farms) were investigated and the cause of the disease was determined by microbiological and molecular techniques and also by testing water quality parameters. In two shrimp farms, only WSSV infection was found, combined infection with WSSV+HPV was found in one farm and the fourth farm was infected with *V. parahaemolyticus*. In a finfish farm, the etiological agent was identified as *A. veronii*. Advisories were given to farmers to combat the outbreak. By the interventions made in these farms, farmers were saved from severe financial crisis.

Out of total 46 imported fish/ shellfish samples tested, 25 frozen finfish were tested for the presence of OIE listed viruses SVCV and KHV and 21 shellfish samples were tested for WSSV, MBV, HPV, IHNV, YHV and TSV. All finfish samples tested were free from SVCV and KHV. Among the 21 shrimp samples tested, two *L. vannamei* samples were positive for YHV, three frozen shrimp samples were positive for WSSV and one frozen shrimp sample was positive for MBV. The genotype of YHV was identified by OIE protocol and by sequencing as genotype I.

Two awareness meetings were conducted at Ernakulam and Thrissur districts for sensitization of farmers about the various farm management practices and different fish and shrimp diseases in aquaculture. A total of 49 farmers attended the programme and actively participated in the group discussion.



## ICAR-National Fellow Project

### Biomodulation of marine biopolymers for the preparation of biomaterials of healthcare importance

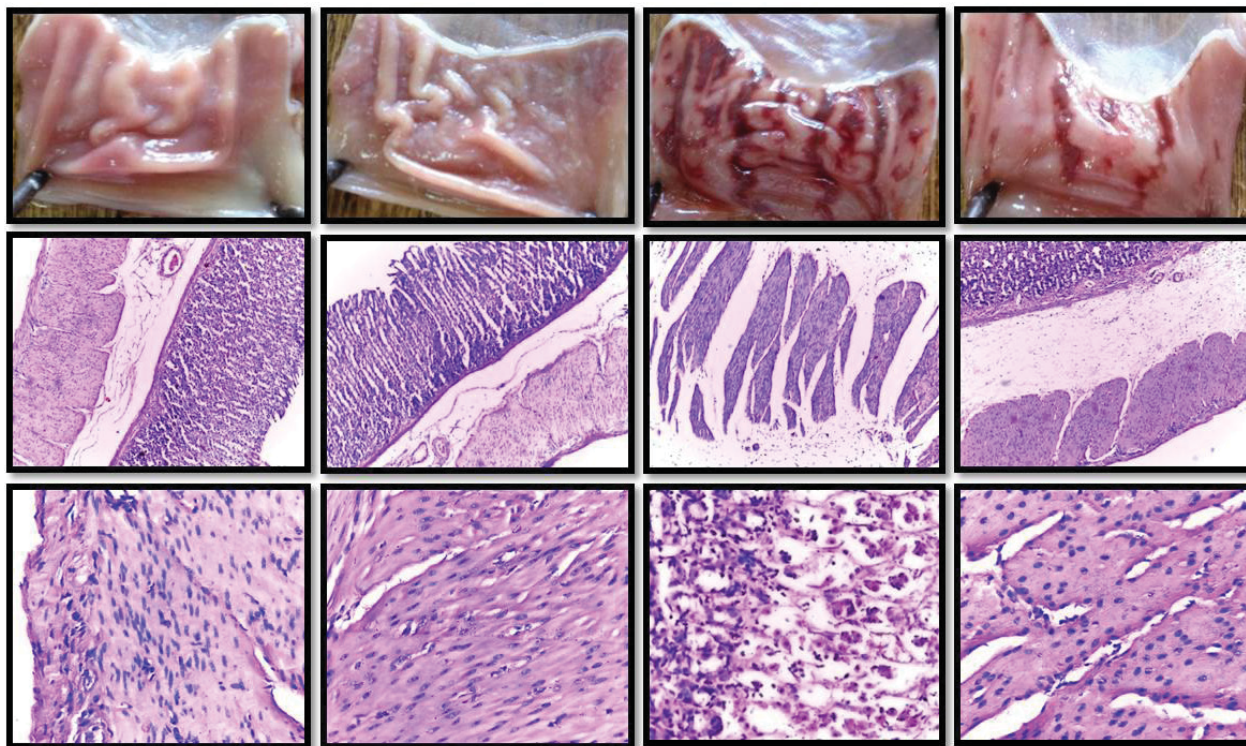
#### Biochemical characterization of collagen extracted from air bladder of striped catfish

An efficient method has been developed for the extraction of pure acid soluble collagen (ASC) from the air bladder of the fish *Pangasianodon hypophthalmus* and the collagen isolated belongs to Type I collagen, comprising of two different  $\alpha$  chains ( $\alpha_1$  and  $\alpha_2$ ). The amino acid profile of ASC contains 258 glycine residues/1000 residues, which is similar to that of bovine collagen i.e., 257 residues/1000 residue.



### Anti-ulcer activities of fish collagen against ethanol-HCl induced peptic ulcer in rats

In ulcer-induced collagen treated group of rats, partial resistance to denudation of the mucosal layer was observed which might be due to the protective effect of collagen supplementation. Gross pathology and histopathological evaluation of gastric lesions in peptic ulcer-induced experimental rats is depicted in Figure.



A. Normal control

B. Collagen control

C. Ulcer

D. Ulcer + Collagen

Gross pathology and histopathology of gastric lesions in peptic ulcer-induced experimental rats

### Development and characterization of chitosan-based composite films

Chitosan, chitosan/Zinc acetate, chitosan/chondroitin sulfate, chitosan/chondroitin sulfate/Zinc acetate films were developed. FTIR spectra showed characteristic peaks of chitosan such as -OH, -NH stretching and, -CO stretching, etc.

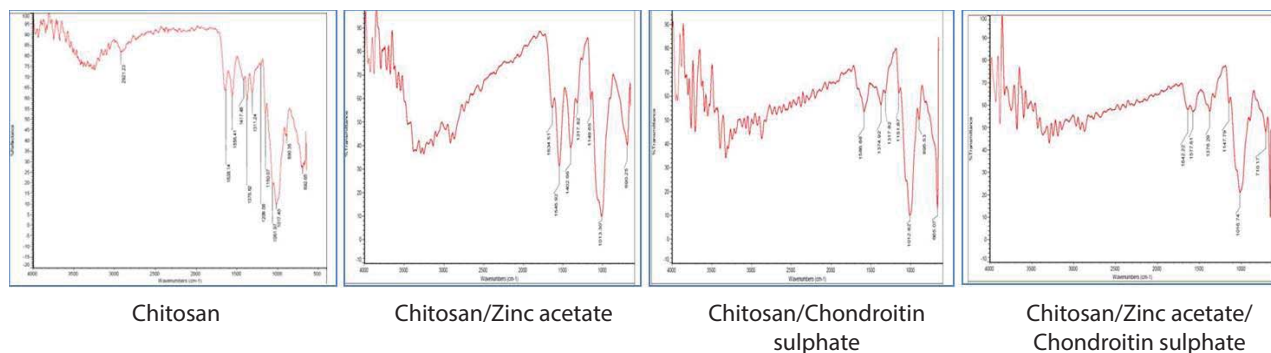


Chitosan

Chitosan/Zinc acetate

Chitosan/Chondroitin  
sulphateChitosan/Zinc acetate/  
Chondroitin sulphate

Chitosan-based films



FTIR spectra showing characteristic peaks of different combinations of chitosan films

The films were subjected to bioavailability studies in Wistar albino rats with incision wounds. No visible signs of tissue damage or inflammation were observed after two weeks.

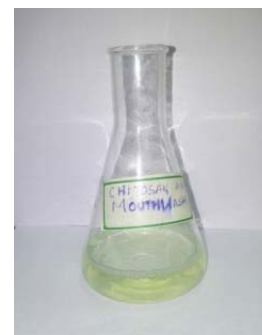


Chitosan/ Zinc acetate /chondroitin sulphate films were inserted into the dorsal part of the Wistar rats by making 1cm incision on skin (Upper panel). No visible signs of tissue damage or inflammation were observed after two weeks (Lower panel)

### Development of chitosan-incorporated mouthwash

Chitosan-incorporated mouthwash was developed using chitosan (2.5%), hydroxyapatite (1%), ethanol (30%), salt (1%), glycerin (0.25%), mannitol (0.5%), Arabic gum (0.2%), menthol (1.5%) and (63%) distilled water.

Chitosan-incorporated mouthwash



### Development of chitosan-assimilated ointment



Chitosan-incorporated ointment

An ointment was developed using chitosan as base. The product contains chitosan of 2.5%, silver nitrate (0.1%) and a crosslinking agent Sodium tripolyphosphate (0.01). Further standardization of the product is in progress.





## National Bank for Agriculture and Rural Development (NABARD) Project

### Assessing of role and impact of fisheries cooperatives in enhancing the livelihood and resource management capabilities of fisherfolk in India

The project was initiated in September, 2015 with the major objectives of identification of roles played by fisheries co-operatives in marine fisheries sector; quantifying the impact of fishery co-operative schemes for input delivery and marketing on the stakeholders; determining the factors affecting the performance of fishery co-operatives and documenting success stories in the fisheries co-operative sector. The project is being implemented in two states - Kerala and Tamil Nadu.

#### Field Visits

Preliminary visits were undertaken to establish linkages with Kerala State Co-operative Federation for Fisheries Development Ltd. (Matsyafed), Manasseri Fishermen Development Welfare Co-operative Society Ltd., Chellanam-Kandakadavu Fishermen Development Welfare Co-operative Society Ltd., Nagapattinam District Fishermen Development Societies Federation, Nagapattinam and Kandakadavu Padasekharams. Field visits were undertaken to Tharangambadi, Nagore and Vellappallam of Nagapattinam district in Tamil Nadu as well as Chellanam and Kandakadavu of Ernakulam district and Kodungallor of Thrissur district in Kerala.

#### Pilot Study

A pilot study has been conducted to moderate the questionnaire. During the pilot study it has been observed that the fishermen cooperatives play an important role in the life of fisherfolk. Members of the Co-operative Societies revealed that there is a positive change in their life after becoming a member of the Co-operative Society. Members of the societies in both states largely depend on Co-operative Societies for credit facilities which is one of the major input for their livelihood.



# GENERAL INFORMATION



## Publications

### Papers Published in Refereed Journals

- Ajeeshkumar, K.K., Visnu, K.V., Remya Kumari, K.R., Navaneethan, R., Asha, K.K., Ganesan, B., Chatterjee, N.S., Anandan, R. and Suseela Mathew (2015) – Biochemical composition and heavy metal content in selected marine fish from the Gulf of Mannar, India, *Fish. Technol.*, **52(3)**: 164-169.
- Anandan, R., Chatterjee, N.S., Sivakumar, R., Suseela Mathew, Asha, K.K. and Ganesan, B. (2015) – Dietary chitosan supplementation ameliorates isoproterenol-induced aberrations in membrane-bound ATPases and mineral status of rat myocardium, *Biol. Trace Elem. Res.*, **15**: 103-109.
- Anandan, R., Senthil Kumar, S.H., Sumi, E.S., Suseela Mathew and Ganesan, B. (2015) – Protective effect of L-glutamine on lysosomal integrity in isoproterenol-induced myocardial infarction in rats, *Acta Biologica Szegediensis*, **59(2)**: 205-209.
- Anbu Rajan, L., Meena, L., Raghavan, R.V., Sridhar, D., Toms C. Joseph, Vinithkumar, N.V., Dharani, G., Dheenan, G.P.S. and Kirubakaran, R. (2015) – Heterologous expression, purification and phylogenetic analysis of oil-degrading biosurfactant biosynthesis genes from the marine sponge-associated *Bacillus licheniformis* NIOT-06, *Bioprocess Biosyst. Engg.*, doi 10.1007/200449-015-1359-x
- Aneesh Kumar, K.V., Pravin, P., Khanolkar, P.S., Baiju, M.V. and Meenakumari, B. (2015) – Performance assessment of tuna longline fishing in Lakshadweep sea, India, *Fish. Technol.*, **52(4)**: 223-227.
- Aneesh Kumar, K.V., Pravin, P., Khanolkar, P.S., Baiju, M.V. and Meenakumari, B. (2016) – The effect of depth of operation and soaking time on catch rates in the experimental tuna longline fisheries in Lakshadweep sea, India, *Iranian J. Fish. Sci.*, **15(1)**: 597-605.
- Ankur Nagori, Zynudheen, A.A. and Ravishankar, C.N. (2016) – Solar PV based chilled storage system for preservation of fresh fish, *Fish. Technol.*, **53(1)**: 86-88.
- Asha, K.K., Remyakumari, K.R., Ashok Kumar, K., Chatterjee, N.S., Anandan, R. and Suseela Mathew (2016) – Sequence determination of an antioxidant peptide obtained by enzymatic hydrolysis of oyster *Crassostrea madrasensis* (Preston), *Intl J. Peptide Res. & Therapeut.*, doi 10.1007/s 10989-016-9521-0
- Balasubramaniam, S., Charles Jeeva, J. and Ashaletha, S. (2015) – Socio-economic factors influencing technology adoption among fishermen operating motorized fishing craft, *Fish. Technol.*, **52(2)**: 123-129.
- Bijji, K.B., Ravishankar, C.N., Mohan, C.O. and Srinivasa Gopal, T.K. (2015) – Smart packaging systems for food applications: A review, *J. Food Sci. & Technol.*, **52(10)**: 6125-6135.
- Bijji, K.B., Shamseer, R.M., Mohan, C.O., Ravishankar, C.N., Mathew, S. and Srinivasa Gopal, T.K. (2015) - Effect of thermal processing on the biochemical constituents of green mussel (*Perna viridis*) in tin-free steel cans, *J. Food Sci & Technol.* **52(10)**: 6804-6809.
- Bindu, J., Ginson, J., Kamalakanth, C.K. and Srinivasa Gopal, T.K. (2015) – High pressure treatment of green mussel *Perna viridis* Linnaeus, 1758: Effect on shucking and quality changes in meat during chill storage, *Indian J. Fish.*, **62(2)**: 70-76.
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- Leela Edwin and Dhiju Das, P.H. (2015) – Technological changes in ring seine fisheries of Kerala and management implications, ICAR-CIFT, Kochi, 104 p.
- Leela Edwin, Nikita Gopal, Remesan, M.P., Samanta, S. and Sahu, S.K. (Eds.) (2015) – Hilsa fisheries and conservation, ICAR-CIFT, Kochi 111 p.
- Leela Edwin, Remesan, M.P., Baiju, M.V., Pravin, P., Saly N. Thomas, Madhu, V.R., Dhiju Das, P.H. and Vipin, P.M. (2015) – Mechanized marine fishing systems: Tamil Nadu, ICAR-CIFT, Kochi, 84 p.
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- Pravin, P., Remesan, M.P., Madhu, V.R. and Boopendranath, M.R. (2015) – Trawl design developed at CIFT for small and medium mechanized vessels (In Hindi), ICAR-CIFT, Kochi, 108 p.
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- Saly N. Thomas, Leela Edwin, Madhu, V.R., Pravin, P., Baiju, M.V., Remesan, M.P. and Muhammed Sherief, P.S. (2015) – Mechanized marine fishing systems: Maharashtra, ICAR-CIFT, Kochi, 102 p
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### Leaflets

- Eco-friendly hybrid solar drier for hygienic preservation of fish (In Marathi) by Murthy, L.N., Visnuvinayagam, S. and Jeyakumari, A. (2015)
- Insulated fish bags to preserve quality of iced fish and to minimize post harvest losses (In Marathi) by Murthy, L.N., Madhusudana Rao, B., Visnuvinayagam, S. and Jeyakumari, A. (2015)
- Palm impression technique for popularizing hygiene literacy among fish handlers (In Kannada) by Murthy, L.N., Vijayakumar, S., Jeyakumari, A., Vijay, A., Visnuvinayagam, S. and Parvathy, U. (2016)
- Palm impression technique for popularizing hygiene literacy among fish handlers (In Marathi) by Murthy, L.N., Madhusudana Rao, B., Visnuvinayagam, S. and Jeyakumari, A. (2015)
- Eco-friendly hybrid solar drier for hygienic preservation of fish (In Kannada) by Murthy, L.N., Vijayakumar, S., Visnuvinayagam, S., Vijay, A., Jeyakumari, A. and Parvathy, U. (2016)
- Solar dryer: An improved and hygienic method of fish drying (In Hindi and Gujarati) by Renuka, V., Jha, A.K., Sivaraman, G.K. and Remya, S. (2016)
- Nutritional value of reservoir fishes by Renuka, V., Jha, A.K. and Sivaraman, G.K. (2015)
- Determination of proximate composition of seafood by Vimaladevi, S., Navaneethan, R., Divy K. Vijayan, Jaya, P.A., Anandan, R. and Suseela Mathew (2016)
- Electrophoresis technique and its applications by Jayarani, R., Navaneethan, R., Vimaladevi, S., Asha, K.K., Anandan, R. and Suseela Mathew (2016)
- Enterocytozoon hepatopenaei (EHP) and early mortality syndrome by Lalitha, K.V., Toms C. Joseph, Murugadas, V., Ashaletha, S., Ahmaed Basha, K., Shaheer, P., and Akhilnad, P.G., (2016)
- Besides four leaflets in Hindi were published during the period under report.

## Communicating Research Outcome

### Participation in Symposia/Seminars/Workshops etc.

Scientists from the Headquarters and Research Centres participated in several national and international symposia, seminar and workshops. A total of 55 meetings, 44 workshops, 25 seminars, 17 conferences and eight symposia were attended during the past year. Some of the notable events were International conference on 'Natural polymers, biomaterials, IPNs, polyelectrolytes and gels' at M.G. University, Kottayam (10-12 April, 2015), International conference on 'Science and geopolitics of Arctic-Antarctic' at New Delhi (29-30 September, 2015), National conference on 'Biopolymers and green composites' at CBPST, Kochi (9-10 October, 2015), National seminar on 'Emerging trends in food quality and safety' at AAU, Ananad (5-16 October, 2015), First international conference on 'Advances in food science and technology' at Kottayam (20-22 November, 2015), National seminar on 'Bio-prospecting microorganisms of marine environment: Hunt for treasure and pleasure' at K.B. Patil College, Navi Mumbai (8 January, 2016), National seminar on 'Fisheries and aquaculture: Livelihood security, sustainability and conservation' at College of Fisheries, Lembucherra, Tripura (21-22 January, 2016), 2<sup>nd</sup> International symposium on 'Genomics in aquaculture' at ICAR-CIFA, Bhubaneswar (28-30 January, 2016), National seminar on 'Advances in marine natural products and nutraceutical research' at ICAR-CIFT, Kochi (26 February, 2016), National seminar on 'Blue revolution-II: Way Forward' at Mangalore (4-6 March, 2016), and National seminar on 'Seafood safety, trade and management' at CUSAT, Kochi (9-13 March, 2016).

Papers on responsible fishing, nutritional aspects of fish, advancements in processing technologies, techniques for detection and diagnosis of pathogens, quality aspects in fish trade, socio-economic issues etc. were presented by scientists, Technical Officers and Research Scholars of the Institute.

The Scientific meetings were attended by scientists, researchers, policy makers, students, teachers, administrators etc. and productive deliberations were held.

### Training/Awareness Imparted

Sl. No.	Subject	No. of beneficiaries	Venue and date
1.	Employment of eco-friendly fishing gears and preparation of value added products with low cost fish	30	Siltiguda, Odisha (30 March – 1 April 2015)
2.	Molecular characterization of <i>Aeromonas</i> sp. isolated from fish disease outbreak	1	Kochi (1 April - 30 May 2015)
3.	Chitinase from <i>Paenibacillus elgii</i> : Production and purification	1	Kochi (1 April – 30 May 2015)
4.	Modern analytical techniques in Biochemistry	80	Kochi (6-18 April 2015; 16-21 July 2015; 1-11 November 2015; 1-12 December 2015; 1-12 February 2016 & 8-12 February 2015)
5.	Expression and characterization of chitinase from <i>Paenibacillus elgii</i>	1	Kochi (6 April – 5 June 2015)
6.	Characterization of biocellulose from bacteria	1	Kochi (6 April – 5 June 2015)



Sl. No.	Subject	No. of beneficiaries	Venue and date
7.	Characterization of <i>Staphylococcus aureus</i> from aquatic environment	1	Kochi (6 April – 5 June 2015)
8.	Antibiotic resistant bacteria in an aquaculture farm	1	Kochi (6 April – 5 June 2015)
9.	Antibacterial activity of <i>Bacillus</i> and <i>Pseudomonas</i> strains against fish pathogens	1	Kochi (6 April – 5 June 2015)
10.	Characterization of <i>Staphylococcus aureus</i> from aquatic environment	1	Kochi (6 April – 4 July 2015)
11.	Thermal and non-thermal food processing technology	1	Kochi (20 April - 20 May 2015)
12.	Processing, packaging and quality evaluation of food products	2	Kochi (27 January – 22 April 2015)
13.	Post harvest handling and value addition of freshwater fishes	50	Darjula, Uttarakhand (3-4 May 2015)
14.	Square mesh codend fabrication	30	Malvan, Maharashtra (4 May 2015) & Mangrol, Gujarat (12-16 February 2016)
15.	Antioxidant potential of fish protein hydrolystae prepared by pepsin treatment from cobia discards	1	Kochi (5 May – 7 August 2015)
16.	Functional properties of fish protein hydrolystae prepared by pepsin treatment from cobia discards	1	Kochi (5 May – 7 August 2015)
17.	Evaluation of nutrients and functional properties loss during various processing and storage of selected fish species	1	Kochi (5 May - 4 November 2015)
18.	Molecular characterization of <i>E. coli</i>	1	Kochi (13 - 22 May 2015)
19.	Ad-hoc training programme for students from Amity University	2	Visakhapatnam (16 May - 16 June 2015)
20.	Laboratory techniques in microbiological examination of seafood	22	Kochi (1-12 June 2015; 25 September - 5 October 2015 & 1-2 February 2016)
21.	Advances in fish processing technology	7	Kochi (1-20 June 2015 & 23 November 2015)

Sl. No.	Subject	No. of beneficiaries	Venue and date
22.	Food safety interventions for women in fishery based microenterprises	40	Moothakunnam, Ernakulam (5 June 2015)
23.	De-scaling of tilapia using de-scaling machine and solar drying using solar dryers	8	Kochi (7-9 June 2015)
24.	Process engineering in fisheries	5	Kochi (15-26 June 2015)
25.	Preparation of value added fish products	51	Visakhapatnam (16 June 2015), Kochi (20-25 April 2015; 20-22 July 2015; 8-9 December 2015; 29-30 January 2016 & 22-23 March 2016)
26.	Modern food processing technology	15	Kochi (16-30 June 2015)
27.	Modern analytical techniques	15	KVASU, Mannuthy (17 June 2015)
28.	Biochemical quality evaluation of fish and fishery products	12	Kochi (23-26 June 2015 & 23-30 November 2015)
29.	Improved harvest and post harvest technologies	68	Motihari, Purvachamparan, Bihar (24-26 June 2015)
30.	Food processing and packaging technologies	4	Kochi (1-27 July 2015)
31.	Responsible fishing technique for reservoir fisheries	30	Ukai, Surat, Gujarat (2-3 July 2015)
32.	Fishermen interactive session	45	Moothakunnam, Ernakulam (4 July 2015)
33.	Responsible fishing using BRDs	25	Malvan, Maharashtra (6 July 2015)
34.	Prevalence of <i>Edwardsiella tarda</i> in fish and aquatic environments	1	Kochi (6 July – 30 September 2015)
35.	Production of chitin and chitosan	6	Kochi (13-14 July 2015, 30 September – 1 October 2015 & 15-16 October 2015)
36.	HACCP concepts	59	Kochi (13-17 July 2015, 5-9 October 2015 & 8-12 February 2016)
37.	Practical aspects of seafood safety	24	Kochi (14-24 July 2015)
38.	Hygienic handling of fish and preparation of salt cured fish	60	Mangamaripetta, Visakhapatnam (16 July 2015)

Sl. No.	Subject	No. of beneficiaries	Venue and date
39.	Retortable pouch processing of fishery products	20	Kochi (16 July 2015)
40.	Analytical instruments viz. G.C., HPLC and AAS	1	Kochi (16-21 July 2015)
41.	Harvest and post harvest technologies	42	Siltiguda, Odisha (20 July 2015) & Thoubal, Manipur (24-26 February 2016)
42.	Harvest technologies	60	Usgaon, Maharashtra (20 July 2015) & Shrivardhan, Maharashtra (28-30 July 2015)
43.	Development of value added fish products	4	Kochi (20-22 July 2015 & 8-9 December 2015)
44.	Total quality assurance in seafoods	12	Mumbai (21-25 July 2015)
45.	Processing and packaging of food products	6	Kochi (22 July – 13 August 2015)
46.	General protocols and specific isolation techniques for pathogenic microorganisms	4	Kochi (3-7 August 2015)
47.	Hygienic preparation of smoke cured fish employing COFISKI	29	Visakhapatnam (6 August 2015)
48.	Square mesh fabrication	100	Vengurla, Maharashtra (12 August 2015), Malvan, Maharashtra (13 August 2015), Devgad, Maharashtra (14 August 2015)
49.	Hygienic preparation of dry cured fish employing CIFT designed solar fish dryer	80	Kodikallavalasa, A.P. (13 August 2015)
50.	Hygienic handling of fresh and dry fish, sun and solar drying, storage and packaging	14	Veraval (14-18 August 2015)
51.	Microbial analysis of water as per IS: 1622	2	Kochi (19-21 August 2015)
52.	Laboratory techniques in microbiological examination of seafood	19	Visakhapatnam (25 August - 5 September 2015)
53.	Product acceptability studies and awareness	48	Umladkhur village, Meghalaya (27 August 2015) & ICAR Complex for NEH Region, Meghalaya (29 August 2015)
54.	Harvest and post harvest technologies	150	Surampalem village, East Godavari district, A.P. (11 September 2015) & Thoubal, Manipur (24-26 February 2016)

Sl. No.	Subject	No. of beneficiaries	Venue and date
55.	Awareness programme on fish and shellfish diseases	62	Kodungalloor, Thrissur, Kerala (14 September 2015)
56.	Identification of bacteria of public health significance and water analysis	28	Kochi (17-19 September 2015 & 9-11 March 2016)
57.	Analytical techniques in processed food science	15	Kochi (22-24 September 2015)
58.	Production of value added fish products	25	Mysore, Karnataka (23-24 September 2015)
59.	Hygienic handling of fish and preparation of value added fish products	50	Hyderabad (28 September 2015) & Salaya village, Kutch, Gujarat (29 December 2015)
60.	Improvement in 'dolnet' fishery in Maharashtra	30	Arnala, Maharashtra (5 October 2015)
61.	Molecular detection of seafood-borne pathogens	1	Kochi (5-17 October 2015)
62.	Preparation of value added fish products	219	Piravam (21 August 2015), Fathima Matha National College, Kollam (6 October 2015), Adava, Gajapati, Odisha (20-22 January 2016), FRIC, Bengaluru (2-4 February 2016), Vijayapura, Karnataka (25-27 February 2016) & ICAR-DCFR, Dehradun (2-4 March 2016)
63.	Scientific salting and drying of fishes	1	Kochi (7 October 2015)
64.	ISO 22000—HACCP for seafood industry	4	Kochi (7-19 October 2015)
65.	Registration of fishing vessels	12	Kochi (9 October 2015)
66.	Registration of fishing vessels	30	Vypeen, Ernakulam (9 October 2015)
67.	Design considerations for deep sea fishing vessels	15	Kochi (12 October 2015)
68.	Advancements in fishing technology	10	Kochi (12-17 October 2015)
69.	Production of chitin and chitosan	1	Kochi (15-16 October 2015)



Sl. No.	Subject	No. of beneficiaries	Venue and date
70.	Monofilament longlining	10	Kochi (26-30 October 2015)
71.	Square mesh for improvement in 'dolnet' fishery	50	Arnala, Maharashtra (28-31 October 2015)
72.	Seafood quality assurance	14	Kochi (27-30 June 2015) & Veraval (2-7 November 2015)
73.	Employment of eco-friendly fishing gears and preparation of value added fish products	40	Umladthur and Thungbali villages, Meghalaya (16-18 November 2015)
74.	Laboratory quality management system and internal audit as per ISO: 17025: 2005	8	Kochi (18-21 November 2015)
75.	Trends in harvest and post harvest fisheries	30	ICAR Res. Complex, Barapani, Assam (20 November 2015)
76.	Sanitation and hygiene	20	Edappally and Tripunithura (28 November 2015, 1 December 2015 & 18 December 2015)
77.	Quality management	15	Kochi (1-3 December 2015)
78.	Fishery byproducts, prawn shell powder, chitin, chitosan and glucosamine hydrochloride	2	Kochi (11-26 December 2015)
79.	Value added fish products and harvesting of fish employing eco-friendly gear	22	Tajangi, Visakhapatnam (15 December 2015)
80.	Merits and demerits of square mesh codends	200	SIFT, Kakinada (15-16 December 2015) & Visakhapatnam (18-19 December 2015)
81.	Analysis of PAH and amino acids	1	Kochi (3-13 January 2016)
82.	Selection of right propeller for achieving fuel efficiency	100	Kollam (5-8 January 2016)
83.	Battered and breaded products from freshwater fish and shellfish	7	Kochi (7-8 January 2016)

Sl. No.	Subject	No. of beneficiaries	Venue and date
84.	Hygienic handling of fishes during pre and post harvesting	100	Muldwarka, Gir Somnath, Gujarat (9 January 2016)
85.	Fish processing technology	12	Kochi (13-17 January 2016)
86.	Harvest and post harvest fisheries	12	Kochi (20-22 January 2016)
87.	Microbiology	2	Visakhapatnam (21 January 2016)
88.	Microbial and biochemical quality of seafood	17	Veraval (23-30 January 2016)
89.	Preparation and packaging of fish pickle	10	Kochi (29-30 January 2016)
90.	Modern analytical techniques in chemical contaminant profiling of fish and fishery products	2	Kochi (1-12 February 2016)
91.	Fish and shrimp based value added products and entrepreneurship development for women	20	Kochi (2 February 2016)
92.	Fish handling, product development and waste utilization	25	Kochi (15-16 February 2016)
93.	Harvest and post harvest fisheries	40	Bhutnal, Karnataka (25-27 February 2016)
94.	Identification of bacteria of public health significance	5	Kochi (9-11 March 2016)
95.	Hygienic handling of fish and preparation of value added fish products	60	Visakhapatnam (11-12 February 2016 & 18/20 February 2016)
96.	Post harvest processing and value addition	16	Kochi (11-26 February 2015 & 7- 23 March 2016)
97.	Preparation of fish soup powder	15	Mangamaripetta, A.P. (12 February 2016)
98.	Value addition of freshwater fish through processing	78	Dehradun (2-3 March 2016)

Sl. No.	Subject	No. of beneficiaries	Venue and date
99.	Fabrication of foldable traps and gillnets	180	Kothada, East Godavari, A.P. (5 March 2016), Bhupatipalem, East Godavari A.P. (18 March 2016), Tajangi, Visakhapatnam, Raja Ommangi, East Goadavari, A.P. (26 March 2016)
100.	Responsible fishing practices	20	Vazhachal, Thrissur (2 March 2016) & Peechi, Thrissur (9 March 2016)
101.	Hygienic handling during fishing, preparation of value added fish products and fish preservation	90	Bheemunipatnam, Visakhapatnam (17, 19 & 20 March 2016)
102.	HACCP and GMP	12	Kochi (22 March 2016)
103.	Demonstration of COFISKI	30	Visakhapatnam (31 March 2016)

☐ Indicates outstation activities



Demonstration on value added products at Loktak, Manipur





Demonstration of preparation of value added fishery products at Ukai, Gujarat



Demonstration of solar fish dryer at Shrivardhan, Maharashtra



Demonstration of value added fish products at Hyderabad



ISO 22000-HACCP for seafood industry at Kochi



Fish processing technology at Kochi



HACCP concepts at Kochi



Bacteria of public health significance at Kochi



Demonstration of square mesh fabrication at Vazhachal



## Outreach training programmes

During the period (April 2015 to March 2016) a total of 55 training/awareness programmes on various aspects of harvest and post harvest technologies were conducted outside the Institute as indicated in screen in the Chapter on 'Training/Awareness Imparted'.

## Exhibitions

The Institute participated in the following exhibitions during the period:

- Exhibition held in connection with 'Advantage Jharkhand – Food processing investor's meet' held at Ranchi during 23-24 April, 2015.
- Agriculture Technologies Exhibition, Pipra Kothi, Motihari, Bihar during 20-21 August, 2015.
- Matsyamela and Krishimela held at UAS, Dharwad during 27-30 September, 2015.
- Exhibition held in connection with the International conference on Science and Geopolitics of Arctic and Antarctic held at New Delhi during 29-30 September, 2015.
- 'Krishi/Matsya Mela – 2015' at University of Agricultural and Horticultural Sciences, Shivamogga Campus, Karnataka during 3-6 October, 2015.
- 'Swasraya Bharat-2015' at Kozhikode during 15-21 October, 2015.
- "Dhyuthi-2015", Vidya Bharathi state level science exhibition at Kochi during 17-18 October, 2015
- Tuber Food Fest-2015 at ICAR-CTCRI, Thiruvananthapuram during 24-25 November, 2015.
- Exhibition organized in connection with 5<sup>th</sup> International symposium on Cage culture in Asia-2015 at Kochi during 25-28 November, 2015.
- 'Annam-Food Festival-2015', Kochi during 10-12 December, 2015.
- 'Vajram 2015' – International science, technology and cultural exhibition organized by Mar Athanasius College, Kothamangalam during 26 December, 2015 to 3 January, 2016.
- Karshika Mela-2016 – Exhibition organized by Gandhiji Study Circle, Thodupuzha during 26 December, 2015 to 4 January, 2016.
- Exhibition held in connection with 103<sup>rd</sup> Indian Science Congress, Mysore University, Mysore during 3-7 January, 2016.
- Exhibition held in connection with the National Seminar on Fisheries and aquaculture: Livelihood security, sustainability and conservation, College of Fisheries, Lembucherra, Tripura during 21-22 January, 2016.
- National Aqua-cum-Science Exhibition and Fish Farmers Training, MES Asmabi College, Kodungalloor during 21-26 January, 2016.
- 'Knowledge Fair-2016' Exhibition, St. Teresa's College, Ernakulam during 22-23 January, 2016.
- 28<sup>th</sup> Kerala Science Congress Exhibition, University of Calicut, Kozhikode during 27-31 January, 2016.
- Exhibition held in connection with the International conference on Towards a sustainable blue economy: Production, strategies and policies held at Kochi during 4-6 February, 2016.

- Exhibition held in connection with the International conference on Aquatic resources and sustainable management held at Kolkata during 17-19 February, 2016.
- 'Vibrant North East 2016' Summit and Exhibition at Guwahati, Assam during 18-20 February, 2016.
- 'Kisan Mela' organized by Acharya N.G. Ranga Agricultural University - Regional Agricultural Research Station, Anakapalle during 26-27 February, 2016.
- 'National Matsya Mela-2016' organized by the Karnataka Veterinary, Animal and Fisheries Sciences University, Bidar and College of Fisheries, Mangalore at Mangalore during 4-6 March, 2016.
- Exhibition held in connection with the National seminar on Seafood safety, trade and management held at CUSAT, Kochi during 9-12 March, 2016.
- Kisan Mela Exhibition held in connection with Centenary celebrations of ICAR-CPCRI, Kasaragod on 12 March, 2016.
- 'Krishi Unnati Mela' organized by ICAR at ICAR-IARI, New Delhi during 19-21 March, 2016.



Dr. M.M. Prasad explaining at 'Advantage Jharkhand'



Matsyamela at UAS, Dharwad



Krishi/Matsyamela – 2015 at Shivamogga



Director, ICAR-CTCRI in ICAR-CIFT stall at Tuber Food Fest





Karshika Mela-2016 at Thodupuzha



Dr. L.N. Murthy explaining at Matsya Mela-2016 at Mangalore



Dr. T. Mohapatra, Secretary, DARE & DG, ICAR and Dr. J.K. Jena, DDG(Fy), ICAR visiting ICAR-CIFT stall at Krishi Unnati Mela



'Vibrant North East 2016' exhibition at Guwahati

## Replies to technical queries

Technical queries received from the various categories of clients such as fish processors, technologists, entrepreneurs, self help groups, Government organizations and fisherfolk were attended to. The queries were related to the topics such as harvest and post harvest technology of fish, participation in training programmes and payment of fees, technical guidance, analytical testing services, assistance under technology transfer programme etc.

## Radio talks

The Scientists and Technical Officers of the Institute gave the following radio talks during the period under report:

- Dr. G. Rajeswari, Principal Scientist – Responsible usage of energy in fishing operations (In Telugu), AIR, Visakhapatnam on 13 October, 2015.
- Dr. U. Sreedhar, Principal Scientist – The use of remote sensing for the fishing industry (In Telugu), AIR, Visakhapatnam on 4 September, 2015.
- Dr. B. Madhusudana Rao, Senior Scientist - Residues of antibiotics in shrimp exports – Problems and precautions (Interview) (In Telugu), AIR, Visakhapatnam on 2 August, 2015.
- Dr. M.S. Kumar, Chief Technical Officer – Role of BRDs in elimination of bycatch in trawling and conservation of biodiversity (In Telugu), AIR, Visakhapatnam on 21 September, 2015.

## North Eastern Hill (NEH) Region Programmes

**At Thoubal district, Manipur:** A training cum demonstration programme on Harvest and post harvest technologies was conducted at Thoubal district of Manipur during 24-26 February, 2016. Fifty tribal beneficiaries attended the programme. The programme was arranged in collaboration with Krishi Vignana Kendra, Thoubal, Manipur. Lectures on 'Responsible and selective fishing practices for reservoir and inland water bodies' and 'Value

added products developed from fish' were also delivered by the Scientists of the Institute. Practical demonstrations were given on fabrication and operation of gillnets, stick held dragnets and foldable fish traps. The post harvest training schedules covered aspects of hygienic handling of fish and preparation of value added products such as fish pickles, fish cutlets, fish balls, fish salting and drying etc. At the end of the programme foldable traps, dragnets, gillnets and equipments for the preparation of value added products and packing of the materials were distributed.



Demonstration of gillnets

### Tribal Sub Plan (TSP) Programmes

**At Motihari, Odisha:** A three day training cum demonstration programme was conducted at Motihari, District Purvachamparan, Bihar during 24-26 June, 2015. The programme has benefitted 68 fishers belonging to economically under-privileged ST & SC groups. Under the programme a "Mini-Value Added Fish Product Preparation Facility" was established providing all inputs on gratis for the benefit of fishers of East Champaran district. The programme was inaugurated by Shri Nishat Ahmad, Director, Department of Fisheries, Government of Bihar. During the programme, the participants were given lectures and demonstrations on hygienic handling of fish at different stages right from harvest to post harvest, product development, storage till it reaches the consumer/plate i.e., *pond to palate*, factors influencing the quality of fish resulting in spoilage of fish and the measures to control the same, preparation of different value added fish products namely fish pickles, fish



Shri Nishat Ahmad, Director of Fisheries, Bihar addressing the audience

powder, fish cutlets, fish pokoda, fish wafers etc. and employment of eco-friendly fishing gears namely foldable fish traps in Motijheel.

**At Ukai, Gujarat:** In association with Department of Fisheries, Govt. of Gujarat a training cum skill development programme for tribal fisherwomen residing around Ukai Dam of Gujarat was conducted during 2-3 July, 2015. The programme was officially inaugurated by Shri Ratan Ahir, Member of Taluk Panchayat Committee, Songadh. Shri N.F. Patel, Deputy Director of Fisheries, Dept. of Fisheries, Surat, Gujarat presided over the function. The training dealt with the development of value added products from locally available fishes. About 70 tribal fisherfolk participated in the programme. During the programme, nylon multifilament nets (150mm, 120mm mesh sizes), PP ropes (4mm), plastic floats and cement sinkers were distributed. Each Fishermen Society received material of about 10 kg nets and 4 kg ropes. On the second day, a



Shri Ratan Ahir inaugurating the programme



training programme on preparation of value added fishery products was conducted. About 43 tribal fisherwomen actively participated in the programme. Preparation of fish pickle, fish balls, fish cutlets etc. from freshwater fishes was demonstrated. Scientists also explained the basics of various aspects of best post harvest practices and hygienic handling of fish and fishery products for quality improvement. Six FRP canoes were also handed over to the tribal fisherfolk of Shri Tokarwa Vibhag Matsyodyog Sahakari Mandali Ltd., Uchal, Tapi and Shri Songadh Taluka Matsyodyog Sahakari Mandali Ltd., Ukai, Serula, Tapi. The canoes were specifically designed by ICAR-CIFT for responsible fishing in reservoirs. The canoes are of light weight, durable, easy to operate and can be used for different kinds of gears such as cast net, gillnet etc.

**At Siltiguda, Odisha:** A one day training cum demonstration on Harvest and post harvest technologies was conducted at Siltiguda, Rayagada district of Odisha on 20 July, 2015. During the programme lectures were delivered and demonstrations were given on value added fish products like fish fingers. Perforated fish washing bowl, fish frying bowl and one gas stove was given on gratis. The programme was conducted in collaboration with Department of Fisheries, Government of Odisha.



Handing over of gas stove on gratis

**At Kodikallavalasa, Andhra Pradesh:** A one day workshop on “Hygienic preparation of cured fish employing ICAR-CIFT solar dryer” was held at Kodikallavalasa, Pedagadda Reservoir, Salur Mandal, Vizianagaram District, Andhra Pradesh on 13 August, 2015. The programme which was inaugurated by Dr. G. Rajeswari, Scientist Incharge of Visakhapatnam Research Centre of ICAR-CIFT benefited 80 tribal fishers. A demonstration was given on hygienic handling of post harvest fish and dry curing of the same with ICAR-CIFT solar dryer. At the end of the programme formal handing over of the keys of solar dryer to the beneficiaries was held.

**At Adava, Harbhangi Reservoir, Odisha:** In collaboration with Department of Fisheries, Government of Odisha a training cum demonstration was held at Adava, Harbhangi Reservoir, Gajapati, Odisha during 20-22 January, 2016. During the programme, lectures



ICAR-CIFT coracle in fishing operations in the reservoir



Training on fabrication of foldable traps

were delivered on importance of fish as food, hygienic handling of fish at different stages right from harvest to post harvest, product development, storage till it reaches the consumer/plate; reasons for spoilage of fish and the measures to control the same, preparation of different value added fish products namely fish pickle, fish cutlet, fish pakoda and uses of eco-friendly fishing gears. Fish soup powder and nutraceutical drink based on seaweed-grape juice developed at ICAR-CIFT were demonstrated and were screened for sensory evaluation among trainees and other local residents totaling 104.

Foldable fish traps were tested at Harbhanga reservoir with three different kinds of baits namely chicken offal, fish and coconut. On the final day of training programme Ms Mansi Nimbhal, IAS, District Collector, Gajapati visited the venue and chaired the Plenary Session. At the end of the session foldable fish traps, gillnets for harvesting fish from the reservoir and more than 20 items related to post harvest handling of fish and value added fish product preparation were distributed.

**At Bhutnal, Karnataka:** A three days 'Training cum Transfer of Technologies programme' in collaboration with the Fisheries Research and Information Centre under KVAFSU, Bidar, Karnataka for transferring the suitable technologies developed by the Institute to the tribal fisherfolk was conducted at Bhutnal, an inland fishing village in Vijayapura district of Karnataka during 25-27 February, 2016. The programme started with the brief overview of the activities to be conducted by Dr. L.N. Murthy, Scientist Incharge, Mumbai Research Centre of ICAR-CIFT. Demonstration of hygienic handling of fish to the participants was also conducted. Fish pickle preparation and packing was done by the fisherwomen under the guidance of the ICAR-CIFT team. Preparation of battered and breaded products viz. fish fingers and fish cutlets was done by the fisherwomen. Fish processing equipments such as insulated fish boxes, insulated fish bags, sealing machines, plastic crates, hand-operated meat mincers, packaging materials, hygienic handling materials, fish cutting boards, knives etc. were distributed and their utilization were demonstrated to the fisherfolk.



Preparation of battered and breaded products

**At DCFR, Dehradun, Uttarakhand:** A training programme on "Value addition of freshwater fish through processing" was conducted in collaboration with ICAR-Directorate of Coldwater Fisheries Research, Bhimtal during 2-3

March, 2016 at Dehradun. The objective of the training was to demonstrate the protocol for post harvest handling and preparation of value added products from fish in order to create awareness for livelihood support among tribal women through initiating small scale entrepreneurship. The trainees comprised of 73 tribal women belonging to Bhotia and Boksha community. The programme was inaugurated by Shri N.S. Napolchyal, Chairman, ST Commission (Govt. of Uttarakhand). Practical demonstration on the post harvest handling of fish, fillets preparation, preparation of fish fingers, fish balls, fish cutlets, fish steaks, fish curry, fish pickle and fish silage were carried out.



Shri N.S. Napolchyal inaugurating the programme

**At Peechi, Thrissur, Kerala:** A programme on "Responsible fishing practices" was conducted at Peechi, Thrissur on 9 March, 2016. Lecture on various aspects of inland fisheries, responsible fishing practices and their importance in achieving sustainable fish catch and demonstration of fabrication of improved gillnets was held. Since stocking of fish fingerlings is prohibited in Peechi dam under the Wild Life Protection Act of Kerala, most of the fishermen stopped fishing in Peechi dam and only 15 active fishermen involved in fishing attended the programme.

**At Vazhachal, Kerala:** A one day training cum demonstration programme on "Responsible fish harvesting practices" was organized for inland fisherfolk at Vazhachal, Thrissur, Kerala on 2 March, 2016. The programme was organized in



collaboration with World Wide Fund for Nature (WWF) India. Fifty tribal fisherfolk from different colonies attended the training programme. The programme was inaugurated by Shri S.N. Sunilal, Assistant Range Officer, Forest Department, Vazhachal area. The technical session was held on 'Challenges in inland fisheries and responsible fish harvesting practices'. Demonstration of selective gillnet mounting was held after the theory class. During the feedback session, fishermen expressed their difficulties and requested for modern fishing craft and improved nets.



Training in progress

**At Surempalem Reservoir, Andhra Pradesh:** A programme on "Fabrication of foldable traps and gillnets" was conducted at Surempalem reservoir, Kothada, East Godavari District, Andhra Pradesh on 5 March, 2016. During the programme, the need for conservation of resources and the importance of the responsible fishing technological practices were explained to the participants. Practical demonstrations were also given on fabrication and operation of gillnets and foldable fish traps. Fifty tribal beneficiaries belonging to three villages of Kothada, Surampalem and Kothapeta attended the programme. The programme was arranged in collaboration with the Department of Fisheries, Government of Andhra Pradesh. At the end of the programme foldable traps and gillnets were distributed to the fishermen.

**At Bhupatipalem Reservoir, Andhra Pradesh:**

Another programme on "Fabrication of foldable traps and gillnets" was conducted at Bhupatipalem reservoir, Rampachodavaram, East Godavari District, Andhra Pradesh on 18 March, 2016 in collaboration with Department of Fisheries Andhra Pradesh. Appraisals were held on foldable traps, gillnets, coracles, canoes and various designs of boats designed at ICAR-CIFT to cater the needs of traditional fishermen of rural areas. Fabrication of foldable traps and gillnets were demonstrated and the operational aspects were explained. Around 50 fishers are benefited with the workshop. Foldable fish traps and gillnets were also handed over to the fishermen of Bhupatipalem and Gandinagaram villages.



Demonstration of foldable traps

**At Raja Ommangi Reservoir, Andhra Pradesh:**

Yet another programme on "Fabrication of foldable traps and gillnets" was conducted at Raja Ommangi Reservoir, East Godavari District, Andhra Pradesh on 26 March, 2016. During the programme, training cum demonstration session was conducted on fabrication of foldable fish traps and gillnets. About 50 tribal beneficiaries belonging to four fishermen cooperative societies along with the Presidents of the Societies attended the programme. At the end of the programme foldable traps and gillnets were distributed to the beneficiaries.



Demonstration of foldable traps

## Workshops/Short Courses/Seminars etc. conducted

**Workshop on Food loss and wasted resources:** The Food and Agriculture Organization of the United Nations (FAO) and ICAR-CIFT, Kochi organized an expert workshop on “Estimating food loss and wasted resources from gillnet and trammel net fishing” at Kochi during 8-10 April, 2015. The Workshop brought together experts from India, Bangladesh, Egypt, Indonesia, Tanzania, Thailand, United States of America and Vietnam. The workshop was formally inaugurated by Dr. C.N. Ravishankar, Director, ICAR-CIFT, Kochi. During the three-day meeting, experts discussed and agreed on a methodology inclusive of all the value chain, for estimating food loss from gillnet and trammel net fishing operations, including potential sites to pilot the methodology.



Dr. C.N. Ravishankar delivering the inaugural address



Workshop in progress

**National seminar on Chitin in agriculture, medicine and allied fields:** ICAR-CIFT, Kochi and Society of Fisheries Technologists (India), Kochi, National Academy of Agricultural Sciences, Kochi Chapter and Indian Chitin and Chitosan Society, Erode jointly organized a one day seminar on ‘Chitin in agriculture, medicine and allied fields’ at Kochi on 29 September, 2015. The Seminar included technical presentations and panel sessions for providing a platform for researchers and professionals from industry to enhance their technical knowledge, share ideas and form new business ideas. Eminent personalities working on chitin in different fields delivered lectures. The sessions were chaired by Dr. T.K. Srinivasa Gopal, (Former Director & Emeritus Scientist, ICAR-CIFT). Dr. A. Gopalakrishnan, Director, ICAR-CMFRI was the Special Invitee for the Seminar. Dr. S.D. Sawant, Director, ICAR-NRC Grapes, Pune, Dr. K.G. Ramachandran Nair (Retd. Head of Division, Fish Processing, ICAR-CIFT), Dr. S. Meenakshi (Gandhigram Rural Institute), Dr. Jayakumar, Dr. Raja Biswas (Amrita Center for Nanosciences and Molecular Medicine, Kochi), Shri K. Mohanan (MATSYAFED), Dr. Suseela Mathew (ICAR-CIFT) and Shri Vikram Sudhakar (M/s. Marshall Marine Products, Erode) delivered lectures on various aspects of chitin. Dr. A.A. Zynudheen, Convener & HOD I/c, Fish Processing, proposed the vote of thanks. The Seminar witnessed participation of 150 researchers and entrepreneurs from across the country.



Inaugural session in progress (L to R: Dr. K. Ashok Kumar, Dr. C.N. Ravishankar, Dr. S.D. Sawant and Dr. A.A. Zynudheen)

**Project initiation workshop:** The project initiation workshop on ‘Indigenous traditional knowledge in fisheries’ under ESSO-INCOIS funded project ‘Indigenous Traditional Knowledge (ITKs) in marine fisheries sector of Kerala: Documentation and Analysis’ in collaboration with Vijnana Bharati, New Delhi was held on 30 October, 2015 at ICAR-CIFT, Kochi. After the introductory remarks by Dr. Suseela Mathew, Director-in-charge, ICAR-CIFT, Dr. Nikita Gopal, PI of the project gave a brief on the project. Presentations of various topics like mapping the traditional ecological



knowledge, folk, folklore and folk identity, significance of ITK, village knowledge register of Thoothoor fishing community, protection of traditional knowledge and assimilating traditional knowledge using data mining were held.



Workshop in progress

**National seminar on Hilsa fisheries and Conservation:** The Institute in association with Society of Fisheries Technologists (India), Kochi and Inland Fisheries Society of India, Kolkata organized a National seminar on Hilsa fisheries and conservation at ICAR-CIFRI, Barrackpore on 18 November, 2015. Dr. S.K. Dutta, Deputy Director General (Crop Science), ICAR, New Delhi inaugurated the Seminar. There were invited lectures on Hilsa fisheries of India, National Plan of Action for Hilsa, Hilsa fishery of Hoogly estuarine system, Hilsa fishery on the west coast of India, Hilsa conservation: Initiatives of Hilsa Research Centre, Sultanpur, West Bengal, Conventional fishing techniques for Hilsa capture, Responsible fishing for Hilsa conservation, Conservation of Hilsa: Fisheries perspective and socio-economics of Hilsa fishery along Hoogly estuary etc. In the Technical Session, 19 posters were presented and three awards were given for the Best Posters. In the Plenary Session, recommendations that emanated from the Seminar were read out by the Convener. After discussion by the house suggestions were incorporated.



Release of the Proceedings of the seminar

**National workshop on Antibiotic residue analysis in aquatic environment:** The first operational workshop of the project 'All India Network Project on Fish Health' was conducted during 11-12 February, 2016 at ICAR-CIFT, Kochi. Twelve scientists and 12 research fellows from the participating institutes participated in the workshop. In the programme a general discussion about the project was followed by a discussion on the working principle and method development for the detection of antibiotics in aquatic samples by LC- MS/ MS. This was followed by official address by the Directors of ICAR-CIBA and ICAR-CIFT and presentations by the co-institutes like WBUAFS, ICAR-CIFA, Bhubaneswar, ICAR-DCFR, Bhimtal and ICAR-CIFRI, Barrackpore. On the second day, an exposure training on the extraction of antibiotic residues from aquatic samples as per standard



Workshop in progress

procedure optimized in ICAR-CIFT was carried out for the benefit of the scientists and research scholars. The analysis of extracted sample by LC-MS/MS was also demonstrated. The workshop concluded by valedictory function.

**National seminar on Marine natural products and nutraceutical research:** The Society of Fisheries Technologists (India), Kochi and ICAR-CIFT, Kochi organized a national seminar on “Advances in marine natural products and nutraceutical research” on 26 February, 2016. The seminar witnessed nine invited lectures and 15 poster presentations. Around 100 delegates including researchers, industrialists, Govt. officials and students participated in the Seminar. Padmashree Dr. V. Prakash, FRSC, Distinguished Scientist of CSIR and former Director CSIR-CFTRI, Mysore delivered the Key Note address on “Dwindling ocean resources as a result of climate change affecting food, nutrition and health - Emergence of aquaceuticals”. Dr. Minnie Mathew, Retired Senior Advisor to the UN World Food programme spoke on “Nutraceuticals for persons living with HIV”. Dr. Benny Antony of M/s Arjuna Chemicals, Kochi spoke on “Production of marine nutraceuticals and their export potential”. Dr. Siddhartha P. Sarma, IISc, Bangalore spoke on “Characterization of marine peptides” while Dr. S. Parameswaran, Scientist Incharge (Retd.), CSIR-NIO Regional Centre, Kochi spoke on “Marine nutraceuticals and bioactive compounds”. Dr. Bimal P. Mohanty, ICAR-CIFRI, Barrackpore spoke on “Marine and freshwater fishes as a storehouse of nutraceuticals”. Dr. P.T. Neeraj of M/s. Synthite Industries Ltd., Kolencherry spoke on “Marine natural products in Indian system of medicine”. Dr. A.A. Zynudheen, Principal Scientist, ICAR-CIFT, Kochi spoke on “Fishaceuticals - A detailed investigation”. Dr. Suseela Mathew, Principal Scientist, ICAR-CIFT, Kochi spoke on “Biochemical characterization and bioactivity studies of natural products from marine sources”.



Inaugural session in progress (L to R: Dr. Suseela Mathew, Dr. T.K. Srinivasa Gopal, Dr. V. Prakash and Dr. C.N. Ravishankar)



Dr. V. Prakash being felicitated by Dr. C.N. Ravishankar

**Specialists Consultation on Energy Saving in Fishing:** ICAR-CIFT, Kochi conducted a Specialists' Consultation on Energy Saving in Fishing on 5 March, 2016. Dr. K. Gopakumar, Former DDG (Fy.), ICAR, New Delhi and Former Director of ICAR-CIFT, Kochi inaugurated the programme which was primarily aimed at discussing the ways to reduce fuel consumption in the fishing sector. The consultation was presided over by Dr. C.N. Ravishankar, Director, ICAR-CIFT. More than 40 invited participants from state and central agencies, fishing industries, NGOs, research and academic institutions attended the consultation. Dr. Leela Edwin, Principal Investigator of the ICAR-NASF funded project, 'Green Fishing Systems for Tropical Seas' gave a brief overview of the project. Dr. V.C. George, Director, Department of Aquaculture, SH College, Thevara and Former Head, Fishing Technology Division, ICAR-CIFT offered felicitations. Presentations were made on Transition to green fishing: Considerations and barriers by Dr. E. Vivekanandan, Former Head, Demersal Fisheries Division, ICAR-CMFRI, Kochi; Fuel saving engines for fishing vessels by Shri H. Balasubramanian, Deputy General Manager, Ashok Leyland, Chennai; Energy efficient new generation fishing gears by Shri Kishore Darda, General Manager - R&D, Garware Wall Ropes Ltd., Pune and Fuel efficient combination fishing vessel by Shri M.V. Baiju, Senior Scientist, ICAR-CIFT. It was suggested by the experts that by investing in fishery management initiatives, the fishing costs can be reduced substantially and the earnings will increase commensurately.



Dr. Leela Edwin giving a brief of the project. On the dias are (L to R) Dr. C.N. Ravishankar, Dr. K. Gopakumar, Dr. V.C. George and Dr. Saly N. Thomas

## Representation in committees

The following officials represented the Institute in various Committees/Board panels etc. in different capacities:

**Dr. C.N. Ravishankar**, Director

### As Member

- Technical committee, Food Safety Standards Authority of India, New Delhi
- Technical committee, Fish and fishery products, BIS, New Delhi
- Editorial Board, Journal of Food Science and Technology, Association of Food Scientists and Technologists, CFTRI, Mysore
- Technical committee, Establishment of Incubation Centres, NFDB, Hyderabad
- Expert committee, Sacred Heart College (MG University), Kochi
- Committee for drafting curriculum and syllabi, KUFOS, Kochi
- Review committee of DBT, New Delhi for reviewing projects in post harvest technology of fish
- Technical committee, Lakshadweep Development Corporation Ltd., Kochi for setting up of tuna canning factory at Minicoy Island.
- Consultant, NACA, Bangkok, Thailand
- National Business Incubation Association, USA
- Agrinnovate India Pvt. Ltd. for technology valuation and pricing of ICAR technologies

**Dr. Suseela Mathew**, Principal Scientist and Head, Biochemistry & Nutrition Division

### As Member

- Reviewer of journals, Fishery Technology, Journal of Food Science & Technology, Indian Journal of Fisheries, Journal of Medicinal Food and Fishing Chimes
- External examiner, Mangalore University, Mangalore

**Dr. K. Ashok Kumar**, Principal Scientist and Head, Fish Processing Division

### As Member

- Inter Departmental Panel of experts for approval of seafood processing plants for EU
- Assessment Board for the approval of technologists for seafood processing plants constituted by EIC, Govt. of India
- Consultative committee for construction and modernization of fish markets with the financial assistance of NFDB, Hyderabad
- Expert group of Ministry of Agriculture for review of standard conditions for sanitary import of various fish/fishery products

**Dr. M.M. Prasad**, Principal Scientist and Head, Microbiology, Fermentation and Biotechnology Division

### As Member

- Committee of AQUIDIRECT.ORG
- Assessment panel of experts of Export Inspection Council and Marine Products Development Authority

**Dr. Leela Edwin**, Principal Scientist and Head, Fishing Technology Division

**As Member**

- Academic Council, KUFOS, Kochi
- Project Monitoring and Review Committee (PMRC) for the project, 'Solar enabled boats at Kanyakumari'
- Committee for assessment of Scientists, ICAR-CMFRI, Kochi

**Dr. A.A. Zynudheen**, Principal Scientist and Acting Head, Engineering Division

**As Member**

- Inter Departmental Panel of experts for approval of seafood processing plants for EU
- Board of Examiners, M.Sc. Industrial Fisheries, CUSAT, Kochi and M.Sc. Aquaculture, Calicut University, Kozhikode
- Technical committee of Matsyafed for setting up of fish meal plant and glucosamine plant

**Dr. Nikita Gopal**, Principal Scientist and Acting Head, Extension, Information and Statistics Division

**As Member**

- Public hearing on issues in small scale fisheries (Women in fish marketing), SEWA, Thiruvananthapuram

**Dr. G. Rajeswari**, Principal Scientist and Scientist Incharge, Visakhapatnam Research Centre

**As Member**

- External examiner for M.Sc. students, Department of Marine Living Resources, Andhra University, Visakhapatnam
- External examiner for vessel navigation course of CIFNET, Visakhapatnam
- Advisory committee for the Centre for Women's Studies, Andhra University, Visakhapatnam

**Dr. G.K. Sivaraman**, Senior Scientist and Scientist Incharge, Veraval Research Centre

**As Chairman**

- Town Official Language Implementation Committee, Veraval

**As Member**

- Inter Departmental Panel of experts for approval of seafood processing plants for EU
- Advisory Committee, Veraval Fisheries College, GAU, Junagadh
- Lokvani Radio Advisory Committee, ICAR-KVK, Ambuja Cement Foundation, Kodinar

**Dr. L.N. Murthy**, Senior Scientist and Scientist Incharge, Mumbai Research Centre

**As Member**

- Inter Departmental Panel of experts for approval of seafood processing plants for EU

**Dr. R. Anandan**, ICAR National Fellow and Principal Scientist

**As Member**

- Inter Departmental Panel of experts for approval of seafood processing plants for EU
- External examiner, Manonmaniyam Sundaranar University, Tirunelveli.



**Dr. K.V. Lalitha**, Principal Scientist

**As Chairperson**

- Curriculum committee for drafting PG curriculum and syllabi for Marine Microbiology and Marine Drugs course, KUFOSS, Kochi

**As Member**

- Assessment committee for promotion of Scientists, ICAR-CMFRI, Kochi
- Inter Department Panel of experts for approval of fish processing plants for export to EU
- Examiner, M.F.Sc./M.Sc. and Ph.D., ICAR-CIFE, Mumbai and CUSAT, Kochi

**Shri M. Nasser**, Principal Scientist

**As Member**

- Inland Harbour Crafts and Fishing Vessel Sectional Committee, TED 18, Bureau of Indian Standards, New Delhi
- Transport Engineering Division Council, BIS, New Delhi

**Dr. Saly N. Thomas**, Principal Scientist

**As Chairperson**

- Textile material for marine fishing purpose, Sectional Committee TX18, BIS, New Delhi

**As Member**

- Expert committee constituted by Matsyafed, Kerala for the implementation of fish net factory at Thiruvananthapuram
- Institute Management Committee, ICAR-CMFRI, Kochi

**Dr. T.V. Sankar**, Principal Scientist

**As Member**

- Institute Management Committee, ICAR-CIBA, Chennai
- Inter Department Panel of experts for approval of fish processing plants for export to EU
- Section committee for fish and fishery products (FAD 12) and hygiene (FAD 15), BIS, Govt. of India
- Scientific panel for Biological hazards, Food Safety Standards Authority of India, New Delhi
- Subcommittee on Animal and fisheries technologies and process for developing guidelines for evaluating and testing of materials/products at ICAR Institutes

**Dr. M.P. Remesan**, Principal Scientist

**As Member**

- Committee for the selection of Group A & B posts of MPEDA, Kochi

**Dr. V. Geethalakshmi**, Principal Scientist

**As Member**

- Examiner for Ph.D. course thesis evaluation in Biostatistics of NIMHANS, Bangalore

**Dr. Femeena Hassan**, Principal Scientist

**As Member**

- Inter Departmental Panel of experts for approval of seafood processing plants for EU

**Dr. J. Bindu**, Principal Scientist

**As Member**

- Internal Complaints Committee, CIFNET, Kochi
- Passing Board, CUSAT, Kochi
- Inter Departmental Panel of experts for approval of seafood processing plants for EU
- Board of examiners, KUFOS, Kochi, CUSAT, Kochi, ICAR-CIFE, Mumbai, TNFU, Nagapattinam and KAU, Thrissur
- Registered guide of the CUSAT, Kochi

**Dr. S. Ashaleta**, Principal Scientist

**As Member**

- MPEDA, Kochi

**Dr. U. Sreedhar**, Principal Scientist

**As Member**

- Examiner for A.S. Raja Women's College, Visakhapatnam
- Examiner for CIFNET, Visakhapatnam

**Dr. George Ninan**, Senior Scientist

**As Member**

- Inter Departmental Panel of experts for approval of seafood processing plants for EU
- Board of examiners, Calicut University, Calicut/CUSAT, Kochi/MG University, Kottayam
- Subsidy Committee for setting up of cold storage facilities, MPEDA, Kochi

**Dr. B. Madhusudana Rao**, Senior Scientist

**As Member**

- Assessment panel of experts of Export Inspection Council and Marine Export Products Development Authority

**Dr. Toms C. Joseph**, Senior Scientist

**As Member**

- Inter Departmental Panel of experts for approval of seafood processing plants for EU
- Animal Ethics Committee, ICAR-CMFRI, Kochi
- Institutional biosafety committee, College of Veterinary and Animal Sciences, KAU, Thrissur
- Examiner and question paper setter for B.F.Sc. course, KUFOS, Kochi

**Dr. S.K. Panda**, Senior Scientist

**As Chairman**

- FSSAI Scientific panel on Fish and fishery products

**As Member**

- Inter Departmental Panel of experts for approval of seafood processing plants for EU
- Expert group for drafting international standard (ISO/TC 234) on Traceability of shellfishes including crustaceans and molluscs

**Dr. K.K. Asha**, Senior Scientist

**As Member**

- Inter Departmental Panel of experts for approval of seafood processing plants for EU

**Dr. V.R. Madhu**, Senior Scientist

**As Member**

- Committee for introduction of marine ambulance service along the coastal districts of Kerala

**Shri M.V. Baiju**, Senior Scientist

**As Member**

- Expert committee of MPEDA, Kochi to provide subsidy for installation of insulated fish hold and refrigeration onboard fishing vessels
- Board of Studies, KUFOs, Kochi
- Tender committee of Fishery Survey of India for the purchase of generators for the vessel Matsyavarshini

**Dr. C.O. Mohan**, Scientist

**As Member**

- Inter Departmental Panel of experts for approval of seafood processing plants for EU

**Dr. S. Visnuvinayagam**, Scientist

**As Member**

- Inter Departmental Panel of experts for approval of seafood processing plants for EU

**Dr. A.K. Jha**

**As member**

- Advisory Committee, Veraval Fisheries College, GAU, Junagadh

**Shri C.G. Joshy**, Scientist

**As Member**

- Faculty, course work for Ph.D. programmes, CUSAT, Kochi

**Dr. P. Viji**, Scientist

**As Member**

- Assessment panel of experts of Export Inspection Council and Marine Products Export Development Authority

**Kum. Jesmi Debbarma**, Scientist

**As Member**

- Assessment panel of experts of Export Inspection Council and Marine Products Export Development Authority

**Dr. P. K. Binsi**, Scientist

**As Member**

- Inter Departmental Panel of experts for approval of seafood processing plants for EU
- Research Advisory Committee of ICAR-CIFE, Mumbai for Masters and Ph.D. programme

**Smt. U. Parvathy**, Scientist

**As Member**

- Inter Departmental Panel of experts for approval of seafood processing plants for EU

**Smt. S.J. Laly**, Scientist

**As Member**

- Inter Departmental Panel of experts for approval of seafood processing plants for EU

**Shri Anuj Kumar**, Scientist

**As Member**

- Inter Departmental Panel of experts for approval of seafood processing plants for EU

**Dr. Pankaj Kishore**, Scientist

**As Member**

- Inter Departmental Panel of experts for approval of seafood processing plants for EU

**Smt. T.K. Anupama**, Scientist

**As Member**

- Inter Departmental Panel of experts for approval of seafood processing plants for EU

**Smt E.R. Priya**, Scientist

**As Member**

- Inter Departmental Panel of experts for approval of seafood processing plants for EU

**Dr. A.R.S. Menon**, Chief Technical Officer

**As Member**

- Inter Media Publicity Co-ordination Committee (Kerala), Ministry of Information and Broadcasting, Govt. of India
- Editorial Board, Applied Science Periodicals, Siwan
- Editorial Board, International Journal of Lakes and Rivers, Lucknow
- Editorial Board as Chief Editor, Science India, Kochi

**Shri C.R. Gokulan**, Asst. Chief Technical Officer

**As Member**

- Committee constituted for selection of Mechanic (Group-C) at FSI, Marine Engineering Division
- Committee constituted for selection of Electrician of NIPHATT, Kochi
- Panel for Apprentice trainees in the discipline B. Tech. and Diploma (Mechanical, Electrical and Electronics)



**Dr. Santhosh Alex**, Senior Technical Officer

**As Member**

- Editor, 'Triveni', Inhouse journal of Kochi TOLIC

**Shri P.S. Nobi**, Technical Officer

**As Member**

- Central Joint Staff Committee (CJSC), ICAR
- ICAR Technical Anomaly Committee

## Training and Capacity Building

### Human resource development activities

During the period under report, the Human Resources Development Cell of the Institute met five times to discuss 63 cases. As recommended by the HRD Cell 106 staff of the Institute participated in training programmes during the period (Scientific - 51, Technical - 29, Administrative and Finance - 6 and Skilled Support Staff - 20). This includes 28 programmes organized by other Institutes. In compliance to the ICAR Training Policy for training all categories of staff, a two days training workshop to enhance the capabilities of Skilled Support Staff of the Institute was organized during 21-22 March, 2016. A total of 20 Skilled Support Staff from the Head Quarters were trained on various aspects. Further three scientists were sent abroad to attend workshops and conferences. The HR Committee ensures that every employee enters the training information in the ERP system within a week after completion of the training through individual Login ID and Password provided by the main server at ICAR-IASRI, New Delhi. Category-wise and individual employee-wise skill deficient areas of various categories of employees were furnished to the Council. Training needs assessment and Annual Training Plan (ATP) for Scientific, Technical, Administrative and Skilled Support Staff were also made for the year 2015-16 and 2016-17. ATP for 2016-17 is uploaded in the Institute website.

### Participation in trainings (Category-wise)

Sl. No.	Name(s) of participant(s)	Training attended	Venue and date
<b>Category - Scientific</b>			
1.	Dr. Leela Edwin (As resource person)	Moving towards sustainability	ICAR-CMFRI, Kochi 22 May 2015
2.	Shri Anuj Kumar	Baking science and technology	CSIR-CFTRI, Mysore 15-19 June 2015
3.	Dr. B. Madhusudana Rao	Aquaculture inspection and sampling	Bhimavaram 9-11 July 2015
4.	Dr. U. Sreedhar (As resource person)	Hygienic handling of fish	Visakhapatnam 23 August 2015
5.	Dr. G. Rajeswari	Geospatial analysis of natural resources management using statistical tools	ICAR-NAARM, Hyderabad 2-11 September 2015

Sl. No.	Name(s) of participant(s)	Training attended	Venue and date
6.	Dr. V. Geethalakshmi Dr. U. Sreedhar Dr. V.R. Madhu	Fishery stock assessment and ecosystem modelling	INCOIS, Hyderabad 16-22 September 2015
7.	Smt. P. Jeyanthi	Integrated aquaponics	ICAR-CIFT, Kochi 23 September 2015
8.	Smt. E.R. Priya	HACCP concepts	ICAR-CIFT, Kochi 5-9 October 2015
9.	Shri P.N. Jha Shri R.K. Renjith Shri S. Chinnadurai	Advancements in fishing technology	ICAR-CIFT, Kochi 12-17 October 2015
10.	Dr. C.O. Mohan Dr. P.K. Binsi Shri C.G. Joshy Shri Anuj Kumar Shri S. Sreejith Smt. S.J. Laly Shri R.K. Nadella Shri K. Ahamed Basha Shri P.N. Jha Dr. Pankaj Kishore Shri S. Chinnadurai Shri K.R. Renjith Smt. E.R. Priya Smt. K. Sarika Shri C.S. Tejpal Kum. Lekshmi R.G. Kumar Smt. T. Muthulakshmi Smt. S.S. Greeshma Smt. T.K. Anupama	Laboratory quality management systems as per ISO: 17025: 2005	ICAR-CIFT, Kochi 18-21 November 2015
11.	Dr. J. Bindu	Recent trends in packaging technology	IIP, Bengaluru 19-20 November 2015
12.	Dr. N.S. Chatterjee	Residue analysis of pesticides and plant growth regulators using GC-MS/MS and LC-MS/MS	ICAR-NRC Grapes, Pune 23-25 November 2015
13.	Dr. G.K. Sivaraman	Isolation of Actinobacteria from sea sediments and detection of shrimp viral pathogens using PCR methods	ICAR-CIFT, Kochi 30 November - 9 December 2015

Sl. No.	Name(s) of participant(s)	Training attended	Venue and date
14.	Dr. Saly N. Thomas	Leadership development	ICAR-NAARM, Hyderabad 30 November – 11 December 2015
15.	Dr. V.R. Madhu Shri P.N. Jha Shri S. Chinnadurai	Pre-MSD introductory training for Ashtamudi clam fishery	Kochi 7 December 2015
16.	Shri C.S. Tejpal	Nutrigenomic approaches in fish nutritional research	ICAR-CIFE, Mumbai 8-18 December 2015
17.	Dr. J. Bindu	Plastic materials and compounding	CSIR-CIPHET, Chennai 21-22 January 2016
18.	Shri S. Sreejith	Testing and quality evaluation of packaging materials	IIP, Mumbai 28-29 January 2016
19.	Dr. Saly N. Thomas	Competency development for HRD Nodal Officers of ICAR	ICAR-NAARM, Hyderabad 10-12 February 2016
20.	Smt. S.J. Laly	Antibiotic residue analysis in aquaculture environment	ICAR-CIFT, Kochi 11-12 February 2016
21.	Shri S. Chinnadurai Shri P.N. Jha	An introduction to fish taxonomy	PMFGR Centre, Kochi 15-20 February 2016
22.	Dr. U. Sreedhar	Regional ocean governance framework	Phuket, Thailand 28 February – 19 March 2016
23.	Dr. S. Visnuvinayagam	Spectroscopic and chromatographic technique for materials characterization	ICAR-CIRCOT, Mumbai 2-5 March 2016
24.	Shri R.K. Nadella	Microbial systematics	CSIR-IMTECH, Chandigarh 8-12 March 2016
25.	Smt. E.R. Priya	Current methods in biochemical quality assessment of aquafoods	FC&RI, Thoothukudy 14-23 March 2016
26.	Shri V. Radhakrishnan Nair	Geospatial analysis in agriculture and data requirements for ICAR-Geo-portal	ICAR-NAARM, Hyderabad 29-30 March 2016
<b>Category - Technical</b>			
1.	Smt. Prinyanka Vichare	Hindi translation	CTB, Mumbai 20-24 April 2015 & 31 August - 4 September 2015

Sl. No.	Name(s) of participant(s)	Training attended	Venue and date
2.	Smt. P.K. Shyma	Priority setting, Monitoring and Evaluation (PME) of agricultural research projects	ICAR-NAARM, Hyderabad 2-6 June 2015
3.	Dr. A.R.S. Menon	Knowledge management and knowledge sharing in organizations	IIPA, New Delhi 7-11 September 2015
4.	Smt. P.K. Shyma Smt. K.B. Beena Shri G. Omanakuttan Nair Smt. K.K. Kala Shri T.V. Bhaskaran Smt. K.G. Sasikala Smt. G. Remani Smt. Bindu Joseph Smt. P.A. Jaya Smt. N. Lekha Shri P.S. Nobi Shri K.A. Noby Varghese Shri V.N. Sreejith Shri P.A. Aneesh Shri T. Jijoy Shri K.C. Anish Kumar Smt. P.J. Mary Shri P. Suresh Shri Ajith V. Chellappan Smt. U. Prenitha Smt. Vineetha Das Shri G. Vinod Smt. G. Archana	Laboratory quality management systems as per ISO: 17025: 2005	ICAR-CIFT, Kochi 18-21 November 2015
5.	Smt. Triveni G. Adiga	Advanced analysis of microbial pathogens detection	BARC, Mumbai 23 November – 11 December 2015
6.	Shri P. Radhakrishna	Competence enhancement training for Technical Officers of ICAR	ICAR-NAARM, Hyderabad 1-10 March 2016
<b>Category - Administrative</b>			
1.	Shri M.N. Vinodhkumar Smt. A.R. Raji	Noting and drafting	ISTM, New Delhi 15-16 April 2015
2.	Shri P.J. Davis	Right to Information Act-2005	ISTM, New Delhi 27-28 April 2015



Sl. No.	Name(s) of participant(s)	Training attended	Venue and date
3	Shri C.K. Sukumaran Smt. G.N. Sarada Smt. Jaya Das	ERP and pay roll	ICAR-IASRI, New Delhi 24-26 September 2015
<b>Category – Skilled Support</b>			
1.	Shri K.S.Ajith Shri T.M. Balan Smt. U.K. Bhanumathy Shri A.V. Chandrasekharan Shri E. Damodaran Shri V. Deepk Vin Shri G. Mahanandia Shri K.K. Karthikeyan Smt. P.T. Mary Vinitha Shri P.N. Nikhil Das Shri M.M. Radhakrishnan. Smt. C.G. Radhamoney Shri P. Raghavan Shri M.V. Rajan Shri P.V. Raju Shri T.K. Rajappn Shri K.R. Rajasaravanan Shri S.N. Dash Shri P.A. Sivan Shri A. Vinod	Competence enhancement training programme for skilled support staff	ICAR-CIFT, Kochi 21-22 March 2016

### Trainings organized for various categories of employees

**In-house training workshop for Competency Enhancement of Skilled Support Staff:** In compliance to the ICAR Training Policy for training all categories of staff, a two days Training Workshop to enhance the capabilities of Skilled Support Staff of ICAR-CIFT, Kochi was organized during 21-22 March, 2016. A total of 20 Skilled Support Staff from the Head Quarters were trained on various aspects. Dr. Suseela Mathew, HOD, B&N and Director Incharge presided over the inaugural function. In the technical sessions, lectures on subject like personality development, motivation, inter-personal skills, time management etc., service rules awareness, basics of computer applications,



Dr. Mary Matilda giving lecture on Personality development



Participants and faculty of the programme along with Director

personal claims/advances, office record keeping and maintenance and Enterprise Resource Planning-ERP (Theory and Practical) were held. The plenary session of the programme was presided over by Dr. C.N. Ravishankar, Director in which participation certificates were given away.

### HRD fund allocation and utilization

The total fund allocated under HRD for the year 2015-16 is Rs.7.00 Lakhs and the utilization was ₹. 6.44 Lakhs.

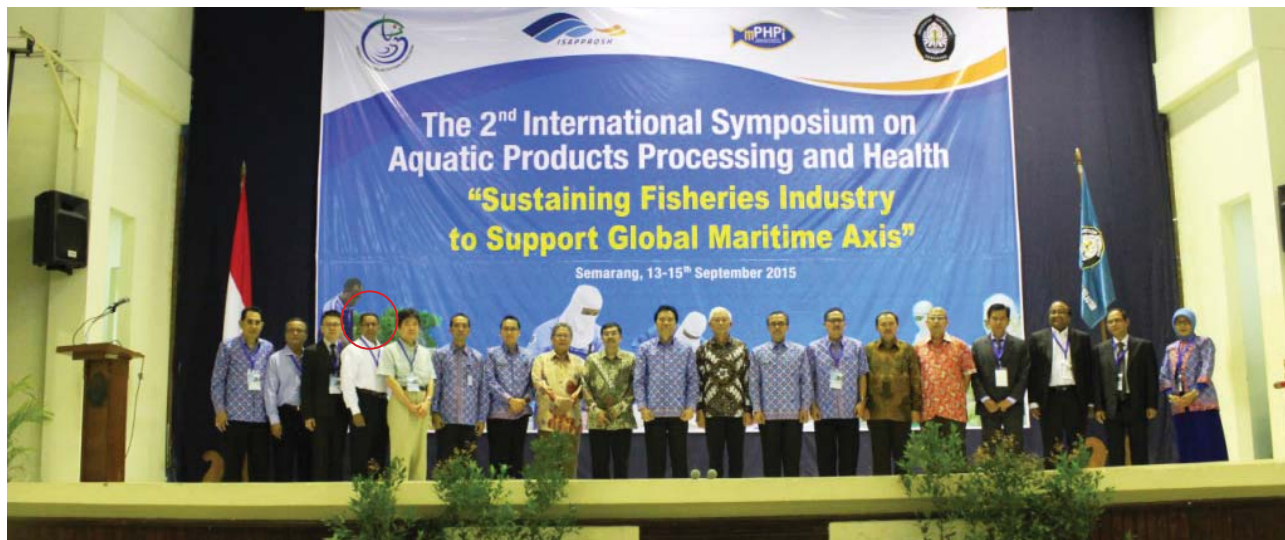
### Visits Abroad

**Dr. P. Muhamed Ashraf**, Principal Scientist, Fishing Technology, ICAR-CIFT, Kochi was deputed to Cairns, Australia to attend the Blue Planet Symposium held during 25-29 May, 2015. Dr. Muhamed Ashraf also presented a paper entitled, "Evaluation of satellite bio-optical algorithms in different water types to retrieve chlorophyll a at Southeastern Arabian Sea" by P. Minu, V.P. Souda, Aneesh A. Lotliker, S.S. Shaju, P. Muhamed Ashraf and B. Meenakumari.



Dr. Muhamed Ashraf (Left) at the Symposium venue

**Dr. C.N. Ravishankar**, Director, ICAR-CIFT, Kochi was deputed aboard to Indonesia to attend the 2<sup>nd</sup> International Symposium on Aquatic Products Processing and Health 2015 organised by Department of Fish Products Technology, Diponegoro University and Ministry of Marine Affairs and Fisheries at Semarang, Central Java, Indonesia during 13-15 September 2015. Dr. Ravishankar also delivered an invited talk on "Recent advances in processing and packaging of fishery products" in the Symposium.



Dr. Ravishankar (in circle) along with other invited speakers

**Dr. U. Sreedhar**, Principal Scientist, Visakhapatnam Research Centre of ICAR-CIFT was deputed to undergo a training on "Regional Ocean Governance Framework - Implementation of the United Nations Convention on The Law of The Sea (UNCLOS) and its related instruments in the South-east Asian seas and the Indian ocean" held at Phuket, Thailand during 28 February to 19 March, 2016. The training was conducted by Department of Marine and Coastal Resources, International Ocean Institute (IOI), Thailand Regional Centre, Phuket, Thailand. In the three week training programme various aspects of ocean governance and law of the sea were taught. Few exercises were also done including SWOT analysis for South east Asian and the Indian Ocean region. Dr. Sreedhar also made presentations

on “Introduction and activities of ICAR-CIFT”, “Deep sea resources of Indian EEZ” and “Advances in satellite remote sensing for exploitation of marine aquatic resources from Indian EEZ”.



Dr. Sreedhar (in circle) with other participants of the training programme

## Linkages/Partnerships

### Collaboration with other institutes

#### Local Institutions in the area other than ICAR Institutes

- Goa Shipyard Ltd., Goa
- Marine Products Export Development Authority
- Export Inspection Agency
- Naval, Physical and Oceanographic Laboratory
- Fishery Survey of India
- National Institute of Oceanography
- Central Institute of Fisheries Nautical Engineering and Training
- Kerala Fishermen's Co-operative Federation (MATSYAFED)
- National Institute of Fisheries Post Harvest Technology and Training
- Kerala State Pollution Control Board
- Cochin University of Science and Technology
- Kerala Biotechnology Commission, Thiruvananthapuram
- Kerala University of Fisheries and Ocean Studies, Kochi
- State Fisheries Departments of Kerala, Karnataka, Tamil Nadu, Telangana, Andhra Pradesh, Odisha, West Bengal, Jharkhand, Bihar, Manipur, Tripura, Meghalaya and Arunachal Pradesh,

#### National Institutes and Agricultural Universities

- Agricultural Universities
- Ministry of Agriculture
- Ministry of Food Processing Industries
- Department of Ocean Development

- Department of Biotechnology
- Department of Science and Technology
- Department of Electronics
- Indian Institute of Technology, Chennai/Kharagpur
- State Fisheries Departments
- Union Territory of Lakshadweep
- Kerala Water Authority
- Science and Technology Entrepreneurship Development project (STED)
- Bureau of Indian Standards
- Industries Department, Andaman & Nicobar Administration
- Rajiv Gandhi Centre for Biotechnology, Thiruvananthapuram
- College of Fisheries, Mangalore
- National Research Centre on Plant Biotechnology, Thiruvananthapuram
- Institute of Microbial Technology, Chandigarh
- ICAR-Central Marine Fisheries Research Institute, Kochi
- ICAR-Central Institute of Fisheries Education, Mumbai
- National Institute of Cholera and Enteric Diseases (NICED), Kolkata
- College of Fisheries, Mangalore
- ICAR-National Bureau of Fish Genetic Resources, Research Centre, Kochi
- INCOIS, Hyderabad
- Marine Products Export Development Authority, Kochi
- Andhra University, Visakhapatnam
- Amity University, Noida
- Jawaharlal Nehru Technical University, Hyderabad
- Sri Venkateswara Veterinary University, Tirupati
- State Institute of Fisheries Technology, Kakinada
- M.V.K.R. Fisheries Polytechnic, Bhavadevarapalli, A.P.
- P.S.G. College of Arts and Science, Coimbatore
- Annamalai University, Annamalai Nagar
- Bharathiyar University, Coimbatore

#### **Private Sector**

- M/s Garware Wall Ropes Ltd., Pune
- M/s DSM India Ltd., Mumbai



### International Institutions

- Food and Agriculture Organization (FAO), Rome
- Bay of Bengal Programme (BOBP)
- Asia Pacific Fisheries Commission (APFC)
- INFOFISH
- Australian National Quality Assurance Programme (ANQAP), Australia

### Extension and Development Agencies

- Central Social Welfare Board
- South Indian Federation of Fishermen Societies (SIFFS), Thiruvananthapuram
- AFPRD, Hyderabad
- Kanyakumari District Fishermen Sangam's Federation
- Bharat Sevak Samaj, Thiruvananthapuram
- Small Industries Development Bank of India (SIDBI)
- Matsya Mahila Vedi, Chellanam
- Alleppey Diocesan Charitable and Social Welfare Society, Alappuzha
- Vanitha Matsya Thozilali Bank, Neendakara
- Kerala Industrial and Technical Consultancy Organization (KITCO)
- Avani Agro Society, North Paravur, Ernakulam
- Kerala State Women's Development Corporation Ltd., Thiruvananthapuram
- Chellanam Panchayat SC/ST Co-operative Society Ltd., Kochi
- Development Action through Self Help Network (DARSHN)
- Agency for Development of Aquaculture in Kerala (ADAK)
- Kudumbasree Community Development Society, Pallipuram
- New Dolphin Mechanized Fishing Boat Operators Welfare Association, Visakhapatnam
- Swarna Andhra Mechanized Boat Owners Association, Visakhapatnam
- A.P. Mechanized Boat Operators Association, Visakhapatnam
- Pattuvam Inland Fishermen Co-operative Society, Kannur
- Chellanam-Kandakadavu Fishermen Development and Welfare Co-operative Society, Kochi
- Karnataka Fisheries Development Corporation, Bengaluru
- Triptisagar Society for Fishermen Ltd., Jafarabad, Gujarat
- Gandhi Smaraka Seva Kendram, Alappuzha
- Kottappuram Integrated Development Society (KIDS), Kodungalloor
- MS Swaminathan Research Foundation, Chennai

- EGREE Foundation
- OXFAM
- District Youth Fisheries Welfare Association, Visakhapatnam

### Consultancies

During the period under report the Institute signed the following consultancy agreements with various firms:

#### With M/s Vinayaka Foods and Beverages, Kochi

for the technology transfer of ready to eat (RTE) products which include palada, payasam and different vegetable curries. The consultancy includes optimization of process time and temperature for desired Fo values and sterility tests for the optimized products. ICAR-CIFT will also provide training and support to M/s Vinayaka Foods for the establishment of a processing unit exclusively for the production of RTE products. The MoU was signed on 6 July, 2015 at ICAR-CIFT and the signatories were Dr. C.N. Ravishankar, Director, ICAR-CIFT and Shri M. Anantharaman, Managing Partner, M/s Vinayaka Foods and Beverages.



Dr. C.N. Ravishankar handing over the MoU to Shri Anantharaman, M/s Vinayaka

**With M/s Green Living Agribusiness Pvt. Ltd., Kochi** to establish production and retailing of hygienically dressed and packed fresh fish in Kerala.

**With M/s. Foodex Village, Kochi** to provide technical advice and assistance for production of fish gravy paste.

**With M/s Nature and Nature, Kochi** for production of Succinylated Chitosan based Hydro-alcohol Hand sanitizer.



Dr. C.N. Ravishankar handing over the MoU to MD, M/s Green Living Agribusiness



Dr. C.N. Ravishankar handing over the MoU to MD, M/s Nature and Nature

### Analytical services

The Headquarters and Research Centres of the Institute undertook testing samples of different types of raw materials and products received from various organizations, State and Central Government departments and entrepreneurs and issued reports on their quality. The samples tested included fresh and frozen fish and shellfish products, byproducts, prawn larvae from hatcheries, swabs from processing tables and workers' hands, chemicals, salt, water, ice, packaging materials etc. Type testing of marine diesel engines was also carried out and performance certificates were issued to the concerned manufacturers in addition to calibration of mercury, alcohol and digital thermometers received from different fish processing plants and the industry.

## Past year in the life of ICAR-CIFT

### Events

#### **DG, ICAR and Secretary, DARE Visited ICAR-CIFT-CMFRI Complex, Visakhapatnam:**

Dr. S. Ayyappan, Hon'ble DG, ICAR and Secretary DARE, Govt. of India visited CIFT-CMFRI Complex, Visakhapatnam on 9 May, 2015. After a quick detour of the laboratories of both CIFT and CMFRI, an interactive meeting was held with all scientists, technical, administrative and supporting staff of both CIFT-CMFRI Regional Centres. Later Dr. Ayyappan addressed the gathering. All the scientists of both Regional Centres of CIFT-CMFRI briefed the Guest on research activities, research projects being handled by them and future plans of work.



Dr. S. Ayyappan with staff of ICAR-CIFT/CMFRI

**DG, ICAR and Secretary, DARE Visited ICAR-CIFT, Kochi:** Dr. S. Ayyappan, Secretary, DARE and Director General, ICAR, New Delhi visited the Institute on 13 August, 2015 and had interaction with the staff



Dr. S. Ayyappan along with the staff of the Institute

#### **ICAR-CIFT hosted ICAR South Zone Sports**

**Tournament:** The ICAR Inter-Institutional Sports Tournament – 2015 hosted by ICAR-CIFT, Kochi was held during 25-29 May, 2015. About 600 participants from 25 ICAR institutions in the southern states like Kerala, Tamil Nadu, Karnataka, Andhra Pradesh and Telangana participated in the tournament. The tournament was held in three different venues including Maharaja's College grounds and Rajiv Gandhi Indoor Stadium. Dr. K.N. Raghavan, IRS, Commissioner of Customs, Kochi declared the tournament open in the inaugural function presided over by Dr. C.N. Ravishankar, Director, ICAR-CIFT, Kochi on 25 May. Dr. A. Gopalakrishnan, Director, ICAR-



Dr. K.N. Raghavan declaring the tournament open (On the dias are Shri R.C. Sinha, Director, CIFNET, Dr. A. Gopalakrishnan, Director, ICAR-CMFRI, Dr. C.N. Ravishankar, Director, ICAR-CIFT and Dr. P. Pravin, Organizing Secretary)



CMFRI, Kochi offered felicitations. After the oath taking ceremony Dr. P. Pravin, Organizing Secretary proposed the vote of thanks. The tournament concluded on 29 May, 2015 with the prize distribution ceremony. Shri T.C. Yohannan, Olympian and Arjuna Awardee was the Chief Guest of the function.

**Coconut Wood Canoe for Artisanal Fisheries launched:** Coconut wood canoe constructed under the project titled “Techno-economic feasibility of coconut wood canoes for small scale fisheries sector in the south west coast of India and Lakshadweep” was handed over to Kannamali Cheriakadavu Fisheries Development Welfare Co-operative Society for conducting the field trials. The canoe was officially launched by Dr. Madan Mohan, Assistant Director General (Marine Fisheries), ICAR, New Delhi in a function held at Chellanam on 8 July, 2015. Dr. E.G. Silas, Former Vice Chancellor, Kerala Agricultural University handed over the canoe to the Society. Dr. Leela Edwin, PI of the project welcomed the gathering and gave a brief about the technology development process. Dr. C.N. Ravishankar, Director, ICAR-CIFT gave the Presidential address and spoke about the continuing service of the Institute to the fisheries sector. Shri P.B. Francis, President of the Fishermen Co-operative Society offered felicitations. Shri M.V. Baiju, Senior Scientist proposed the vote of thanks.



Handing over the document (L to R: Dr. Leela Edwin, Dr. C.N. Ravishankar, Shri P.B. Francis, Dr. E.G. Silas and Dr. Madan Mohan)

## Meetings

**Institute Research Council Meeting:** The Annual Meeting of the Institute Research Council was held at Head Quarters during 27-28 April, 2015. The house discussed in detail the progress achieved in the ongoing research projects during 2014-15 and finalized the work plan for 2015-16. A total of six ongoing projects, seven new projects and 12 concluded projects were discussed.



IRC meeting in progress

**Research Advisory Committee Meeting:** The Meeting of the Institute Research Advisory Committee was held on 21 April, 2015 at Head Quarters under the Chairmanship of Dr. V. Prakash, Former Director, CSIR-CFTRI, Mysore. Another meeting of the Committee was held on 22 February, 2016.



RAC meeting in progress



**Vigilance Study Circle Meeting:** The Annual General Body Meeting (AGM) of the Vigilance Study Circle, Kerala Chapter was held on 23 September, 2015 at ICAR-CIFT, Kochi. The first session of the meeting was chaired by Shri Satyaki Rastogi, Chief Vigilance Officer, State Bank of Travancore and President, VSC-K. In the second session of the





Inaugural session in progress

AGM, the Chief Guest was Shri P.J. Joy, CVO, State Bank of India who gave the key note address. Shri M.G.A. Raman, Patron, VSC-K gave an inspiring speech on the need for ethics in administration. Dr. C.N. Ravishankar, Director, ICAR-CIFT felicitated the meeting. Shri Satyaki Rastogi also offered felicitation in the function. He gave a presentation on Overview – Procedures and Process Central Vigilance Commission. Besides CVOs, vigilance officers and guests from various central government organizations, Heads of Divisions, Senior Administrative Officers, Administrative Officers, Finance and Accounts Officer, Assistant Administrative Officers and staff of the Purchase Section of ICAR-CIFT attended session II and participated in the discussion.

### Celebrations

**Institute Foundation Day:** The Institute celebrated its 58<sup>th</sup> Foundation Day on 29 April, 2015. Dr. M. Anandaraj, Director, ICAR-Indian Institute of Spices Research, Kozhikode was the Chief Guest of the day. Selected personnel from the retired staff of the Institute were also honoured on the occasion.



Dr. M. Anandaraj inaugurating the Foundation Day Celebrations

**Anti Terrorism Day:** The Institute observed Anti Terrorism Day on 21 May, 2015. The Director and staff of the Institute assembled together and took Anti Terrorism Day Pledge.

**World Environment Day:** The Institute observed World Environment Day and Swachh Bharat Abhiyan on 5 June, 2015 by planting tree saplings around the campus and cleaning the office premises.

**World Ocean Day:** The Veraval Research Centre of ICAR-CIFT observed World Ocean Day on 6 June, 2015.

**National Sadbhavana Diwas:** 'National Sadbhavana Diwas' was observed on 20 August, 2015 in connection with the observance of 'Communal Harmony Fortnight'. The Director and staff of the Institute assembled together in the lobby of the Institute and took the Sadbhavana Day Pledge.

**World Tribals Day:** As part of World Tribals Day, Dr. M.M. Prasad, Principal Scientist has undertaken visits to different places of Visakhapatnam district namely Chintapalli, Paderu, Araku and Anantagiri. Discussions were also held with Dr. A.K. Singh, Director, ICAR-DCFR, Bhimtal to include new fish varieties precisely Chocolate Mahsheer owing to the low temperature conditions existing all through the year in the areas.

**Onam:** The harvest festival of Kerala, “Onam” was celebrated at ICAR-CIFT, Kochi on 25 August, 2015 with pomp and gaiety. Floral carpet competition was held in the morning followed by traditional ‘Sadya’ (feast). Shri Thushar, renowned singer was the Chief Guest of the function. A cultural programme also followed.



Cleanliness activity at the Institute

**World Fisheries Day:** As part of Swachh Bharat Mission and as per the directive of Ministry of Rural Development, Government of India, Kannamali village in Ernakulam district was adopted under the Swachh Bharat Abhiyan. On World Fisheries Day 21 November, 2015, a cleanliness drive was initiated at Ward No. 10 of Kannamali. A 500 m stretch along side the coastal village was cleaned and plastic waste cleared from the premises. From the Institute scientists, technical staff, administrative staff and skilled support staff participated in the programme.



Shri Thushar inaugurating the Onam Celebrations

**Swachh Bharat Abhiyan:** The observance of Swachh Bharat Abhiyan was initiated on 2 October, 2015 with the staff of ICAR-CIFT taking oath and participating in the cleanliness activities of the Institute surroundings. Cleanliness drive was continued on all afternoons of every second Friday of each month.



Swachh Bharat Abhiyan in progress

**International Women's Day:** International Women's Day was celebrated at the Institute on 8 March, 2016. Dr. K. Chitra Thara, Oncological Surgeon, Lakeshore Hospital, Kochi was the Chief Guest of the Day. The meeting was presided over by Dr. C.N. Ravishankar, Director. Dr. K.K. Asha, Senior Scientist and Liaison Officer, Women's Cell welcomed the gathering while Dr. P.K. Binsi, Scientist proposed the vote of thanks. Dr. Chitra Thara delivered a talk on 'Detection and prevention of cancer'.



Dr. K. Chitra Thara delivering the talk. On the dias are Dr. K.K. Asha, Dr. C.N. Ravishankar and Dr. P.K. Binsi

### **Mera Gaon Mera Gaurav Programmes**

Under the Mera Gaon Mera Gaurav Programme, awareness programmes, training programmes and technology transfer programmes were conducted by ICAR-CIFT at different villages across the country.

**Training programme at Mangamaripetta, Andhra Pradesh:** ICAR-CIFT Visakhapatnam Research Centre conducted one day training and skill development in Post harvest fisheries for the benefit of women fishers of Mangamaripeta on 16 July, 2015. The programme was organized in collaboration with an NGO, OXFARM. Dr. M.M. Prasad, Principal Scientist of the Centre gave the presidential address which was followed by a demonstration on hygienic handling of post harvest fish and salt curing of the same. The programme benefited 60 women fishers.





Dr. M.M. Prasad delivering the talk



Practical demonstration in progress

**Training programme at Usgaon village, Maharashtra** As part of implementation of Mera Gaon Mera Gaurav programme, Mumbai RC of ICAR-CIFT organized a training programme on value added products for tribal fisherfolk at Usgaon, an inland fishing village in Thane district of Maharashtra. Distribution and demonstration of the canoes and coracles to the representatives of the four tribal fishermen societies were done. In the meeting representatives of the tribal fishermen societies shared their opinions about the programme, incentives and expressed their further needs.

**Demonstration of hygienic fish handling practices:** Demonstration of hygienic handling of fish was conducted. The hygienic way of deheading, descaling and fin removal was demonstrated. Filleting operation in order to get higher filleting yield was also shown to the fisherwomen. Headgears, aprons, mouth pieces, cutting boards and knives were also provided to them.

**Preparation and packing of shrimp pickle:** Preparation and packing of shrimp pickle in standing pouch was participatively done by the fisherwomen as per the standard procedure recommended by ICAR-CIFT.

**Preparation of battered and breaded fish products:** Hands on training cum demonstration for preparation of battered and breaded products viz. fish fingers, fish cutlets and butterfly shrimp (*Nobashi* style) was given to tribal fisherwomen. All the participants were asked to sensorily evaluate the product and give feed backs.

**Distribution of the fish processing equipment and other incentives:** Distributed fish processing equipment such as insulated fish bags, sealing machines, hand operated meat mincer, fish cutting board, knives etc. to tribal fishermen. Pamphlets from eight different topics (25 nos. each) in regional language (Marathi) were distributed among tribal fishermen for awareness and training purpose. The topics covered were fish/shrimp pickle, fish fingers, fish cutlets, palm impression technique, hybrid solar fish dryer, insulated fish bags and *Pangasius*: Ideal candidate for value addition.

**Group discussion and feedback session:** After product demonstration, the Chairman of the Society gave his feedback about the programme where he highlighted the usefulness of provided material for the tribal community. The programme ended with concluding remarks and vote of thanks.

**Training programme at Muldwarka, Gujarat:** Under the Mera Gaon Mera Gaurav programme, Veraval Research Centre of ICAR-CIFT has selected five villages in Gir Somntah district viz. Jaleswar, Seruva, Jambur, Muldwarka and Dhamlej. Team comprising six scientists was formed at the Centre for popularizing research activities and recent technologies developed by ICAR-CIFT. As part of data collection and initial survey, the team visited government offices, district governing offices, Krishi Vigyan Kendra of ICAR, Kodinar, Village offices, Fishermen Society office etc.

Under Mera Gaon Mera Gourav programme training on hygienic handling and dry fish preparation were demonstrated. More than 1200 fishermen participated in the programme.



Initial meeting at the selected villages



Scientists interacting with villagers at Jaleswar fishing village of Patan-Veraval

### Awards and Recognitions

**Dr. C.N. Ravishankar**, Director, ICAR-CIFT, Kochi has been conferred with the Fellow of National Academy of Agricultural Sciences, New Delhi in the field of Fisheries. Dr. Ravishankar received the Fellowship from Dr. M.S. Swaminathan in a function held at NAAS Complex, New Delhi on 15 June, 2015. Dr. P.L. Goutham and Dr. R.B. Singh were the dignitaries present on the occasion.



Dr. C.N. Ravishankar receiving the FNAAS Fellowship

**Dr. Toms C. Joseph**, Senior Scientist, **Dr. P.K. Binsi** and **Smt. T. Muthulakshmi**, Scientists, ICAR-CIFT, Kochi received the Prof. Hiralal Chaudhuri Medal for 'Excellence in innovative research' in the National level Young Scientist's Meet and Prof. Hiralal Chaudhuri Commemorative Conference organized by the Zoological Society, Kolkata at University of Kolkata during 4-6 February, 2016.

**Smt. P. Jeyanthi**, Scientist received the Best Poster Award for the presentation on 'Comparative assessment of conventional and cage culture fish farming in Ernakulam district, Kerala, India' by P. Jeyanthi, V. Chandrasekar and Nikita Gopal in the International Symposium on Cage Aquaculture in Asia held at Kochi during 25-28 November, 2015.



Smt P. Jeyanthi receiving the award from Dr. J.K. Jena and Dr. A. Gopalakrishnan



**Kum. Jesmi Debbarma**, Scientist received the Best Paper Award for the presentation on 'Nutritional and physical properties of noodles incorporated with seaweed puree' by Jesmi Debbarma, P. Viji, B. Madhusudana Rao and M.M. Prasad in the National seminar on Fisheries and aquaculture: Livelihood security, sustainability and conservation held at College of Fisheries, Lembucherra, Tripura during 21-22 January, 2016.



Kum. Jesmi receiving the Best Paper Award

**Shri K.K. Ajeesh Kumar**, Research Fellow received the Best Paper Award for the presentation on 'Proteoglycans extracted from shark cartilage (*Echinorhinus brucus*) inhibits proliferation of MCF-7 human breast cancer cells by inducing apoptosis' by K.K. Ajeesh Kumar, K.V. Vishnu, K.K. Asha, K.R. Remyakumari, R. Navaneethan and Suseela Mathew in the International symposium on 'Biodiversity, agriculture, environment and forestry' held at Ooty during 11-12 December, 2015.

**Shri K.K. Ajeesh Kumar**, Research Fellow received the Best Paper Award for the presentation on 'Extraction, isolation, characterization and anti-proliferative activity of proteoglycans from *Scolidon* spp. against breast cancer cell line, MCF-7' by K.K. Ajeesh Kumar, Aswathy Anand, K.V. Vishnu, K.K. Asha, R. Navaneethan, Linu Balan and Suseela Mathew in the National seminar on 'Advances in marine natural products and nutraceutical research' held at ICAR-CIFT, Kochi on 26 February, 2016.

**ICAR-CIFT comes out with flying colours in South Zone Sports Meet:** The contingent from ICAR-

CIFT, Kochi came out with flying colours at the ICAR South Zone Sports Meet held at Kochi. Smt. P. Jeyanthi became the individual athletic champion (Women) with one first position and three second positions [100 m dash (Women) – First, 200 m dash (Women), Long jump (Women) and High jump (Women) – Second]. Shri P.G. David was Third in 200 m dash (Men). The 4 x 100 m relay (Men) team from the Institute consisting of Shri G. Vinod, Shri Ramesh Mirdha, Shri A. Vinod and Shri P.G. David came in Third position by clocking 54.30 Sec. Shri Devananda Uchoi was in Third



ICAR-CIFT Foot Ball team with the Winners trophy

position in Long Jump (Men). Shri K.C. Anish Kumar and Shri K. Ajeesh grabbed the Second and Third position in High Jump (Men). In Carrom (Men) Shri K. Rajasravanan was the Winner while in Chess (Women) Smt. Tessy Francis and Smt. N. Karthika became the Winner and Runner up. Smt. K.G. Sasikala and Dr. J. Bindu were the Badminton (Women) Doubles Winners. The ICAR-CIFT team was the Winners in Foot Ball and Runners up in Volley Ball (Smashing).

**Smt. Tessy Francis**, Senior Technical Assistant, ICAR-CIFT, Kochi emerged as the Champion in Chess (Women) during the ICAR Inter Zonal Sports Tournament held at ICAR-CAZRI, Jhodpur, Rajasthan during 8-12 February, 2016. **Shri K.R. Rajasaravanan**, Skilled Support Staff, ICAR-CIFT, Kochi emerged as the Winner in Carrom (Singles) in the tournaments.

**Shri K.R. Rajasaravanan**, Skilled Support Staff, ICAR-CIFT, Kochi also became the Winner in Carrom (Singles) at the S. Ramaswamy Memorial Kerala State 31<sup>st</sup> Carrom Championship held at Thiruvananthapuram during 25-27 March, 2016.



Smt. Tessy and Shri Rajasaravanan being felicitated

### Post Graduate Studies



**Ms G.S. Hema** was awarded Ph.D. degree for her thesis entitled, "Biochemical characterization and bioevaluation of collagen peptides extracted and purified from fish skin: *In vitro* and *in vivo* studies on antiarthritic and wound healing properties" from Cochin University of Science and Technology, Kochi. Ms Hema worked under the guidance of Dr. Suseela Mathew, Principal Scientist and HOD, B&N Division, ICAR-CIFT, Kochi.

on the structural and operational changes of ring seine fishing systems of Kerala and its life cycle assessment (LCA)". He worked under the guidance of Dr. Leela Edwin, Principal Scientist and HOD, FT Division, ICAR-CIFT, Kochi.

**Shri P.H. Dhiju Das**, Technical Assistant, Visakhapatnam Research Centre of ICAR-CIFT was awarded Ph.D. degree of Cochin University of Science and Technology, Kochi for his thesis titled, "Investigations on the structural and operational changes of ring seine fishing systems of Kerala and its life cycle assessment (LCA)". He worked under the guidance of Dr. Leela Edwin, Principal Scientist and HOD, FT Division, ICAR-CIFT, Kochi.



**Shri T. Obelesu** was awarded Ph.D. degree for his thesis entitled, "Studies on the synergistic effects of dietary squalene and N-3 polyunsaturated fatty acids (PUFA) supplementation in modulating aging process" from ICAR-Central Institute of Fisheries Education, Mumbai (Deemed University). Shri. Obulesu worked under the guidance of Dr. R. Anandan, Principal Scientist and ICAR National Fellow, ICAR-CIFT, Kochi.



### Important Visitors

- Dr. S. Ayyappan, Secretary, DARE & DG, ICAR, New Delhi (Kochi on 5 August, 2015 and Visakhapatnam on 9 May, 2015)
- Dr. S. Dam Roy, Director, ICAR-CIARI, Port Blair, Andamans and Nicobar Islands (Kochi on 5 August, 2015)
- Shri A.K. Angurana, Secretary and Shri A.K. Joshi, Joint Secretary, Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture, Shri Ramsankar Nayak, Fisheries Commissioner, AP and Shri P. Koteswara Rao, Joint Director of Fisheries, AP (Visakhapatnam on 15 October, 2015)
- Dr. P. Pravin, ADG (M. Fy.), ICAR, New Delhi (Kochi on 6 December, 2015 and Veraval on 18 January, 2016)

- Shri Manas Choudhury, Deputy Adviser, NITI AYO, Delhi (Veraval on 4 September, 2015)
- Four delegates from Kenya and Liberia as part of the U.S.-India-Africa Triangular International training programme on 'New dimensions in agricultural extension management for extension functionaries' (Kochi on 12 August, 2015)
- Two Eritrean scientists from College of Marine Science and Technology under FAO support programme to the Government of Eritrea in Africa to strengthen their college (Kochi on 21 January, 2016)
- Shri Guru Charan Singh, Director of Fisheries, Himachal Pradesh (Kochi on 11 February, 2016)



African delegates visiting the laboratories at Kochi



Shri Rakesh M. Raghavan delivering the talk

Shri Asghar Wajahat, Hindi Fiction Writer gave a technical talk in Hindi on 'Hindi in current scenario' at ICAR-CIFT, Kochi on 27 January, 2016.



Shri Asghar Wajahat delivering the talk

### Agricultural Technology Information Centre (ATIC)

At ATIC, arrangements were made for the visitors such as fisher persons, students, technologists and officials. Analytical samples were received at ATIC and test reports were sent after analysis. Various priced publications and value added fishery products were sold through ATIC. Various technical queries received regarding training and other extension activities were replied.

### Administration

Administration section deals with recruitment, service and policy matters, discipline, staff welfare, land and building, procurement of stores, budget expenditure, settlement of claims etc.



During the period under report, the following Committees met for purposes as shown below:

1. Departmental Promotion Committee : Once
2. Departmental Selection Committee : Once
3. Assessment Committee : Twice
4. Career Advancement Committee : Once
5. Modified ACP Committee : Twice
6. Selection test : Once

#### Cases considered by the Departmental Promotion Committee

Category	Promo-tion	Declaration of probation and Confirmation	Granting MACP
Scientific	8	2	-
Technical	16	6	-
Administrative	1	3	-
Supporting	-	1	6
Auxiliary	-	-	1

### Priority setting, Monitoring and Evaluation (PME) Cell

The PME Cell dealt with the following technical matters during the year:

**Verification of CAS reports of Scientists:** The PME Cell verified the Career Assessment Reports submitted by Scientists for their promotion and gave due recommendations.

**Submission of monthly, quarterly and half yearly reports:** Monthly reports on the important activities of the Institute and significant research findings were compiled and sent to ICAR regularly for inclusion in the ICAR monthly report to the Cabinet Secretariat. Quarterly and six monthly reports on the targets and achievements of the Institute comprising both research and financial aspects were regularly furnished to the Council.

**Publication of the scientific papers:** The scientific research papers meant for publication in research journals and for presentation in Symposia/Seminars by scientists of the Institute were arranged for reviewing and further approval of the recommended papers communicated.

**Institute Research Council:** The Institute Research Council meeting was convened during 27-28 April, 2015 to review the progress achieved in the ongoing research projects of the Institute during 2014-15 and to discuss the research project proposals for the year 2015-16. The Institute Research Project Document for the year 2015-16 was compiled and brought out for discussion at the Meeting. The House discussed in detail the seven ongoing research projects, besides 12 completed projects and seven new projects apart from the various ad hoc projects.

**PERMISnet, IRS and PIMS-ICAR:** The PME Cell helps in maintaining the Personal Management Information System network (PERMISnet-II) of ICAR up-to-date. Further, furnishes quarterly inputs to the Intelligent Reporting System (IRS-II) being maintained by ICAR. Through the Project Information Management System (PIMS-ICAR) software, the Institute research projects are being computerized and uploaded online.

**Publication of newsletter and other reports:** Four issues of CIFT Newsletter and two issues of Fish Tech Reporter were published during the period. Besides, the Institute Annual Report 2014-15 and Research Highlights 2014-15 (both bilingual) were also brought out.

**Other technical matters:** The Cell continued to answer queries on various technical matters received from



other organizations and individuals. The queries received by the CTO, PME Cell in the additional capacity of Public Relations Officer, as well as from the feedback option in the Institute Website were attended to. Further, materials for various publications like ICAR News/ICAR Reporter, Agrinews, Fishing Chimes, MPEDA Newsletter, Seafood News, Aqua International, Sea Queen, ICAR Web page etc. were forwarded regularly for publication.

The publicity related and extension oriented activities of the Institute are being regularly presented in the monthly meetings of the Inter Media Publicity Co-ordination Committee of Ministry of Information and Broadcasting, Govt. of India. Besides, the PME Cell functions as the nodal point for releasing Press Releases and Reports.

### Official Language Implementation

**Hindi Chetanamas-2015:** Hindi Chetanamas - 2015 was conducted during 12 August to 11 September, 2015 at the Head Quarters and Research Centres. Different competitions like Section-wise Terminology (Administration and Divisions), Quiz, Essay writing, Slogan writing, Cross word, 'Matsya darshan', 'Nukkad natak', News reading and Advertisement were conducted. Apart from this, prizes were given for best Hindi Implementation for Administration and Divisions, besides 'Rajbhasha Prathibha Puraskar'. The valedictory function was held on 22 September, 2015 in which Dr. P. Radhika, Professor & Head, PGP Research Institute, Dakshina Bharat Hindi Prachar Sabha, Kochi was the Chief Guest. Dr. Radhika also released the inaugural issue of 'Jhalak' (A publication containing the literary contributions of the staff) on the occasion.



Rajbhasha Puraskar to Smt. Asha Gopalan

**Hindi Workshop:** Two Hindi workshops were conducted during the period under report on 15 and 16 September, 2015 for the benefit of technical staff and scientists, respectively.

**'Jaladhi' released:** The 2015 issue of 'Jaladhi', the in-house technical journal in Official Language was formally released by Shri Girish Shankar, IAS, Secretary, Department of Official Language, Govt. of India during the Regional Language Conference held at Kochi on 19 February, 2016.

Release of Jaladhi (L to R: Shri Paul Stanley, IAS, Chairman, Cochin Port Trust, Smt. Poonam Juneja, Joint Secretary, Dept. of Official Language, Govt. of India, Shri P.J. Davis, S A. O, ICAR-CIFT, Shri Girish Shankar, IAS, Secretary, Dept. of Official Language, Govt. of India, Smt. Leena Nair, IAS, Chairman, MPEDA, Shri P.R. Ravi Kumar, IRS, Income Tax Commissioner, Kochi, Dr. Srinivasa Rao, Director, ICAR-CRIDA, Hyderabad)



### Library

Library is playing a vital role in providing services to support the information needs of the scientific community of the Institute. The library is well equipped with modern facilities and resources in the form of online databases, CD-ROMs, DVDs, books, e-journals, e-standards, theses, reports etc. During the period under report, library acquired 124 books

and seven scientific periodicals. At present the library holds 12,558 books and 6,193 bound journals. Aquatic Science and Fisheries Abstracts (ASFA) online database and Indian Standards on DVD have also been subscribed during the period.

**Library Portal:** The library home page provides electronic access to bibliographic databases and full text documents. Bibliographic databases have been developed using WINISIS and search interfaces have been developed using 'GenISISweb'.

**Digital Repository:** Digitization of the Institute publications and putting them in the open digital repository is an important activity of the library. During the period 302 documents have been digitized and added to the repository. At present the Digital Repository holds 1966 digital documents. Fourty seven Hindi publications have also been added to the repository.

**Remote access to e-resources:** Remote access to subscribed e-resources has been provided to the users through a web proxy server. Now the users are getting access to IP protected resources outside the campus also *via* the Library's list of online resources. The facility is also available to the faculty members of the Research Centres.

**Consortium of e-Resources on Agriculture (CeRA):** More than 2,000 journals are available online through CeRA. The library has supplied copies of 273 articles under Document Delivery Request (DDR) facility of CeRA.

**IAMSLIC membership:** The ICAR-CIFT library is a member of The International Association of Aquatic and Marine Science Libraries and Information Centers (IAMSLIC) and is part of the Interlibrary Loan Programme, with more than 90 member libraries from more than 25 countries offering materials to other member libraries *via* interlibrary loan and document delivery.

**ASFA Input Centre:** The library in association with National Institute of Oceanography (NIO), Goa continued to act as a National Input Centre of ASFA (Aquatic Science and Fisheries Abstracts) database.



### Agricultural Knowledge Management Unit (AKMU)

Agricultural Knowledge Management Unit (AKMU) caters to the Information Technologies and Communications (ITC) needs of the institute by providing and maintaining the Internet, Email, Video Conferencing and other computer-related facilities. AKMU also periodically updates Institute Website and Personnel Management Information System Network (PERMISnet) of the employees of the Institute. AKMU provides internet connectivity to nearly 250 systems through LAN and wifi connectivity to nearly 200 users. ICAR-CIFT is presently connected with 1000 mbps lease line under National Knowledge Network (NKN) provided by Govt. of India and 10 mbps ILL from BSNL to provide all the ICT services round the clock for the employees of the Institute.

AKMU provides K7 Enterprise Security through the server for protection from malware threats and other external sources of threats, thus improving the ICT efficiency. It also acts as a gateway to protect from intrusion attacks to prevent the leakage of confidential data by adding 193 clients in the system.

AKMU manages ICAR-CIFT Website and it is available in the url [www.cift.res.in](http://www.cift.res.in). It highlights the overall research activities and achievements of the Institute and act as an interface between the Institute and end-users. The contents of the Institute Website are periodically updated. The information on training programmes, recruitments of temporary staff,

tender notices and other circulars of the Institute are periodically uploaded in the Institute Website for transparency of working condition. The IP-based video conferencing facility is being operated and maintained effectively by the AKMU. This facility is being used for monitoring and evaluating research programmes in the Research Centres of the Institute and also other organizations.

AKMU is maintaining and updating of Personnel Management Information System Network (PERMISnet-II) of ICAR at Institute. The information on institute cadre strength and details of individual employees in PERMISnet is periodically updated. As per the provision given, the Institute provides user name and password to the Regional Centres to update the information in PERMISnet on periodical basis.

### NABL Activities

ICAR-CIFT laboratories were accredited to ISO/IEC 17025:2005 in the year 2005 and the Quality Management System is in operation for the last 11 years. The recommended scope of accreditation (National Accreditation Board for Laboratories (NABL), New Delhi) include 112 parameters with 89 parameters in chemical area, 17 parameters in biological area and six parameters in mechanical area. During 2015-16 more than 700 samples were analyzed which includes over 300 customs import samples recommended for release as per Sanitary Import Permit, for the benefit of the fish processing industries and an amount of ₹ 41,50,096/- was generated during the period.

As far as accreditation activities are concerned, a Desktop Audit was carried out by NABL in 2015 and the scope has been cleared for continuity without any problem. The Institute also participated in FAPAS proficiency programme in chemical and microbiological scopes. Inter-laboratory testing were performed with other accredited laboratories and also participated in the inter-laboratory testing initiated by other laboratories to be in tune with the requirements of the standard.

### Committees

#### Quinquennial Review Team

**Chairman:** Dr. S.D. Tripathi, Former Director, ICAR-CIFE, Mumbai

#### Members

1. Dr. K. Venkatesh Murthy, Senior Principal Scientist, CSIR-CFTRI, Mysore
2. Dr. V.C. George, Director, Aquaculture Department, SH College, Kochi
3. Prof. B.A. Shyam Sunder, College of Fisheries, Mangalore
4. Dr. Krishna Srinath, Former Director, ICAR-DRWA, Bhubaneswar
5. Shri S.S. Rajpathak, Vice President, M/s Garware Wall Ropes Ltd., Pune

**Member Secretary:** Dr. P. Pravin/Dr. Leela Edwin, Principal Scientist, ICAR-CIFT

#### Research Advisory Committee

**Chairman:** Dr. V. Prakash, Former Director, CSIR-CFTRI, Mysore

#### Members

1. Dr. Rintu Banerjee, Professor, Dept. of Agriculture & Food Engineering, IIT, Kharagpur
2. Dr. D.S. Shesappa, Former Dean, College of Fisheries, Mangalore
3. Dr. K.C. Dora, Dean, College of Fisheries, West Bengal University of Animal & Fisheries Sciences, Kolkata

4. Dr. S. Jeevan, Chief Executive Officer, M/s.Samudra Shipyard (P.) Ltd., Aroor
5. Dr. Madan Mohan/Dr. P. Pravin, Asst. Director General (M. Fy.), ICAR, New Delhi
6. Dr. C.N. Ravishankar, Director, ICAR-CIFT

**Member Secretary:** Dr. Leela Edwin, HOD, FT, ICAR-CIFT

### **Institute Management Committee**

**Chairman:** Dr. C.N. Ravishankar, Director, ICAR-CIFT

#### **Members**

1. Dr. V.V. Kulkarni, Director, ICAR-NRC on Meat, Hyderabad
2. Dr. S. Samantha, Principal Scientist, ICAR-CIFRI, Barrackpore
3. Dr. V. Kripa, HOD, FEMD, ICAR-CMFRI, Kochi
4. Adv. Ranjeet Srinivas, Alappuzha
5. Shri K. Radha Madhavan, Kozhikode
6. Dr. T.V. Sankar, Principal Scientist, ICAR-CIFT
7. Dr. P. Pravin, Assistant Director General (M. Fy.), ICAR, New Delhi
8. Shri T.D.S. Prakash, Finance and Accounts Officer, ICAR-CPCRI, Kasaragod

**Member Secretary:** Shri P.J. Davis, Senior Administrative Officer, ICAR-CIFT

### **Grievance Cell**

**Chairman:** Dr. C.N. Ravishankar, Director, ICAR-CIFT

#### **Members**

1. Dr. Suseela Mathew, HOD, B&N
2. Shri P.J. Davis, Senior Administrative Officer
3. Shri P.P. Anil Kumar, Asst. Finance & Accounts Officer
4. Dr. M.P. Remesan, Principal Scientist
5. Shri H.V. Pungera, Senior Tech. Asst.
6. Shri D.L. Pattanaik, Lower Division Clerk
7. Shri P. Ragavan, Skilled Support Staff.
8. Shri M.V. Rajan, Auxillary Staff.

**Member Secretary:** Shri T. Viswanathan, Assistant Admn. Officer, ICAR-CIFT

### **Institute Joint Staff Council**

**Chairman:** Dr. C.N. Ravishankar, Director, ICAR-CIFT

#### **Members (Official side)**

1. Dr. Suseela Mathew, HOD, B&N
2. Dr. A.A. Zynudheen, Hod I/c, FP



3. Dr. M.P. Remesan, Principal Scientist
4. Smt. Christina Joseph, Administrative Officer
5. Assistant Finance & Accounts Officer

#### Secretary (Official Side)

Shri P.J. Davis, Senior Administrative Officer

#### Members (Staff Side)

1. Shri G. Vinod, Technician
2. Shri K.B. Subukuttan, Assistant Admn. Officer
4. Shri P.K. Somasekharan Nair, Assistant
5. Shri K.K. Karthikeyan, Skilled Support Staff
6. Shri P.N. Nikhil Das, Skilled Support Staff

#### Secretary (Staff Side)

Shri P.S. Nobi, Tech. Officer

### On-going Research Projects

#### Institute Projects

Sl. No	Name of Project	Principal Investigator	Location of Project	Co-Investigators	
1.	Nano technological intervention to mitigate fishing craft and gear material degradation	Dr. P. Muhamed Ashraf	Kochi	Kochi	Dr. Leela Edwin Dr. Saly N. Thomas Shri G. Kamei
2.	Risk assessment of emerging food-borne pathogens and chemical residues in aquatic systems	Dr. K. Ashok Kumar	Kochi & Veraval	Kochi         Veraval	Dr. T.V. Sankar Dr. Femeena Hassan Dr. J. Bindu Dr. S.K. Panda Dr. C.O. Mohan Dr. N.S. Chatterjee Smt. S.J. Laly Dr. Pankaj Kishore Smt. T.K. Anupama Dr. G.K. Sivaraman
3.	Species specific technologies for the improved utilization of the fishery resources of north west coast region	Dr. L.N. Murthy	Mumbai & Veraval	Mumbai       Veraval	Dr. S. Visnuvinayagam Dr. A. Jeyakumari Smt. U. Parvathy Dr. G.K. Sivaraman Dr. A.K. Jha Smt. S. Remya Smt.V. Renuka

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				Visakha- patnam Veraval	Smt. E.R. Priya Dr. B. Madhusudana Rao Kum. Jesmi Debbarma
				Mumbai	Dr. A.K. Jha Smt. V. Renuka Smt. S. Remya Dr. L.N. Murthy Dr. S. Visnuvinayagam Dr. A. Jeyakumari Smt. U. Parvathy
7.	Investigations on fish behavior and responsible fishing systems	Dr. V.R. Madhu	Kochi, Visakha- patnam & Veraval	Kochi	Dr. Leela Edwin Dr. Saly N. Thomas Dr. P. Pravin (till November, 2015) Dr. M.P. Remesan Shri M.V. Baiju Smt. Arathy Ashok Shri S. Chinndurai Shri R.K. Renjith Shri P.N. Jha Dr. G. Rajeswari Dr. R. Raghu Prakash Dr. U. Sreedhar Dr. K.K. Prajith Shri G. Kamei
8.	Design and development of standard deep sea fishing vessel and gear systems for commercial operation	Shri M.V. Baiju	Kochi, Visakha- patnam & Veraval	Kochi	Dr. Saly. N. Thomas Dr. P. Pravin (till November, 2015) Dr. M.P. Remesan Shri P.N. Jha Shri R.K. Renjith Dr. R. Raghu Prakash Dr. U. Sreedhar Dr. K.K. Prajith
9.	Marine biomolecules – Characteri-zation and utilization for neutraceutical, biomedical and industrial applications	Dr. K.K. Asha	Kochi, Visakha- patnam & Veraval	Kochi	Dr. Suseela Mathew Dr. R. Anandan Dr. George Ninan Dr. Femeena Hassan Dr. S.K. Panda Dr. C.O. Mohan Shri C.G. Joshy Dr. N.S. Chatterjee

				Visakha- patnam Veraval	Shri C.S. Tejpal Kum. Lekshmi R.G. Kumar Dr. Raja Swaminathan (ICAR-NBFGR, Kochi) Dr. B Madhusudana Rao Kum. Jesmi Debbarma Dr. A.K. Jha
10.	Modelling studies for estimation of revenue based capacity and valuation of selected fishing systems and fish supply chain analysis	Smt. P. Jeyanthi	Kochi	Kochi	Dr. Nikita Gopal Dr. V. Geethalakshmi Shri V. Radhakrishnan Nair Shri V. Chandrasekar Smt. Arathy Ashok Shri G. Kamei
11.	An assessment of the impact of S&T outputs of ICAR-CIFT on the socio-economic fabric of fisheries stakeholders	Dr. S. Ashaletha	Kochi	Kochi	Dr. V. Geethalakshmi Shri V. Radhakrishnan Nair Shri V. Chandrasekar Smt. Arathy Ashok
12.	Molecular heterogeneity and bioprospecting of aquatic and fish bacteria for novel molecules and genes	Dr. Toms C. Joseph	Kochi, Visakha- patnam, Veraval, Mumbai & Thiruvana- nthapuram	Kochi          Visakha- patnam Veraval Mumbai Thiruvana- nthapuram	Dr. K.V. Lalitha Dr. K.K. Asha Shri V. Radhakrishnan Nair Dr. V. Murugadas Shri K.A. Basha Shri R.K. Nadella Smt. S.S. Greeshma Smt. T. Muthulakshmi Dr. M.A. Pradeep (ICAR- CMFRI, Kochi) Dr. Raja Swaminathan (ICAR-NBFGR, Kochi) Dr. M.M. Prasad Dr. B. Madhusudana Rao Dr. G.K. Sivaraman Dr. S. Visnuvinayagam Dr. E. Sreekumar (RGCBT, Thiruvananthapuram) Dr. R. Ajaykumar (RGCBT, Thiruvananthapuram) Dr. Santhosh Mundayoor (RGCBT, Thiruvananthapuram)



13.	Quality improvement of Indian fishing fleet and engineering interventions in post harvest sector	Shri M. Nasser	Kochi	Kochi	Dr. S. Ashaletha Dr. V. Geethalakshmi Shri Ankur Nagori
<b>Externally funded projects</b>					
<b>Indian Council of Agricultural Research (ICAR) Projects</b>					
14.	Agri-business Incubation	Dr. George Ninan	Kochi, Visakha- patnam & Mumbai	Kochi  Visakha- patnam Mumbai	Dr. C.O. Mohan Dr. N.S. Chatterjee Smt. Elizabeth Paul* Shri C. Shyam Kumar* Dr. B. Madhusudana Rao Dr. L.N. Murthy
15.	Nutrient profiling and evaluation of fish as a dietary component	Dr. R. Anandan	Kochi	Kochi	Dr. Suseela Mathew Dr. K.K. Asha Dr. N.S. Chatterjee Shri C.S. Tejpal Kum. Lekshmi R.G. Kumar Smt. Divya K. Vijayan* Smt. R. Jayarani*
<b>National Agricultural Science Fund (NASF) Project</b>					
16.	Green fishing systems for tropical seas	Dr. Leela Edwin	Kochi, Goa, Pune & Mumbai	Kochi  Goa  Pune  Mumbai	Dr. Saly N. Thomas Dr. P. Pravin (till November, 2015) Dr. M.P. Remesan Shri M.V. Baiju Dr. V.R. Madhu Shri P.S. Muhammed Sherif* Smt. K.A. Sayana* Smt. Leena Raphael* Shri Rithin Joseph* Shri P.K. Mahato* Shri V.T. Antony* Smt. Jolsana Jeevan* Shri H. Unnikrishnan* Shri S. Vinayak Karma* Shri K.R. Harikrishnan* Shri B.K. Upadhyay Shri Ashok Naik Shri Sanjay V. Raut Shri Kishore Darda Kum. Margot Wunnikvan Shri Rakesh Gaikwad

Centre for Marine Living Resources & Ecology (CMLRE) Projects					
17.	Assessment of myctophid resources in the Arabian Sea and development of harvest and post harvest technologies	Dr. M.P. Remesan	Kochi, Visakha-patnam & Veraval	Kochi  Visakha-patnam Veraval	Dr. R. Anandan Dr. George Ninan Dr. A.A. Zynudheen Shri R.K. Nadella Shri R. Navaneethan* Shri M.M. Lijin Nambiar* Dr. G. Rajeswari Dr. R. Raghu Prakash Dr. K.K. Prajith
18.	Extraction and purification of marine bio-molecules and their derivatives for nutritional and industrial applications	Dr. Suseela Mathew	Kochi	Kochi	Dr. K.K. Asha Dr. N.S. Chatterjee Smt. K. Shyni* Smt. Deepa K. Vijayan*
19.	Characteri-zation of harmful algal blooms along Indian coast	Dr. K. Ashok Kumar	Kochi	Kochi	Dr. T.V. Sankar Dr. Pankaj Kishor Kum. R. Rajisha* Kum. Rose Mary Mathew*
20.	Exploration and assessment of demersal fishery resources along the continental slope (200-1200 m) of Indian EEZ and central Indian Ocean	Dr. U. Sreedhar	Visakha-patnam, Mumbai & Kochi	Visakha-patnam  Mumbai Kochi	Dr. G. Rajeswari Dr. R. Raghu Prakash Shri B. Prema Raju* Kum. S. Lavanya* Shri K. Rushinadha Rao* Dr. L.N. Murthy Dr. Suseela Mathew Shri K. Ajeesh Kumar* Shri K.V. Vishnu*
Department of Biotechnology (DBT) Projects					
21.	Development of bioplastic based sustainable biocomposites food packaging – “Sustain Nanopack”	Dr. J. Bindu	Kochi	Kochi	Dr. S.K. Panda Kum. Vidya*
22.	Genetic diversity of <i>Clostridium botulinum</i> in seafoods and development of Lateral Flow Immuno Assay (LFIA) for toxinotyping	Dr. K.V. Lalitha	Kochi	Kochi	Dr. Toms C. Joseph Shri Arun Jyothi* Smt. Athira Vidyadharan* Kum. Reethu Sara Anil*

<b>Department of Science and Technology (DST) Project</b>					
23.	Food safety interventions for women in fishery based micro enterprises in coastal Kerala	Dr. Femeena Hassan	Kochi	Kochi	Kum. Treesa Gracious* Kum. K.V. Nija*
<b>Ministry of Food Processing Industries (MoFPI) Project</b>					
24.	Use of natural resins and gums for preservation and value addition of fishery products	Dr. P.K. Binsi	Kochi & Ranchi	Kochi  Ranchi	Dr. C.N. Ravishankar Dr. George Ninan Kum. Natasha Naik* Dr. P.C. Sarkar
<b>Coconut Development Board (CDB) Project</b>					
25.	Techno-economic feasibility of coconut wood canoes for the small-scale fisheries sector in the southwest coast of India and Lakshadweep	Dr. Leela Edwin	Kochi	Kochi	Dr. Nikita Gopal Shri M.V. Baiju Dr. V.R. Madhu Shri K.A. Roshan* Smt. K.L. Chitrakala* Shri James J. Pulikottil*
<b>Indian National Centre for Ocean Information (INCOIS) Projects</b>					
26.	Retrieval of phyto-plankton and associated optical constituents based on long term bio-optical studies	Dr. P. Muhamed Ashraf	Kochi	Kochi	Smt. P. Minu* Smt. V.P. Souda*
27.	Validation of tuna advisories off east coast	Dr. U. Sreedhar	Visakha-patnam	Visakha-patnam	Shri R. Uma Maheswara Rao* Shri D. Dhananjay*
28.	Studies on ecological linkages between plankton production and <i>Acetes</i> sp. along Gujarat coast	Dr. V.R. Madhu	Veraval	Veraval	Dr. K.K. Prajith Kum. Vadher Kiran* Shri Muchhal Hareesh*
29.	Indigenous traditional knowledge (ITKs) in marine fisheries sector of Kerala: Documentation and analysis	Dr. Nikita Gopal	Kochi	Kochi	Dr. J. Bindu Smt. Arathy Ashok Shri S. Sreejith Kum. Diana Benjamin* Kum. M.V. Neelima* Shri Jiswin Jose* Kum. K.R. Remya* Kum. K.M. Mrudula* Kum. Sumisha Velloth (Vijnana Bharati, New Delhi)*

<b>UNDP-Global Environment Facility Project</b>					
30.	Demonstration and field testing of bycatch reduction and juvenile excluder devices along Sindhudurg district, Maharashtra	Dr. V.R. Madhu	Maharashtra	Maharashtra	Shri P.S. Khanolkar* Shri P.S. Dudhwadkar* Shri H.B. Redkar*
<b>National Fisheries Development Board (NFDB) Project</b>					
31.	National surveillance programme for aquatic animal diseases	Dr. K.V. Lalitha	Kochi	Kochi	Dr. Toms C. Joseph Dr. V. Murugadas Shri K. Ahamed Basha Dr. S. Ashaletha Shri P.G. Akhil Nath* Shri P. Saheer*
<b>ICAR-National Fellow Project</b>					
32.	Biomodulation of marine biopolymers for the preparation of biomaterials of healthcare importance	Dr. R. Anandan	Kochi	Kochi	Dr. P.R. Sreerekha* Smt. S. Vimaladevi*
<b>National Bank for Agriculture and Rural Development (NABARD) Project</b>					
33.	Assessing the role and impact of fisheries cooperatives in enhancing the livelihood and resource management capabilities of fisherfolk in India	Dr. Nikita Gopal	Kochi	Kochi	Smt. P. Jeyanthi Shri V. Chandrasekar Smt. Arathy Ashok Shri G. Jayesh*
* Research Fellow					



## List of Personnel in ICAR-CIFT

(As on 31 March, 2016)

### Managerial Personnel

Director: Dr. Ravishankar C.N.

#### Heads of Divisions

Biochemistry and Nutrition Division	: Dr. Suseela Mathew, Principal Scientist
Fish Processing Division & Quality Assurance and Management I/c	: Dr. K. Ashok Kumar, Principal Scientist
Microbiology, Fermentation and Biotechnology	: Dr. M.M. Prasad, Principal Scientist
Fishing Technology Division	: Dr. Leela Edwin, Principal Scientist
Engineering Division I/c	: Dr. A.A. Zynudheen, Principal Scientist
Extension Information & Statistics Division I/c	: Dr. Nikita Gopal, Principal Scientist

**Senior Administrative Officer** : Shri P.J. Davis

**Finance & Accounts Officer** : Shri K.S. Sreekumaran

Visakhapatnam Research Centre : Dr. G. Rajeswari, Principal Scientist

Veraval Research Centre : Dr. G.K. Sivaraman, Senior Scientist

Mumbai Research Centre : Dr. L.N. Murthy, Senior Scientist

### Other Personnel

#### Headquarters, Kochi

#### Scientific Personnel

##### Principal Scientist

1. Dr. K.V. Lalitha
2. Shri M. Nasser
3. Dr. Saly N. Thomas
4. Dr. T.V. Sankar
5. Dr. A.A. Zynudheen
6. Dr. M.P. Remesan
7. Dr. V. Geethalakshmi
8. Dr. R. Anandan
9. Dr. Femeena Hassan
10. Dr. S. Ashaletha
11. Dr. J. Bindu
12. Dr. P. Muhamed Ashraf

##### Senior Scientist

1. Dr. George Ninan
2. Dr. Toms C. Joseph
3. Dr. K.K. Asha
4. Dr. S.K. Panda
5. Dr. V.R. Madhu
6. Shri M.V. Baiju

##### Scientist

1. Shri V. Radhakrishnan Nair
2. Smt P. Jeyanthi
3. Dr. C.O. Mohan
4. Dr. V. Murugadas
5. Shri C.G. Joshy
6. Smt. Arathy Ashok
7. Shri V. Chandrasekar

8. Smt. S.J. Laly
9. Dr. P.K. Binsi
10. Dr. N.S. Chatterjee
11. Dr. Pankaj Kishore
12. Shri K. Ahamed Basha
13. Shri R.K. Nadella
14. Shri S. Sreejith
15. Smt. T.K. Anupama
16. Kum. H. Mandakini Devi
17. Shri Anuj Kumar
18. Shri R.K. Renjith
19. Smt. K.R. Sreelakshmi
20. Kum. Lekshmi R.G. Kumar
21. Smt. E.R. Priya
22. Smt. K. Sarika
23. Shri P.N. Jha
24. Smt. T. Muthulakshmi
25. Smt. S.S. Greeshma
26. Shri C.S. Tejpal
27. Dr. K. Elavarasan
28. Shri S. Chinnadurai
29. Shri Devananda Uchoi
30. Shri K. Sathish Kumar

### **Technical Personnel**

#### **Chief Technical Officer**

1. Dr. A.R.S. Menon

#### **Assistant Chief Technical Officer**

1. Shri C.R. Gokulan
2. Smt. K.B. Beena
3. Smt. P.K. Shyma
4. Dr. M. Baiju
5. Smt. T. Silaja

#### **Senior Technical Officer**

1. Shri T.V. Bhaskaran
2. Smt. M. Rekha
3. Shri K.D. Jos
4. Dr. B. Ganesan
5. Smt. K.K. Kala

6. Shri Sibasis Guha
7. Shri P.S. Babu
8. Shri G. Omanakuttan Nair
9. Dr. Santhosh Alex
10. Smt. G. Remani
11. Dr. P. Shankar
12. Dr. Ancy Sebastian

#### **Technical Officer**

1. Shri Jose Kalathil
2. Shri K.B. Thampi Pillai
3. Smt V.C. Mary
4. Shri P.T. Viswambharan
5. Smt. K.G. Sasikala
6. Shri V.N. Dileepkumar
7. Shri Aravind S. Kalangutkar
8. Shri Arockia Samy
9. Shri P.S. Nobi
10. Shri K.C. Gopalan
11. Smt. K.S. Mythri
12. Shri A.K. Naik
13. Shri T.P. Haridasan
14. Smt. P.K. Geetha
15. Shri C. Subash Chandran Nair
16. Shri Sajith K. Jose
17. Shri P.V. Sajeevan
18. Smt. P.A. Jaya

#### **Senior Technical Assistant**

1. Shri V.K. Siddique
2. Shri T. Mathai
3. Shri T.B. Assisse Francis
4. Smt. N. Lekha
5. Shri K.S. Babu
6. Shri P. Bhaskaran
7. Smt. Bindu Joseph
8. Shri T.P. Saju
9. Smt. N.C. Shyla
10. Shri G. Gopakumar
11. Shri P.D. Padmaraj
12. Smt. Tessy Francis

13. Shri P.S. Sunil Kumar

14. Shri N. Sunil

#### **Technical Assistant**

1. Shri K.V. Mohanan

2. Shri C.K. Suresh

3. Shri V.T. Sadanandan

4. Shri P.A. Aneesh

5. Shri K.D. Santhosh

6. Shri K. Dinesh Prabhu

7. Shri K.A. Noby Varghese

8. Smt. Vineetha Das

9. Shri J. Saju

10. Shri V. Vipin Kumar

11. Shri T. Jijoy

12. Smt. P. Sruthi

13. Shri Rahul Ravindran

14. Smt. U.P. Prinetha

15. Shri Rakesh M. Raghavan

#### **Senior Technician**

1. Shri K.C. Anish Kumar

2. Shri Ajith V. Chellappan

3. Shri G. Vinod

#### **Technician**

1. Shri K. Nakulan

2. Shri M.T. Udayakumar

3. Smt. K. Reshmi

4. Smt. Anu Mary Jose

5. Smt. G. Archana

6. Shri V.N. Sreejith

7. Smt. P.J. Mary

8. Shri P. Suresh

#### **Administrative Personnel**

##### **Administrative Officer**

1. Smt. Christina Joseph

##### **Assistant Administrative Officer**

1. Smt. Pushpalatha Viswambharan

2. Shri P. Krishna Kumar

3. Shri T. Viswanathan

4. Shri K.B. Sabukuttan

##### **Assistant Finance & Accounts Officer**

1. Shri P.P. Anil Kumar

##### **Private Secretary**

1. Shri P.K. Reghu

2. Smt. S. Kamalama

##### **Assistant**

1. Smt. V.S. Aleyamma

2. Smt. T. D. Usheem

3. Shri K.K. Sasi

4. Smt. T.K. Shyma

5. Smt. G.N. Sarada

6. Shri C.K. Sukumaran

7. Smt. V.K. Raji

8. Smt. K. Renuka

9. Shri M.N. Vinodh Kumar

10. Shri K. Das

11. Shri P.K. Somasekharan Nair

12. Smt. G. Surya

13. Smt. Nilina Elais

14. Smt. N.R. Akhila

15. Smt. Asha Gopalan

16. Smt. A.R. Raji

17. Shri P. Mani

18. Smt. Jaya Das

19. Smt. E. Jyothilakshmy

20. Smt. P.R. Mini

21. Shri T.N. Shaji

##### **Personal Assistant**

1. Smt. N. Leena

2. Shri K.V. Mathai

3. Shri R.D. Goswami

4. Smt. Anitha K. John

##### **Upper Division Clerk**

1. Smt. Shiji John

2. Shri P.G. David

3. Shri Santhosh Mohan

4. Smt. K.V. Suseela

**Lower Division Clerk**

1. Shri T.D. Bijoy
2. Shri P.P. George
3. Shri Subin George
4. Smt. Suni Surendran
5. Kum K.S. Sobha
6. Kum. T. Deepa
7. Shri G.S. Sahoo
8. Shri Deu Umesh Aroskar

**Supporting Personnel****Skilled Support Staff**

1. Shri P.A. Sivan
2. Shri G.B. Mahanandia
3. Smt. C.G. Radhamoney
4. Shri E. Damodaran
5. Shri P.V. Raju
6. Shri A.V. Chandrasekharan
7. Shri M.M. Radhakrishnan
8. Shri K.K. Karthikeyan
9. Smt. U.K. Bhanumathy
10. Shri T.K. Rajappan
11. Shri O.P. Radhakrishnan
12. Shri P. Raghavan
13. Shri T.M. Balan
14. Shri V. Deepak Vin
15. Smt. P.T. Mary Vinitha
16. Shri K.R. Rajasaravanan
17. Shri K. Thinakaran
18. Shri P.N. Nikhil Das
19. Shri A. Vinod
20. Shri K.S. Ajith
21. Shri S.N. Dash

**Auxiliary Staff**

1. Shri M.V. Rajan

**Visakhapatnam Research Centre****Scientific Personnel****Principal Scientist**

1. Sr. R. Raghu Prakash

2. Dr. U. Sreedhar

**Senior Scientist**

1. Dr. B. Madhusudana Rao

**Scientist**

1. Kum. Jesmi Debbarma
2. Dr. P. Viji

**Technical Personnel****Chief Technical Officer**

1. Dr. M.S. Kumar

**Assistant Chief Technical Officer**

1. Shri B.K. Pradhan
2. Shri B.K. Panda

**Senior Technical Officer**

1. Shri A.K. Panigrahi

**Technical Officer**

1. Shri Damodar Rout
2. Shri P. Radhakrishna

**Senior Technical Assistant**

1. Shri H.S. Bag
2. Shri M. Prasanna Kumar

**Technical Assistant**

1. Shri S.N. Dishri
2. Shri P.H. Dhiju Das

**Technician**

1. Shri G. Bhushanam

**Administrative Personnel****Assistant Administrative Officer**

1. Shri L.N. Badi

**Personal Assistant**

1. Smt. D.A.L. Satyanarayanamma

**Lower Division Clerk**

1. Shri D.L. Pattanaik
2. Shri Amit Vengraj
3. Shri Ramesh Mirdha

**Supporting Personnel****Skilled Support Staff**

1. Shri Sanyasi Ganik
2. Shri M.S. Prabhakar Rao



3. Smt. Nalla Naveena
4. Smt. Gyana Netri Nag
5. Shri S.K. Mehar
6. Shri T.N. Banchoor
7. Shri Kedar Meher
8. Shri Jaisingh Oram

### **Veraval Research Centre**

#### **Scientific Personnel**

##### **Scientist**

1. Dr. A.K. Jha
2. Smt. S. Remya
3. Smt. V. Renuka
4. Dr. K.K. Prajith
5. Shri G. Kamei

#### **Technical Personnel**

##### **Assistant Chief Technical Officer**

1. Shri J.B. Paradwa

##### **Technical Officer**

1. Shri K.U. Sheikh

##### **Senior Technical Assistant**

1. Shri H.V. Pungera

##### **Technical Assistant**

1. Shri G. Kingsely
2. Shri S.H. Ummer Bhai
3. Smt. V. Susmitha
4. Kum. Nimmy S. Kumar

##### **Senior Technician**

1. Shri K. Ajesh

##### **Technician**

1. Shri J.B. Malmadi
2. Shri Y.D. Kriplani

#### **Administrative Personnel**

##### **Assistant Administrative Officer**

1. Shri M.M. Damodara

##### **Assistant**

1. Shri D.P. Parmar

##### **Upper Division Clerk**

1. Shri Arockia Shaji

#### **Supporting Personnel**

##### **Skilled Support Staff**

1. Shri B.M.A. Khokhar
2. Shri K.J. Damor
3. Shri D.K. Viram
4. Shri R.N. Go sai
5. Shri A.M. Vala
6. Shri M.K. Kana
7. Smt. Harshaban A. Joshi
8. Smt. Pushpaben P. Chudasama
9. Shri N.K. Masani
10. Smt. Motiben K. Fofandi
11. Shri P. Ramakrishna

##### **Auxiliary Staff**

1. Shri J.K. Khodidas
2. Smt. Veena Sreedhar Narkar

### **Mumbai Research Centre**

#### **Scientific Personnel**

##### **Scientist**

1. Dr. S. Visnuvinayagam
2. Dr. A. Jeyakumari
3. Smt. U. Parvathy

#### **Technical Personnel**

##### **Assistant Chief Technical Officer**

1. Smt. Sangeetha D. Gaikwad
2. Smt. Triveni G. Adiga

##### **Technical Officer**

1. Shri P.S. Gadankush

##### **Technical Assistant**

1. Smt. Priyanka S. Vichare

##### **Senior Technician**

1. Shri T.A. Waghmare

#### **Administrative Personnel**

##### **Assistant**

1. Shri A.N. Agawane

#### **Supporting Personnel**

##### **Skilled Support Staff**

1. Shri V.S. Salvi
2. Smt. Priyanka P. Bait



“Research is to see what everybody else has seen,  
and to think what nobody else has thought”  
-Albert Szent-Gyorgyi  
Nobel Prize Winner, Medicine, 1937



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