ICAR CIFT

ANNUAL REPORT 2018-19

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ICAR-Central Institute of Fisheries Technology
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Annual Report
2018 - 2019

ICAR-Central Institute of Fisheries Technology
(Indian Council of Agricultural Research)
CIFT Junction, Matsyapuri P. O., Cochin - 682 029
(An ISO/IEC 17025-2005 Accredited; ISO 9001-2015 Certified Institution)

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ICAR-CIFT SUNBOAT-II
(solar powered fishing boat for inland waters)

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Contents

निदेशक के डेस्क से

स्थापना के बाद से (62 वर्षों में) 1957 में भाकृअनुप-केन्द्रीय मात्स्यिकी प्रौद्योगिकी संस्थान ने मात्स्यिकी में प्रग्रहण और पश्च प्रग्रहण के क्षेत्रों में क्रांति लाने के लिए अथक प्रयास किया है। संस्थान ने स्वयं को राष्ट्र की सेवाओं के लिए समर्पित किया है और देश की आर्थिक वृद्धि और पोषण सुरक्षा के लिए अत्यधिक योगदान दिया है। यह प्रतिवेदन संस्थान की (वर्ष 2018-19) उपलब्धियों पर प्रकाश डालता है। साथ ही संस्थान अपने वैज्ञानिकों और अन्य सहायक कर्मचारियों के समर्पित सेवाओं और उपलब्धियों पर गौरवान्वित है।

केमाप्रौसं, भारतीय खाद्य और सुरक्षा एवं मानक प्राधिकरण (एफएसएसएआई), स्वास्थ्य और परिवार कल्याण मंत्रालय, भारत सरकार द्वारा 2018 में मत्स्य और मत्स्य उत्पादों के लिए राष्ट्रीय संदर्भ प्रयोगशाला का सम्मान प्राप्त है। पिछले वर्ष इसे राष्ट्रीय संदर्भ प्रयोगशाला का प्रतिष्ठित दर्जा भी प्राप्त है।

उत्तरदायी मत्स्यन को बढ़ावा देने के उद्देश्य से संस्थान में देश की पहली मत्स्य व्यवहार का अध्ययन करने वाली प्रयोगशाला स्थापित की गई। संस्थान ने मत्स्यन यान के संक्षारण प्रतिरोध में सुधार करने के लिए नानो प्रौद्योगिकी को प्रयोग में लाया गया। मस्य पकड़ को बढ़ाने के लिए विभिन्न प्रकार के जालों का परीक्षण किया गया। मत्स्यन के दौरान खोये गये जाल आज विश्व भर में एक गंभीर समस्या है। इस मुद्दे पर संस्थान के द्वारा देश में पहली बार शोध कार्य आरंभ किया गया है। इस अध्ययन के दौरान यह पता लगा है कि तमिलनाडु के इनयम में प्रति वर्ष, प्रति व्यक्ति 1 से 12 ट्राप खो जाता है जो चिंताजनक है। केमाप्रौसं को नीली क्रांति योजना के तहत कोचिन शिपयार्ड के साथ जुड़ने पर गर्व है, जिसके द्वारा संस्थान द्वारा अभिकल्प किए और शिपयार्ड द्वारा निर्मित गहरे समुद्री जहाजों को तमिलनाडु में लाभार्थियों के बीच वितरित किया गया। इससे मछुआरों को अधिक पकड़ मिलने में सुविधा प्राप्त हुई।

मत्स्य की खरीदी में उपभोक्ताओं के लिए ताज़गी, एक महत्वपूर्ण पहलू है। इसकी ओर ध्यान रखते हुए संस्थान ने कई ताजगी संकेतक विकसित किए हैं, जिनमें से एक रजत नैनोकणों पर आधारित है। मत्स्य के जीवित परिवहन की आवश्यकता को ध्यान में रखकर, एक जीवित मत्स्य परिवहन प्रोटोटाइप विकसित किया गया और इसके निष्पादन का मूल्यांकन किया गया। पिछले कुछ वर्षों में, संस्थान ने समुद्री शैवाल के माध्यम से किसान की आय को दोगुना करने के लिए प्रधानमंत्री के आह्वान की ओर ध्यान केंद्रित कर समुद्री शैवाल के उपयोग करने के प्रयास में वृद्धि की है। हरित रसायन विज्ञान की प्रक्रिया से फ़्यूकॉइडेन और फ़ॉक्सोक्सैन्थिन का निष्कर्षण, उलवा लैक्टुका शैवाल से एसिटिलेटेड उल्वन के उत्पादन और उसका बायोरेमेडिएशन में उपयोग, भूरे समुद्री शैवाल (पैडीना जिम्नोस्पोरा) का रोगाणुरोधी गुणा आदि का अध्ययन किया जाता है।

संस्थान, उत्पाद, प्रक्रिया और विधि विकास अनुसंधान में प्राय सक्षम रहा है। समुद्रीय बयोआक्टिक अणुओं का उपयोग कार्यत्मक खाद्य विकास के लिए किया गया है। काइटोप्रो, स्क्विड और टूना मीट प्रोटीन हाइड्रोलाइजेट, डाइटरी फाइबरयुक्त टूना सॉसेज, फूकोयोडान कुछ उल्लेखनीय उपलब्धियाँ हैं। विटामीन बी 12 सहित वसा और पानी में घुलनशील विटामिन के निर्धारण के लिए विश्लेषणात्मक तरीके, कोलेजन हाइड्रोलिसिट्स में अमीनो अम्ल के निर्धारण के लिए तरीके, समुद्री तेलों में टोकोफेरोल आइसोमर्स की मात्रा के ठहराव के तरीके और फूकोसैन्थिन के निष्कर्षण के तरीके विकसित किए गये हैं।

इसके अतिरिक्त संस्थान ने विश्लेषणात्मक प्रोटोकाल को भी विकसित किया, प्रतिजैविक अवशेष, कीटनाशक अवशेष, भारी धातु, मीथैल मेरक्यूरी, सोडियम बेंजोएट, सिगुआटोक्सिन, अमोनिया और फारमाल्डीहाइड को जाँचने के लिए इन्हें आइ एस ओ 17025 आवश्यकताओं के अनुसार मान्य किया गया। फारमाल्डीहाइड और अमोनिया के साथ मत्स्य के मिलावट को जाँचने के लिए तैयार सिफटेस्ट की सफलता के बाद केरल सरकार के खाद्य सुरक्षा आयुक्तालय से प्राप्त वैध नमूनों को अमोनिया के मिलावट के लिए विश्लेषित किया गया। 70 प्रतिशत नमूनों में अमोनिया की मात्रा 1.32 एम जी/कि ग्राम थी, 17 नमूनों में अमोनिया नहीं था, जबकि 13 जाँच स्तर से कम था।

ई. कोली 0157 और ई कोली के जांच के लिए स्वर्णिम नानो कणों को मिलाकर तैयार किए काग़ज आधारित स्ट्रिप का विकास किया गया। दुनिया में सबसे ज्यादा दवा प्रतिरोध रोगाणु भारत में पाया जाता हैं। इस बढती समस्या के समाधान हेतु संस्थान की अनुसंधान टीम भिन्न पहलुओं को लेकर कार्य कर रही है। आँध्रप्रदेश में खेती किए गए पीनस वन्नेमी झींगा से पाये गए बैक्टीरिया ने एरिथोमैसिन के खिलाफ 100 प्रतिरोध दर्शाया।

संस्थान में संवहनीय ऊर्जा उपयोग के लिए प्रभावी ऊर्जा और पुन उपयोगी ऊर्जा के क्षेत्र में अनुसंधान जारी है और अनेक उपकरणों का अभिकल्प किया है जो सस्ती, ऊर्ना और इंधन प्रभावी और पर्यावरणानुकूल है। इनमें टेंट शुष्कक और मत्स्य विश्कलन मशीन शामिल है। बैच किस्म वाले इनफ्रारेड शुष्कक और सौर एल पी जी हाईब्रिड ड्रायर का अभिकल्प किया गया। संस्थान द्वारा समुद्री आहार उद्योगों के वास्तविक समय ऊर्जा खपत पर अध्ययन किया जा रहा है। संस्थान द्वारा उद्यमकर्त्ता विकास, हौज मात्स्यिकी और आजीविका, पूंजी निर्माण और उपभोक्ता व्यवहार जैसे महत्वपूर्ण सामाजिक आर्थिक विषयों पर भी अध्ययन किया जा रहा है। कई सुदूर गतिविधियाँ भी आयोजित की गई जिसमें 37 प्रौद्योगिकी हस्तांतरण कार्यक्रम भी शामिल थे।

पिछले वर्ष, संस्थान ने अंतर्राष्ट्रीय स्तर के संगठन जैसे एफ ए ओ, वर्ल्ड फिश, बेआफ बंगाल प्रोग्राम, व एशिया पेसिफिक फिशरीज कमीशन के साथ साझेदारी की। राष्ट्रीय और अंतर्राष्ट्रीय स्तर के पत्रिकाओं में आलेखों के प्रकाशन से हमारे शोध परिणामों का प्रचार किया जाता है। भारत सरकार के प्रमुख कार्यक्रम जैसे स्वच्छ भारत अभियान और मेरा गाँव, मेरा गौरव को बड़े उत्साह के साथ मनाया गया।

वर्ष 2020 के परिदृश्य को देखते हुए के मा प्रौ सं सम विचारात्मक संगठनों के साथ मिलकर देश के मात्स्यिकी क्षेत्र को सुदृढ़ करने के प्रति लक्ष्यप्रद है। हम अभिनव अवसर, नव साझेदारी और वर्तमान सहभागियों के साथ सहयोग सुदृढ़ करने के प्रति परिलक्षित हैं।

जय हिन्द

कोच्चि
30 जून 2019

रविशंकर सी.एन.
(निदेशक)

FROM THE DIRECTOR'S DESK

For the past 62 years, since its inception in the year 1957, ICAR-Central Institute of Fisheries Technology, has worked relentlessly towards revolutionizing the harvest and post harvest sectors in fisheries. The Institute has dedicated itself to the services of the nation and has contributed immensely towards the country's economic growth and nutritional security. This report shines light on the Institute's achievements in the year 2018-19, celebrating key successes and accomplishments borne out of the dedicated and concerted efforts of its research and other support staff.

ICAR-CIFT has been bestowed with a rare honor, being adorned with National Reference Laboratory status for Fish and Fish products by Food Safety and Standards Authority of India (FSSAI), Ministry of Health and Family Welfare, Govt. of India in 2018 having been conferred with National Referral Laboratory status earlier.

The country's first laboratory to study fish behavior has become operational at the Institute with the aim of promoting responsible fishing. The Institute has applied nanotechnology to improve corrosion resistance of fishing craft and field tested a varied range of traps for increasing the catch in terms of both number and weight of species caught. Working in tune with the global initiative against the grave issue of ghost gears, ICAR-CIFT has initiated research in this area for the first time in the country. Studies has revealed that off Enayam, Tamil Nadu, about 1 to 12 traps are lost per year per person which is a cause for concern. ICAR-CIFT is proud to have associated with Cochin Shipyard Ltd. under the Blue Revolution scheme whereby deepsea vessels designed by ICAR-CIFT and constructed by the shipyard were distributed among beneficiaries in Tamil Nadu. The later celebrated a bumper catch from their maiden deep sea operations which is a commendable achievement.

Acknowledging the importance of freshness attribute in consumer preference, the Institute has developed several freshness indicators based on biomaterials and simple chemicals. With the need for live transportation of fish ever rising, a live fish transportation prototype was developed and its performance was evaluated. As in the previous couple of years, the Institute has increased efforts to utilize seaweeds in response to Prime Minister's call for doubling of farmer's income through seaweed farming. From green chemistry process for extraction of fucoidan and fucoxanthin, use of acetylated ulvan from *Ulva lactuca* as a biomaterial, assessing role of *U. lactuca* in bioremediation to proven antimicrobial property of brown seaweed (*Padina gymnospora*), we believe research in this area is cruising ahead in the right direction.

Product, process and method development have always been the strong forte of research at ICAR-CIFT. Marine-derived bioactive molecules assume roles such as that of inhibitors, enzymes, antimicrobials making them the right candidates for nutraceutical/functional food development. Research efforts have met with success in the form of either commercialized or in-the-pipeline products; ChitoPro, squid and tuna red meat protein hydrolysate, dietary fibre-incorporated tuna sausages, fucoidan are a few worth mentioning.

Analytical methods have been developed for: determining fat and water soluble vitamins including vitamin B12, pre column derivatization method for determining amino acids in collagen hydrolysates, method for quantification of tocopherol isomers in marine oils and supercritical carbondioxide extraction method of fucoxanthin. In addition, the Institute has also developed analytical methodologies/ protocols, validated and accredited as per ISO 17025 requirements for detection of antibiotic residues, pesticide residues, heavy metals, methyl mercury, sodium benzoate, ciguatoxin, ammonia and formaldehyde. Following the immense success of the CIFTest for detection of adulteration of fish with formaldehyde and ammonia, legal samples obtained from Food Safety Commissionerate, Govt. of Kerala were analyzed for ammonia adulteration. An alarming 70% samples had ammonia content in the range of 1.32-30.5 mg/kg, 17% of samples were free of ammonia while 13% had below detection levels.

Prompted by low tolerance of pathogens in fish, the development of paper based strips incorporated with gold nanoparticles for detection of *E. coli* O:157 and *E. coli* is need-driven research outcome of the Institute. India carries one of the largest burdens of drug-resistant pathogens worldwide. To address this growing problem, Research in ICAR-CIFT is addressing many aspects of antimicrobial (drug) resistance, including basic research on how microbes develop resistance. AMR pattern of the bacteria isolated from farmed *Penaeus vannamei* shrimp of Andhra Pradesh indicated 100% resistance of *E. coli* towards erythromycin. Water of retail fish markets in Cochin, testing positive for *Chromobacterium violaceum* a biofilm bacteria of Enterobacteriacea, garnering wide attention due to its high mortality rate, is a cause for concern.

Recognizing the fact that efficient energy use and renewable energy are two essential components for sustainable energy, research in the Institute has led to the design and development of several equipment that are low cost, energy and fuel efficient and user friendly, like walk-in solar tent dryer, portable non-invasive fish freshness sensor button operated mini fish descaling machine. Improvisation of design and performance evaluation were carried out for batch-type infrared dryer and solar-LPG hybrid dryer. Innovative smart dryers with mobile alert system that informs about the degree of drying with automated operations has also been developed. The Institute has been carrying out studies on real time energy consumption of seafood industries. ICAR-CIFT also took up crucial socio-economic studies on entrepreneurship development, reservoir fisheries and livelihoods, capital formation and consumer behaviour. Several outreach activities were also organized of which about 37 were transfer of technology programs.

In the past year, the Institute had fostered partnerships with several organizations of international significance like the FAO, WorldFish, Bay of Bengal Programme, Asia Pacific Fisheries Commission etc. that has had positive impact on the quality of our research. Our research outcomes are extensively communicated through publishing of papers in journals of national and international repute. The flagship programs of the Government of India, the Swachha Bharat Abhiyan, Mera Gaon Mera Gaurav etc. were observed with great fervor.

Looking ahead to 2020, ICAR-CIFT intends to join forces with like-minded organizations in strengthening the fisheries sector in the country through research, policy and development. We look forward to the new opportunities that will arise, to new partnerships, and to strengthen collaboration with existing partners.

Jai Hind

Cochin
30 June 2019

Ravishankar C.N.
(Director)

कार्यकारी सारांश

- भिन्न किस्म के ग्राफेनिया से लेपित बोट निर्माण स्टील पर नानो जिंक आक्साइड सेरियम सम्मिलित फोसफेटिंग किया गया और रासायनिक रूप में कम किए हुये ग्राफीन द्वारा बेहतर प्रतिरोध दर्शाया गया।
- पोलीनालिन लेपित पाली एथीलीन जलकृषि पिजंडे जाल पर लेपित नानोसिलिकोन डाईआक्साइअड और जिंक आक्साइड (0.01 नानो SiO_2 + 0.02 हचर्हढ्ढ) समुद्री अवस्था में छह महीने में रखने के बाद भी उत्तम जैव फफूँद प्रतिरोध दर्शाया गया।
- नानो कॉफर आक्साइड दृढ काजू खोल तेल सूराब जीवों के खिलाफ उत्तम प्रतिरोध दर्शाया गया, उपचार किए गए लकडी पेनलों के यंत्रवत गुणों में समवर्ती सुधार पाया गया।
- मत्स्य व्यवहार प्रयोगशाला में ट्रालिंग गतिविधियों के अनुकरण के लिए पीपों के चौपाये आधार की सुविधा प्रदान की गई।
- तमिलनाडु, केरल, कर्नाटक और गोवा राज्यों में प्रचलित गिल जालों के 38 अभिकल्प का दस्तावेजीकरण किया गया।
- वेरावल तट में भिन्न किस्म के फंदों (सुधार किया गया गारगूर, मिन्नो ट्रेण्स, मोडकर ले जा पाने वाले और के मे प्रौ सं लाबस्टर फंदा) की क्षेत्र जांच की गई।नसलों की संख्या और वजन और पकड के आवृति के आधार पर सुधार किए गये गारगूर फंदों में उच्च पकड़ थी।
- कोल्लम में वाणिज्यिक मत्स्यन यानों से इकटठे किए आंकडों से पता चला कि 300-400 की गहराई में प्रचालित निचले ट्राल से 22 नसल प्राप्त हुए। पकड़े गए मुख्य नसलों में कुस्क ईल,कलोरोफथालम्स कोरनिगर और वेब्रोस्केडिमाकूलाटा थे। वाणिज्यपरक यानों का सी पी यू ई लगभग 350 कि ग्राम/घंटा था।
- भिन्न तरीकों द्वारा आंध्रप्रदेश के विशाखपट्टणम, काकिनाडा,निजामटणम और मछलीपट्टणम के मत्स्य पद्धतियों के संरचनात्मक और प्रचालनात्मक परिवर्तनों को दस्तावेजीकृत किया गया।
- आंध्रप्रदेश तट के छोटे और मध्यम ट्रालरों से पता चला कि 40 और 50 निर्णय लेनेवाले युनिट कम आर्थिक स्तर से प्रचलित किए गए।
- कोचिन, विषिंजम और इनायम में गोता लगाकर खोए गिअरों के सबूत का निर्धारण किया गया। मछुआरों से लिए गए साक्षात्कार से पता चला कि फंदा के घाटे का दर प्रति फंदा, प्रति व्यक्ति 1 से 12 था।
- वेरावल में मछुआरों को समुद्रीराज्य भविष्यवाणी को प्रसारित करने एवं लहर की ऊँचाई और अन्य समुद्री प्राचल को मान्यता प्रदान करने के लिए एक लहर बॉय को प्रतिस्थापित किया गया।
- डायमंड और चौकोर मेश कोड एंड में *ट्रिचूरियस लेपट्रेस* का L_{50} मूल्य (स्तरीय गलती) 48.47 (0.069) और 50.97 (1.28) क्रमश थे। इस नसल के पहले परिपक्वता की लंबाई के आधार पर डायमंड और चौकोर मेश कोडएंड का अनुकूलन मेश आकार 50.5 सस और 48.0 सस क्रमश थे।
- अंतस्थलीय और समुद्री मत्स्यन प्रचालन के लिए मोडेजानेवाले फंदों को अभिकल्प कर संरचित किया गया।समुद्री पिंजरे के साइट के पास किए गये क्षेत्र परीक्षण के दौरान अडबेफडफ वयागियानिस और अकांतुरस माटा पकड़ा गया।
- मणिपुर के अंतस्थलीय क्षेत्र में उपयोग किए जा रहे पारंपरिक फंदों का सर्वेक्षण किया गया।
- केरल के अंतस्थलीय मत्स्यन क्षेत्र में बाढ़ के कारण हुए घाटे का शीघ्र मूल्यांकन किया गया।
- पापेण किण्वक से टूना लाल मांस में अनुकूलित जैवसक्रिय प्रोटीन हाइड्रोस्लेट का अपस्केलिंग किया गया।
- भा कृ अनु प के वार्षिक सामान्य शासीय बैठक में कृषि एवं किसान कल्याण विभाग के केन्द्रीय मंत्री ने झींगा सिर अवशिष्ट से अस्ताजानतिन का विमोचन किया।
- आहार तंतु सम्मिलित टूना के लिए प्रोटोकाल को स्तरीयकृत किया गया और इसे टूना सासेज के घरेलू उत्पादन हेतू चेन्नई के एक प्रसंस्करण युनिट में वाणिज्यपरक रूप में हस्तांतरित किया गया।
- स्वच्छ मत्स्य के गुण और स्वच्छता मूल्यांकन के लिए एक डिमेरिट स्कोर आधारित मत्स्य गुणता इंडेक्स (एफ क्यू आई) विकसित किया गया।
- पी एल ए आधारित फिल्म और ट्रे विकसित किया गया और मात्स्यिकी उत्पादों के संवेष्ठन के लिए इसका मूल्यांकन किया गया।

- अरेका ट्रे की तुलना में बगासी ट्रे बेहतर पाया गया और यह कम तापमान संचयन में मत्स्य मांस के फुटकर संवेष्ठन के लिए अच्छी जैव अवनत सामग्री है।
- उपयोग किए जा रहे भिन्न जैविक अम्लों में, आक्सीजन स्केवेंजिग के लिए एस्कोरबिक अम्ल और लोहा ज्यादा प्रभावकारी रहा।
- ट्रेसोडियम सिट्रेट द्वारा तैयार किए गए छय नानो कण को स्वच्छ और हिमीकृत संचयित मत्स्य के फर्क को समझने के लिए उपयोग किया जा सकता है।
- लाल किडनी बीन्स द्वारा तैयार किए गएॅरसंवेदी फिल्म को स्वच्छता सूचक के रूप में उपयोग किया जा सकता है।
- भा कृ अनु प-के मा प्रौ सं द्वारा अभिकल्पित परिवहन प्रोटोटाइप द्वारा जिंदा मत्स्य जैसे निले टिलेपिया, आम टिलेपिया, दूध मत्स्य और ट्रेवाली का कार्य निष्पादन मूल्यांकन किया गया।
- मत्स्य संवेष्ठन उपयोग के लिए जलकुभी ठंडल से शोषक और गैर शोषक परत से एक नमी शोषक पैड विकसित किया गया।शोषक अंतर्भाग के रूप में कारबोक्सिमीथैल कैटोसन चुना गया।
- कैटिन प्रोटीन डेरिवेटिव 'कैटो प्रो' जैव कार्यात्मक अनुपूरक के रूप में विकसित किया गया।
- भूरे समुद्री शैवाल से फूकोयडन को निचोडा गया और लक्षणयुक्त किया गया।
- मसालेदार और सूखे टूना टुकड़ा के लिए माइक्रोवेव शुष्कन प्रक्रिया को स्तरीयकृत किया गया।
- बर्फ में संचयित पिंजरे में पाले गए ग्रूपर के गुणात्मक बदलावों का मूल्यांकन किया गया और इसकी कवच आयु 22 दिनों की थी।
- फोम मेट शुष्कन तकनीक द्वारा स्किविल्ला प्रोटीन तैयार की गई।
- ब्रेड में समुद्री शैवाल आहार तंतु को क्रियाशील घटक के रूप में जोडने से संचयन के दौरान नमी कम होती है और इस प्रकार टुकडे की कठोरता कम होती है।
- सूखे बांम्बे डक को अदरक लहसून से पूर्व उपचार करने से स्पाइल घोल और नियंत्रण नमूनों की तुलना में यह बेहतर गुण दर्शाए।
- कैटोसन लेप के साथ ट्राई सोडियम उपचार करने पर, हिस्टमिन के निम्न स्तर के साथ, मैकरेल कीकवच आयु 11 दिनों तक बढाने में प्रभावकारी रही।
- नवी मुंबई मत्स्य बाज़ार में कलोरामफेनिकोल और ए ओ जेड जैसे प्रतिजैविक अवशिष्ट के जांच से यह पता चला कि फुटकर बाजार के नमूनो में झींगों में सिफारिश की गई सीमा उच्च मात्रा में थी।
- स्टाफलोकोकस ओरियस का टोक्सिनैटाईपिंग किया गया। ज्यादा प्रचलित जीनोटाइप एस इ सी (17.44), एस इ बी (12.2), एस इ ए (2.9) और टी एस एस टी 1 (16.2) था।
- स्वच्छ मत्स्य नमूनों (n=150) में फारमाल्डीहाइड मात्रा का साधारण स्तर <LoQ से 5.0 mg/किलोग्राम था।
- आहार सुरक्षा कमिशेनेरेट, केरल सरकार से प्राप्त वैधिक नमूनों (56) को अमोनिया में मिलावट के लिए जांचा गया। 17% नमूनों में आमोनिया नहीं था, 13% जांच स्तर से कम था और 70% में 1.32-30.5 सय/य के रेंज में था।
- भूरा झींगा (मेटापीनस मोनोसेरस), जिंग झींगा (मेटापीनस एफिनिस)और किडडी झींगा (पेरोनेपसिस स्टिलोफेरा) जांचा गया और अलेरजीवाले भाग को पहचाना गया। झींगा अलेरजन को खिलाने से BALB/c चूहों की अत्यंत संवेदनात्मक प्रतिक्रिया रही। मेट ापीनस डोबसोनी से शुद्ध किए गए ट्रोपोमयोसिन का मूल्यांकन किया गया।
- पूर्वोत्तर राज्यों के सूखे और किण्वित मत्स्य उत्पादों की सुरक्षा का मूल्यांकन किया गया। नागालैंड के फासाशिडाल से हिस्टेमिन (118.18±1.22 ppm)का उच्च सांद्र दर्ज किया गया। प्रमुख हिस्टेमिन फोरमेरों में बासिलस आर्य भट्टे और पेनिबेसिलस फेवी स्पोरस थे।
- झींगा के वाणिज्यपरक रूप में हिमीकृत शुष्कन प्रक्रिया के प्रसंस्करण मूल्यांकन से पश्च हिमीकरण अवस्थाओं में अनुचित स्वच्छता की सूचना मिली,जिससे अंतिम उत्पाद में कालिफार्म भार बढा।
- फुटकर स्टोर और सुपरमार्केटों में वाणिज्यक रूप में विपणन किए गए और खाने के लिए तैयार मत्स्य का सूक्ष्म जैविक सुरक्षा निर्धारित की गई। मत्स्य बाजारों में लिस्टिरिया मोनोसैटोजेन्स 4.4 प्रचलित रहा।
- लिस्टिरिया मोनोसैटोजेन्स और अन्य लिस्टिरिया जाति के साथ साथ जांच के लिए डूपलेक्स पी सी आर विकसित की गई। एंटेरो हीमोरेक एश्चेरिया कोली (इ कोली 0157117) के जांच के लिए मल्टीप्लेक्स पी सी आर विकसित की गई।

- समुद्री आहार में वी. पाराहीमोलिटिकस (036) के पांडेमिक स्ट्रेन को जांचने के लिए उच्च संवेदी पी जी एस पी सी आर एसे विकसित किया गया।
- भिन्न प्राथमिक मत्स्य उत्पादन क्षेत्रों में स्वास्थ्य स्तर का मूल्यांकन, परिधीय आहार संपर्क सतह और ठंडेपन के लिए उपयोग किए गए बर्फ में स्वास्थ्य सूचक जीवाणु का उच्च लोड था।
- एंटीबयोटिक अवशिष्ट, कीटनाशक अवशिष्ट, भारी धातु, मीथैल मेरकुरी, सोडियम बेनजाएट, सिगुआ टोक्सिन, अमोनिया और फोरमाल्डीहाइट के जांच के लिए ISO 17025 जरूरतों के अनुसार विश्लेषणात्मक तरीके/प्रोटोकॉल को विकसित और मान्य किया गया।
- जांच किए गए 133 नमूनो में से 73 नमूनों में एकरोबैक्टर जाति पाया गया। एकरोबैक्टर के 96 आइसोलेटों में आण्विक लक्षणीकरण किया गया जिसमे एकरोबैक्टर बजलेटी (401 bp), ए. स्किरोवी (641 bp) और ए. क्रमारोफिलस (257 bp) शामिल है। 51 आइसोलेटों के ए. बुजलेरी के रूप में पहचाना गया। चार आइसोलेटों को ए. स्किरोवी के रूप में पहचाना गया, 26 आइसोलेटों को ए. क्रयोफिलोस के रूप में पहचाना गया और 15 आइसोलेटों को मल्टीप्लेक्स पी सी आर द्वारा अलग नहीं किया गया।
- डिस्क डिफूशन तरीके द्वारा 1103 जीवाणु आइसोलटों को चुनकर, शुद्ध कर पांच भिन्न ऐंटीबयोटिकों के विरूद्ध प्रतिरोध का अध्ययन किया गया। सिप्रोफलेक्सिन (141; 12.7%), कलोरामफेनिकोल (48; 4.3%), को ट्रैमोवजोल (161; 14.5%), एरिथ्रोमैसिन (132; 11.9%) और आक्सीटेट्रासेकलीन (460; 41.7%) के लिए ऐंटीबयोटिक प्रतिरोध की जांच की गई। 192 में से 68 आइसोलेटों मे टेट छजीन पाया गया (387 bp), 25 में से आइसोलेट में केट एल जी था (349 bp), 50 में से 4 आइसोलेट में 1 जीन (433 bp) और 50 में से 4 आइसोलेट में स्टिल जीन (657 bp) पाया गया।
- 16 S rDNA सीक्वेसिंग द्वारा 4 सल्फेट आक्सीकारक जीवाणु आइसोलेटों में (मेंग्रोव से 3 SC 10, SD 6 और एस बी आई और स्वच्छ पानी मत्स्यफार्म -TA-1) को पहचाना गया। यह हालोथियोबासिलस जाति और थियोमोनास जाति के थे।
- ट्राई सोडियम सिट्रेट से तैयार किए गए छपशज शुद्ध किण्वक के साथ स्थिरीकरण पर अच्छा रंग दर्शाया।
- कोलोरिमेट्रिक एसे के लिए, कलोरोफेनोल रेड β-D गेलेक्टोपी रानोसाइड (CPRG) और 5-ब्रोमो-4-कलोरो-3-इंडोल्लि β-D गालूकूरोनाइड (X- ग्लुक), शुद्ध किण्वकों के लिए चयनात्मक थे जिसमें β- गलेक्टोसिडेस, β ज्लूकोरोनिडेस शामिल थे जहाँ *इ.कोली* O:157 और *इ.कोली* क्रमश थे।
- फिल्टर कागज द्वारा जीवाणुओं को जांचने के लिए काग़ज आधारित स्ट्रिप, विकसित किए गये।
- *इ. कोली* O:157 के साथ संवेष्ठित झींगा नमूनों में 37°C में 9 घंटे और 12 घंटे एनरिचमेंट के बाद और 30 मिनट और 2 घंटों के उष्मायन से काग़ज के स्ट्रिप जोड़े सुनहरे नानो कणों में विशिष्ट रंग पाए गये।
- क्रोमोबैक्टीरियम वायोलेसियम इन्ट्रोबेक्टीरियेसी का एक जैवफिल्म जीवाणु है यह अपनी उच्च मृत्यु दर के कारण नैदानिक मामलों में व्यापक ध्यान को आकर्षित कर रहा है। खुदरा मत्स्य बाज़ार के जल का छानबिन करते समय, तीन नमूने सी. वायोलेसियम संदूषित है। दस वियुक्तियों को शुद्ध किया गया और जैव रसायन एवं आणु लक्षणा चित्रण की पुष्टि की गई।
- काइटोसैन -ZnO सम्मिश्र प्रति से नानोकाइटोसैन -ZnO सम्मिश्र कुछ ज्यादा प्रतिजैविक प्रतिक्रिया को रखता और काइटोसैन -ZnO या नानोकाइटोसैन सम्मिश्र की प्रतिजैविक प्रतिक्रिया H_2O_2 संयोजित काइटोसैन नानोकाइटोसैन प्रतिजैविक प्रतिक्रिया के समान है।
- *फीलन्टोस एसीडस* (अम्ल) फल निचोड संयोजित काइटोसैन -ZnO सम्मिश्र खाद्य जान्य रोगजनक के विरूद्ध प्रतिजैविक प्रतिक्रिया की वृद्धि करता।
- 5% के समुद्री नमूनों में रोगजनक विब्रियों वियुक्तियों को खोजा गया।
- 13.3% समुद्री खाद्य नमूनों से *वी.कोलेरा* नॉन 01 वियुक्तियों को प्राप्त किया गया।
- समुद्री शैवाल संबद्ध जीवाणु *बेसिलस सीरस* से एक्सोपॉलिसकरीड्स युक्त सल्फेट समूह को निष्कर्षित किया गया।
- वी. पाराहेमोलीटीक्स के वियुक्तियों से ागर जेन आश्रय भिन्न को वियुक्त किया गया और दक्षिणी धब्बा और संकरण द्वारा पुष्ट किया गया।
- किण्वक में 11 बैच पालन के रूप में बैक्टेरीयफेजस के व्यापक प्रचार की प्रक्रिया विकसित की गई और $1.8X10^{11}$ बैक्टेरीयमफेजस (कोलिफेजस से *इ.कोली* का 454 अनुपात) के व्युत्पन्न को प्राप्त किया गाय।
- फेज कॉकटेल (चार भिन्न बैक्टेरियफेजस) तैयारी के लिए विकसित एक पद्धित 84% के *इ.कोली* वियुक्त उच्च लैटिक प्रतिक्रिया को दिखाया।

- आँध्रप्रदेश के खेती किए पेनस वेनमई झींगा (n=32) से वियुक्त जीवाणु के ए एम आर प्रतिमान का अध्ययन किया गया और एरिथोमैसिन (100%) की ओर, स्टेफीलोकोकस औरस पैन्सीलीन G (57%) की ओर और ओक्सीलीन (63%) सीफोक्सीरीन (65%) और विब्रियों पाराहेमोटीक्स एम्पीसीलीन (25%) और सीफोक्सीटीव की ओर यह परिणाम उच्च प्रतिरोध को सूचित किए।
- प्रयोगशाला स्थिति के अधीन एक्रोमोबैक्ट रसाइलोसोक्सीडेन्स के नाइट्रीफीकेशन संभावना के लिए एक प्रक्रिया विकसित की गई।
- इल्लुमिना प्लाटफर्म की प्रयुक्ति से 16 झइिशछ क्षेत्र के अनुक्रमण केलिए एक पद्धित को विकसित किया गया।
- समुद्री खाद्य से *ई.कोली* के प्रतिजैविक प्रतिरोध प्रोफाइल पर एक अवधारणों को विकसित किया गया। झींगों के समान प्रजातियों को आर्थिक रूप से प्रेरित गुमराह करने के खोज के लिए एक एफ टी आई आर फिंगर प्रिंटिंग और कीमोट्रिक्स आधारित तेज पद्धति को विकसित किया गया।
- मेथीसीलिन प्रतिरोध स्टेफीलोकस औरस के छानबिन के लिए एक एएफटीआईआर फिंगर प्रिंटिंग और कीमोट्रिक्स आधारित तेज पद्धति को विकसीत किया गया।
- ईखुदरा के पौष्टिकऔषधीय चूर्ण आधारित समुद्री शैवाल में 141 रासायनिक दूषकों के अल्ट्रा स्तर मात्रात्मकता के लिए एक जीसीएमएस/एमएस बहुअवशेष पद्धति को विकसित किया गया।
- समुद्रीशैवाल से फ्यूकॉइडेन के निष्कर्षण के लिए एक हरित रसायन प्रक्रिया विकसित की गई। इस प्रक्रिया एवं उत्पाद को मेसर्स अम्लगम फूड प्राइवेट लिमिटेड को वाणिज्यीकरण किया गया।
- सुपरक्रिटिकल कार्बन डाइक्साड निष्कर्षण आधारित एक नवीन आरएसएम से भूरे समुद्रीशैवाल की प्रयुक्त से उच्च मूल्य न्यूट्रॉसीटिकल फॉक्सोक्सैन्थिन अनुकूलित किया गया।
- सभी साहित्य द्वारा रिपोर्ट किए मूल्यों से फॉक्सोक्सैन्थिन की मात्रा विशेष रूप से उच्च थी।
- वसा घोल विटामिन, जलघोल विटामिन ळ12 के साथ और फोलिक अम्ल के लिए विश्लेषणात्मक सुविधा को स्थापित किया गया।
- 25% शामिल स्तर में मत्स्यचारासंघटक के रूप में समुद्रीशैवाल का आहारी संपूरण प्राणियों के वृद्धि क्षमता एवं उत्तरजीवित दर में वृद्धि करता।
- मेथोनॉल, इथोनॉल और जल निष्कर्षित पद्धतियों की तुलना में परीक्षित सभी विततियों के विरूद्ध सुफरक्रिटीकल दव्य निष्कर्षण के द्वारा निष्कर्षित भूरा समुद्रि शैवाल (पाडिना जिमनोस्पिस) के प्रति सूक्ष्मजीवीय अध्ययन उच्च प्रतिक्रिया को दिखाया।
- पोषक और औषद्य परिदान में शार्क उपास्थि चूर्ण से शुद्ध चोनड्रोटीन सल्फेट संभावी अनुप्रयोग को रखता है।
- 1.6% घोल में उल्व लैक्टूका रूपायित हाइड्रोक्लोराइड से उल्व को शुद्ध किया गय। यह सुडोलोचदार व्यवहार को दिखाया। उल्व को एसीटलउल्वा (छबे) व्युत्पन्न के लिए एसिटिलेटेड को जल घोल की वृद्धि करने और जैव सामग्री के रूप में प्रयुक्ति के लिए उसके यांत्रिक शक्ति में सुधार के लिए किया गया।
- समुद्री तेलों में टोकोफीरोल के एसोमेरों की वियुक्ति एवं नकरात्मकता के लिए एक पद्धति को विकसित किया गया।
- मत्स्य कोलाजन/जिलेटिन हाइड्रोलाइसेटों में एमीनों अम्ल की मात्रा के निर्धारण के लिए एक सरल एवं लागत प्रभावी एचपीएलसी प्री कॉलम व्युत्पत्ति पद्धति को विकसित किया गया।
- पुन संचार प्रणाली में निर्धारण प्रायोगिक जाँच ने संकेत दिया है कि तटीय समुद्रीशैवाल उल्व लैक्टूका जल में उपस्थित ऑर्गेनोक्लोरिन कीटनाशक निष्कासन में जैविक उपचार क्षमता की संभवना को रखता है।
- मत्स्य एवं मात्स्यिकी उत्पादों के थोक शुष्कन, अल्प लागत, ऊर्जा कार्यक्षम एवं वॉकइन प्रकार सौर टेंक शुष्कक को अभिकल्पित एवं विकसित किया गया।
- बाँगडे के लिए पोर्टेबल नॉनइन्वेसिव मत्स्य ताज़गी संवेदक के मूलरूप को विकसित किया गया।
- अल्प लागत, एवं उपयोग अनुकूल बटन परिचालित एक मिनी मत्स्य डिस्कलिंग मशीन को अभिकल्पित एवं विकसित किया गया।
- मत्स्य एवं अन्य कृषि उत्पादों की प्रयुक्ति द्वारा संशोधित सौरएलपीजी संकर शुष्कक का निष्पादन मूल्यांकन अध्ययन संचालित किया गया।
- बैच टाइप इन्फ्रारेड शुष्कक के अभिकल्प को सुधरित और निष्पादन मूल्यांकन किया गया।
- मोबाइल आलर्ट प्रणाली के साथ स्मार्ट शुष्कक जो प्रयोक्ता को शुष्कन विस्तार पर सूचना देता और परिचालन को स्वचालित करता।

- समुद्री खाद्य उद्योग में ऊर्जा एवं जल उपभोग पर एतिहासिक ऑकड़ों को एकत्रित एवं विश्लेषित किया गया।
- समुद्री खाद्य उद्योग में ऊर्जा उपभोग वास्तविक समय ऑकड़ों को एकत्रित एवं विश्लेषित किया गया।
- वर्ष 2018 के उत्पादन के संबंध में एक कारखाने विशेष के ऊर्जा उपभोग को अनुकूलित किया गया।
- (i) केरल मात्स्यिकी में उद्यम विकास के संबंध में भूमिका समझ पर लिंग असमानता मूल्यांकन के लिए प्रणाली विज्ञान (ii) केरल में मत्स्य विक्रताओं केलिए उत्पादक सामग्री एवं सेवा प्रदान प्रणाली का मूल्यांकन (iii) तीन अलग आधार रेखा सर्वेक्षण एवं साहित्य समीक्षा के आधार पर विकसित स्वास्थ, सुरक्षा एवं गुणता मामलों के संदर्भ में केरल में मत्स्य उपभोग की गति का मूल्यांकन ैप. कदमकुड़ी, वेरावल एवं मेंगमरीपेटा, विशाखपट्टणम में एसड्ब्ल्यूओटी एएचपी तकनीक के उपयोग द्वरा मत्स्य उद्यम विकास के संबंध में समस्या प्राथमिकता एवं आवश्यकता विश्लेषण किया गया, उसके बाद एसड्ब्ल्यूओटी के तुलनात्मक विश्लेषण द्वारा सभी तीन अध्ययन स्थानों में मत्स्य उद्यम विकास के संबंध में प्राथमिकता समान है या नहीं की जानकारी के लिए अध्ययन किया गया।
- क्रमानुसार 5.524, 2.604 और 3.051 के सी आर मूल्य के साथ वैयक्तिक मनोभाव, उद्यमशील क्षमता और व्यवसायिक विकल्प उद्यमशील आशय विशेष संबंध को रखता। यह सूचित करता कि पेशा विकल्प के लिए विद्यार्थियों का वैयक्तिक मनोभाव उद्यमशील आशय के मूल्यांकन के लिए अधिकतम भाविष्य वाणी (55.24%) उसके बाद व्यवसयिक विकल्प (30.5%) को सहयोग करता।
- अलियार जलाश्य से म्रिगल के सप्ताहिक शिकार पर समय श्रृंखला आँकड़ो के लिए जैव आर्थिक नमूनों (फाक्स, 1970 और स्कूनूट, 1977) को नियोजित किया गया। यह दो नमूनों के आकलित प्राचल थे आंतरिक वृद्धि 0.89; 0.645 वहन क्षमता 155.05; 195.03 टन। पकड़ने की क्षमता सह कार्यक्षमता 0.00002; 0.000007 और क्रमानुसार एड्ज इ 2 58.9 और 21.3 था।
- अलियार जलाशय में एक मत्स्यन यूनिट के लिए प्रतियूनिट निवेश रु0.55 से रु2 लाख के बीच में था। जबकि मत्स्यन परिचालन का अर्थ तंत्र थे बीसीआर 1.23, एनवीपी रु1.75,448 और आईआरआर 66 संपोषनीयता को सूचित करने को निकाला गया।
- अलियार मछुवारे की सामाजिक आर्थिक स्थित को मूल्यांकित किया गया और इसे कमजोर पाया गया और घरेलु जीविका सुरक्षा इंडेक्स को प्रयुक्त कर आर्थिक, स्वास्थ, खाद्य और शिक्षा डोमेन को 0.176, 0.537, 0.361 और 0.285 के रूप में निकाला गया।
- अलियार जलाशय के पारितंत्र में मात्स्यिकी के प्रयोग मूल्य को आकलित करने के लिए बाज़ार कीमत पद्धति को अपनाया गया। जिसे करीब 41 टन, मत्स्य के लिए 42.44 की गणना की गई जो उनके प्रति वर्ष लक्षित 39 टन से ज्यादा है। वर्ष 2018 के लिए पर्यटन के प्रयोग मूल्य को आकलित करने के लिए बांध आगंतुक से एकत्रित शुल्क की गणना (35.07 लाख) थी।
- मात्स्यिकी में पूंजी निर्माण (1990-91 से 2014-15) और पूंजी निर्माण के लिए इस क्षेत्र की जवाबदेही के रुझन को विश्लेषित किया गया यह प्रकट किया कि वृद्धिशील पूंजी उत्पादन अनुपात (आई सी ओ आर) में वृद्धि हुई। जिससे पूंजी की दक्षता में गिरावट आई। यह इस उपक्षेत्र के कुछ खंडों का अति पूंजीकरण के फलस्वरूप हुआ। विशेषकर समुद्री मात्स्यिकी, यह बड़ी मात्रा में यंत्रीकृत मत्स्यन जहाज़ों से युक्त है।
- 1990-91 से 2014-15 की अवधि के लिए मात्स्यिकी क्षेत्र में वृद्धिशीला पूंजी उत्पादन अनुपात (आई सी ओ आर) में वृद्धि को पाया गया जिससे पूंजी की दक्षता में गिरावट आई। यह इस उप क्षेत्र के कुछ खंड़ो को अति पूंजीकरण के फलस्वरूप हुआ। विशेषकर समुद्री मात्स्यिकी, यह बड़ी मात्रा में यंत्रीकृत मत्स्यन जहाजों से युक्त है।
- 1974-2014 की अवधि के लिए मात्स्यिकी विस्तार पर खर्च का प्रतिमान प्रकट किया कि यह रुझन प्रभावशाली है, व्यापक तट रेखा और बढ़ती जल कृषि को ध्यान में रखने से, यह कम फैली हूई है। पिछले दशक (2005-06 से 2013-14) में, विस्तार खर्च (केन्द्र और राज्य सरकारों) में मात्स्यिकी क्षेत्र का वृद्धि दर 4 हो सकता है।
- मत्स्य साइलेज निर्माण यूनिटों पर प्राथमिक विश्लेषण के दो मामले अध्ययन प्रकट किया फायदा लाभ अनुपात 2.0 और 2.6 के बीच होगा।
- एरणाकुलम जिला, केरल में परिचालित 15 ऑनलाइन मत्स्य विकेताओं के उत्पाद मूल्य सूची, कीमता का दायरा, गुणता एवं सुरक्षा गरंटी, वितरण प्रणाली और ऑनलाइन पर उपभोक्ता की अभिगम्यता, मोबाइल एवं सामाजिक माध्यम प्लाटफर्म के संबध में प्रकट हुआ कि उपभोक्ताओं के लिए ऑनलाइन पोर्टल द्वारा व्यापक विकल्प देना आकर्षण का केन्द्र है। ऑनलाइन पोर्टलों द्वारा विभिन्न प्रकार के उत्पाद/ड्रेसिंग विकल्पों की सुविधा और आसान उपलब्धता पर ध्यान केन्द्रित किया गया है।
- सभी ऑनलाइन विकेताओं द्वारा विपणन करने वाले संकर मिडिया के संबंध में यह अवलोकिता किया गया है कि अपनाई गई लोक प्रिय रीति ईमेलवेबसाइट है और उसके बाद निकट में फेसबुकमोबाइल रीति है।
- डीएसडी एसईईडी परियोजना के अधीन पेरूमबलम ग्राम में बड़ी सीपी संसाधन सुविधा को स्थापित किया गया।

EXECUTIVE SUMMARY

- Nano zinc oxide-cerium incorporated phosphating was done over boat building steel coated with different types of graphene and chemically reduced graphene exhibited better corrosion resistance.
- Nano silicon dioxide and zinc oxide mixture (0.01% nano SiO_2+0.02% nano ZnO) coated over the polyaniline coated polyethylene aquaculture cagenets exhibited excellent biofouling resistance even after six month's exposure in marine environments.
- Nano copper oxide fortified cashew nut shell oil showed excellent resistance against boring organisms with concurrent improvement in mechanical properties of treated wood panels.
- Gantry arrangements for simulating trawling movements was installed in the fish behaviour laboratory.
- A total of 38 designs of gillnets operated in the states of Tamil Nadu, Kerala, Karnataka and Goa were documented.
- Field trials of four different types of traps (Modified gargoor, Minnow traps, Fold and take model and CIFT Lobster traps), were carried out along Veraval Coast. Modified Gargoor traps had the highest catch, both in terms of number and weight of species and also in terms of frequency of catch.
- Data collected from commercial fishing vessels off Kollam showed about 22 species in the catches from bottom trawls operated in the depth range of 300-400 m. Major species caught were cusk eels followed by *Chlorophthalmus corniger* and *Bembrops caudimacula*. CPUE of commercial vessels were approximately 350 Kg/h.
- Structural and operational changes in fishing systems of Andhra Pradesh from Visakhapatnam, Kakinada, Nizampatnam and Machallipatnam were documented by different methods. Design characteristics of trawl nets, gill nets, boat seine, shore seine, hook and line were documented.
- The performance of small and medium trawlers along Andhra Pradesh coast revealed that more than 40 and 50 % Decision Making Units (DMUs) respectively operated with high technical efficiency but operated under low economies of scale.
- Evidence of lost gears was assessed by underwater diving in waters off Cochin, Vizhinjam and Enayam. Trap loss rate as revealed from fishers' interview was in the range of 1 to 12 traps per year per person.
- A wave rider buoy to validate the wave height and other oceanographic parameters that aids to disseminate the Ocean State Forecasts to Fishermen was installed off Veraval.
- The L_{50} value (standard errors) for *Trichiurus lepturus* were 48.47 (0.69) and 50.97 (1.28) in diamond and square mesh codend respectively. The optimum mesh size based on the length at first maturity for this species was calculated as 50.5 mm and 48.0 mm for the diamond and square mesh codend respectively.
- Designed, fabricated a serially foldable traps for inland and marine fishing operation. Field trial of the trap nearby a marine cage site caught *Adubefduf vaigiensis* and *Acanthurus mata*.
- A survey of traditional traps being used in inland sector of Manipur was conducted.
- A rapid assessment of losses due to flood in the inland fishing sector of Kerala conducted
- Upscaling of optimized bioactive protein hydrolysate from tuna red meat using enzyme papain was done and its economic feasibility on commercial scale was evaluated.
- Astaxanthin from shrimp head waste was released at the Annual General Body Meeting of ICAR by the Union Minister of Agriculture and Farmers welfare.
- Standardized the protocol for dietary fiber-incorporated tuna sausage and is commercially transferred to a processing unit in Chennai for domestic production of tuna sausages.
- A demerit score-based fish quality index (FQI) has been developed to assess the quality/freshness of fresh fish

- Developed PLA-based films and trays and evaluated its suitability for packaging fishery products.
- Bagasse trays are found superior to areca trays and is an ideal biodegradable material for retail packaging of fish meat in low temperature storage
- Among the different organic acids used, combination of ascorbic acid and iron was found to be more effective for oxygen scavenging
- The Ag nanoparticles prepared using trisodium citrate can be used as an indicator to distinguish fresh and frozen stored fish.
- pH sensitive film prepared using red kidney beans can be used as freshness indicator.
- Performance evaluation of live fishes *viz*., Nile tilapia, common tilapia, milk fish and trevally in the ICAR-CIFT designed transportation prototype was carried out.
- For fish packaging application, developed a moisture absorbent pad by combining absorbent and non-absorbent layers prepared from water hyacinth stalks. Carboxymethyl chitosan was selected as the absorbent core.
- A chitin-protein derivative, 'Chito-Pro' was developed as bio-functional supplement.
- Fucoidan was extracted from brown seaweed and was characterized.
- Standardized microwave drying process for marinated and dried tuna chunks
- Evaluated quality changes in cage farmed grouper stored in ice and the shelf life was 22 days.
- Prepared squilla protein concentrate by foam mat drying technique.
- Addition of seaweed dietary fibre in bread as a functional ingredient reduced the loss of moisture content during storage, thus retarded the crumb hardness.
- Dried Bombay duck after pretreating with ginger-garlic had better quality compared to spine mix and control samples.
- Tri-sodium phosphate treatment along with chitosan coating was efficient in extending the shelflife of mackerel to 11 days with very low level of histamine.
- Screening of antibiotic residue such as chloramphenicol and AOZ in Navi Mumbai fish Market indicated that retail market samples had higher level than the recommended limit in shrimp.
- Toxinotyping of *Staphylococcus aureus* was carried out; the most prevalent genotypes detected were SEC (17.44%), SEB (12.2%), SEA (2.9%), TSST-1 (16.2%).
- Natural level of formaldehyde content in fresh fish samples (n=150) ranged from <LoQ to 5.0 mg/Kg
- Legal samples (56) obtained from Food Safety Commissionerate, Govt. Kerala were analyzed for ammonia adulteration. Around 17% of samples were free of ammonia, 13% below detection level and 70% were having ammonia content in the range of 1.32-30.5 mg/Kg.
- Screened and identified allergenic proteins of Brown shrimp (*Metapenaeus monoceros*), Jinga shrimp (*Metapenaeus affinis*) and Kiddi shrimp (*Parapenaeopsis stylifera*). Hypersensitive responses in BALB/c mice due to intra-gastric administration of shrimp allergen, Tropomyosin purified from *Metapenaeus dobsoni* was evaluated.
- Safety of dried and fermented fish products of North Eastern states were evaluated. High concentration of histamine (118.18±1.22 ppm) was recorded from Phasashidal of Nagaland. *Bacillus aryabhattai* and *Paenibacillus favisporous* were found to be dominant histamine formers.
- Process evaluation of commercial accelerated freeze drying process of shrimp indicated improper sanitation in post freeze-drying steps contributed to spike in coliform load in the final product.
- Microbiological safety of domestically marketed and ready to eat fish in retail stores and supermarkets was determined. *Listeria monocytogenes* was prevalent at 4.4% level in fish markets.
- Duplex PCR was developed for simultaneous detection of *Listeria monocytogenes* and other *Listeria* spp. Multiplex PCR was developed for detection of Entero hameorrhagic *Escherichia coli* (*E. coli* 0157:H7).

- A highly sensitive PGS-PCR assay was developed for the detection of pandemic strain of *V. parahaemolyticus* (O3:K6) in seafood.
- Evaluation of hygiene status in various primary fish production areas indicated high load of hygiene indicator bacteria in peripheral food contact surfaces and ice used for chilling.
- Analytical methodologies/protocols were developed, validated and accredited as per ISO 17025 requirements for detection of antibiotic residues, pesticide residues, heavy metals, methyl mercury, sodium benzoate, ciguatoxin, ammonia and formaldehyde.
- Seventy three samples out of 133 screened harboured *Arcobacter* sp. Molecular characterization was carried out for 96 isolates of Arcobacter by species specific PCR for *Arcobacter butzleri* (401 bp), *A. skirrowii* (641 bp) and *A. cryaerophilus* (257 bp). Fifty one isolates were identified as *A. butzleri*, four isolates as *A. skirrowii*, 26 isolates as *A. cryaerophilus* and 15 isolates were not differentiated by multiplex PCR.
- A total of 1103 (soil-441, water-363 and shrimp-299) bacterial isolates were selected, purified and resistance was studied against five different antibiotics by disc diffusion method. Antibiotic resistance was observed for ciprofloxacin (141; 12.7%), chloramphenicol (48; 4.3%), co-trimoxazole (161; 14.5%), erythromycin (132; 11.9%) and oxytetracycline (460; 41.7%). Sixty eight isolates out of 192 harboured tetA gene (387 bp), five isolates out of 25 harboured cat1 gene (349 bp), four isolates out of 50 harboured sul1 gene (433 bp) and four isolates out of 50 harboured sul1 gene (657 bp).
- Four potential sulphur oxidizing bacterial isolates (three from mangrove- SC10, SD6, and SB1 and one from freshwater fish farm-TA-1) were identified by 16 S rDNA sequencing as *Halothiobacillus* sp. and *Thiomonas* sp.
- AuNPs prepared using trisodium citrate gave better colour response upon immobilization with pure enzyme.
- For the colorimetric assay, substrates chlorophenol red β –D-galactopyranoside (CPRG) and 5-Bromo-4-chloro-3-indolyl β-D-glucuronide (X-gluc) were selective to pure enzymes β- galactosidase and β glucoronidase of *E. coli* O: 157 and *E. coli*, respectively..
- Paper-based strip was developed for the detection of pathogens by using filter paper.
- Prominent colour was noticed on paper strips incorporated with gold nanoparticle for the shrimp samples piked with *E. coli* O:157 and *E. coli* after 9 h and 12 of enrichment with incubation of 30 min. and 2h,respectively, at 37°C.
- *Chromobacterium violaceum* is one of the biofilm bacteria of Enterobacteriacea garnering wide attention in the clinical cases due to its high mortality rate. While screening the water of retail fish markets, three samples were found contaminated with *C. violaceum*. Ten isolates were purified and confirmed by biochemical and molecular characterization.
- Nano-chitosan-ZnO composite possessed slightly higher antibacterial activity than chitosan–ZnO composite and antibacterial activity of chitosan-ZnO or nano-chitosan ZnO composite is equal to antibacterial activity H_2O_2 incorporated chitosan/nano-chitosan.
- *Phyllanthus acidus* (Amla) fruit extract incorporated chitosan-ZnO composite enhanced antibacterial activity against food-borne pathogens.
- Pathogenic Vibrio isolates was detected in 5% of seafood samples.
- *V. cholera* non O1 isolateswas recovered from 13.3% seafood samples.
- Exo-polysaccharide containing sulphate group was extracted from seaweed associated bacteria-*Bacillus cereus*
- Isolates of *V. parahaemolyticus* harboring variant tdh gene were isolated and confirmed by southern blotting and hybridization.
- Process developed for mass propagation of bacteriophages as 1 L batch culture in a fermenter and obtained a yield of 1.8 x 10^{11} bacteriophages (Coliphage to *E.coli* ratio of 454).
- Method developed for preparing Phage cocktail (four different bacteriophages) that showed high lytic activity against 84% of the *E. coli* isolates.
- Studied AMR pattern of the bacteria isolated from farmed Penaeus vannamei shrimp (n=32) of Andhra Pradesh and the results indicated higher resistance of *E.coli* towards erythromycin (100%), *Staphylococcus*

aureus towards penicillin G (57%) and erythromycin (43%); coagulase negative Staphylocci towards penicillin-G (95%), oxacillin (63%), cefoxitin (63%) and *Vibrio parahaemolyticus* towards ampicillin (25%) and cefoxitin (25%).

- Developed a process for nitrification potential of *Achromobacter xylosoxidans* under laboratory conditions.
- Developed a method for the sequencing of 16SrRNA region using Illumina platform.
- Developed a concept on antibiotic resistant profile of *E. coli* from seafood.
- A FTIR fingerprinting and chemometrics based rapid method was developed for detection of economically motivated mislabelling of species identity of shrimp.
- A FTIR fingerprinting and chemometrics based rapid method was developed for screening of methicillin resistant *Staphylococcus aureus*.
- A GC-MS/MS multi-residue method was developed for ultra-trace level quantification of 141 chemical contaminants in seaweed based nutraceutical powders in e-retail.
- A 'Green Chemistry Process' was developed for extraction of fucoidan from seaweed. The process and the product have been commercialized to M/s Amalgam Foods Pvt. Ltd.
- A method has been optimized for the extraction of high value nutraceutical fucoxanthin from brown seaweed using a novel RSM based supercritical carbon dioxide extraction. The content of fucoxanthin was significantly higher than all literature reported values.
- Analytical facility for fat soluble vitamin, water-soluble vitamin including vitamin B12 and folic acid has been established.
- The dietary supplementation of seaweed waste as fish-feed-ingredient at 25% inclusion level was found to enhance the growth performance and survival rate of experimental animals.
- Studies on antimicrobial property of brown seaweed (*Padina gymnospora*) extracted through supercritical fluid extraction method showed highest activity against all the strains tested as compared to methanol, ethanol and water extraction methods.
- Chondroitin sulphate purified from shark cartilage powder has possible application in nutrient and drug delivery.
- Ulvan purified from *Ulva lactuca* formed hydrocolloids at 1.6% solutions which showed pseudo-elastic behavior. Ulvan was acetylated to yield acetyl-Ulvan (Ac-U) to increase its water solubility and improve its mechanical strength for use as biomaterials.
- Method has been developed for the separation and quantification of isomers of tocopherols in marine oils
- A simple and cost effective HPLC pre column derivatization method has been developed for the determination of amino acid content in fish collagen/gelatine hydrolysates.
- Experimental investigation set in a re-circulatory system has indicated that Indian coastal seaweed *Ulva lactuca* is having potential for bioremediation capability in removal of organochlorine pesticides present in water.
- Designed and developed a low cost, energy efficient and walk-in type solar tent dryer for bulk drying of fish and fishery products.
- Developed a prototype of portable non-invasive fish freshness sensor for mackerel.
- Designed and developed a low cost and user-friendly button operated mini fish descaling machine.
- Performance evaluation study of modified solar-LPG hybrid dryer was conducted using fish and other agricultural products.
- Improvised the design and evaluated the performance of batch-type infrared dryer.
- Studies carried out on smart dryers with mobile alert system which send information on the extent of drying to the user and automate the operations.
- Collected and analyzed the historical data on energy and water consumption for seafood industries.
- Collected and analyzed real time data of energy consumption of seafood industries.

- Optimized the specific energy consumption of one factory with respect to the production for the year 2018.
- Methodology for (i) assessment of gender disparity on role perception with regard to entrepreneurial development in Kerala fisheries, (ii) assessing input and service delivery system for fish vendors in Kerala, (iii) assessing dynamics of fish consumption in Kerala with reference to emerging health, safety and quality issues was developed based on three separate baseline surveys and literature review.
- Problem prioritization and need analysis with respect to fish entrepreneurship development was carried out at Kadamakkudy in Ernakulam, Veraval and Mangmaripeta in Visakhapatnam, by using SWOT-AHP technique followed by a comparative analysis of SWOT in all three study locales to know whether the priorities are common or not in respect of the fishpreneurship development.
- Variables like personal attitude, entrepreneurial capacity and professional option have significant relationship with entrepreneurial intention with C.R. value of 5.524, 2.604 and 3.051; respectively, that showed that personal attitude of the students contributing for maximum prediction (55.24%) for assessing the entrepreneurial intention followed by professional option (30.5%) for career choice.
- Bio-economic models were employed to time-series data on weekly catch of Mrigal from Aliyar reservoir. The estimated parameters of the two models considered were Intrinsic Growth (r) 0.89; 0.645, Carrying capacity (K) 155.05; 195.03 ton, Catchability Coefficient (q) 0.00002; 0.0000007, and Adj. R^2 was 58.9 and 21.3 respectively.
- The per unit investment towards a fishing unit at Aliyar reservoir ranged from ₹ 0.55 to ₹ 2 lakhs whereas the economics of fishing operation were worked out as BCR = 1.23, NPV = ₹ 1,75,448 and IRR as 66% indicating sustainability.
- The socio-economic conditions of Aliyar fishers was evaluated and it was found to be poor and the household livelihood security index worked out using economic, health, food and education domains was worked out as 0.176, 0.537, 0.361 & 0.285.
- Market price method adopted to estimate use value for fisheries at Aliyar reservoir ecosystem which accounted for ₹ 42.44 Lakhs of about 41 tonnes of fish which is more than their targeted 39 tonnes per annum. Fee collected from dam visitors was computed to estimate use value of tourism for the year 2018 (₹ 35.07 Lakhs).
- Trend in capital formation in fisheries (1990-91 to 2014-15) and responsiveness of the sector to capital formation analyzed which revealed that the incremental capital output ratio (ICOR) increased denoting decline of the efficiency of capital. This could be due to over-capitalization of some segments of this sub-sector, particularly marine fisheries, characterized by a large number of mechanized fishing vessels.
- The incremental capital output ratio (ICOR) in fisheries sector for the period of 1990-91 to 2014-15, was found to have increased denoting decline of the efficiency of capital. This could be due to over-capitalization of some segments of this sub-sector, particularly marine fisheries, characterized by a large number of mechanized fishing vessels.
- The pattern of expenditure on fisheries extension for the period of 1974-2014 reveal that though the trend is impressive, it is thinly spread, considering the vast coast line and increasing aquaculture. In the past decade (2005-06 to 2013-14), growth rate in extension expenditure (Centre plus State governments) in fisheries sector was found to be 4%.
- Preliminary analysis from two case studies on fish silage manufacturing units has revealed a benefit-cost ratio ranging between 2.0 and 2.6.
- An analysis of 15 online fish vendors operating in Ernakulam district, Kerala with respect to their products menu, price range, quality and safety guarantees, delivery systems and consumer accessibility over online, mobile and social media platforms revealed that wide range of options provided by online portals was the major attraction for consumers. The online portals focused on convenience and easy availability of variety of products/dressing options.
- As regard to hybrid media marketing done by all the online vendors, it was observed that 'e-mail+website' was the most popular mode adopted closely followed by 'Facebook+mobile' mode.
- Clam processing facility was set up at Perumbalam village under the DST-SEED Project.

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 Kochi 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 1st October, 1967.

Vision

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

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).

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 and water foot print per unit volume; and to ensure equitable benefits to the stakeholders, across the value chain.

Mandate

- Basic and strategic research in fishing and processing, bioactive compounds and food safety.
- Design and develop energy efficient fishing systems for responsible fishing and sustainable management.
- Development of implements and machinery for fishing and fish processing.
- Consultancy services, human resource development through skill development, training, education and extension.

Staff position as on 31st March, 2019

Category	Sanctioned	Filled
RMP/Director	1	1
Scientific	95	85
Technical	127	86
Administrative	81	55
Supporting	63	36
Auxiliary	5	2
Total	372	265

Budget allocation and expenditure

(For the year 2018-19 – All values in INR in Lakhs)

Budget Head	Allocation	Expenditure
Establishment charges	3225.00	3225.00
Pension and Retirement Benefits	400.00	400.00
Grants for creation of Capital Assets	300.00	299.99
Traveling allowances	75.00	74.99
Research and Operational Expenses	410.75	410.75
Administrative Expenses	553.75	553.75
Miscellaneous Expenses	20.50	20.50
Tribal Sub Plan	18.00	18.00
North East Hill	5.00	5.00
Total	**5008.00**	**5007.98**

ICAR-CIFT

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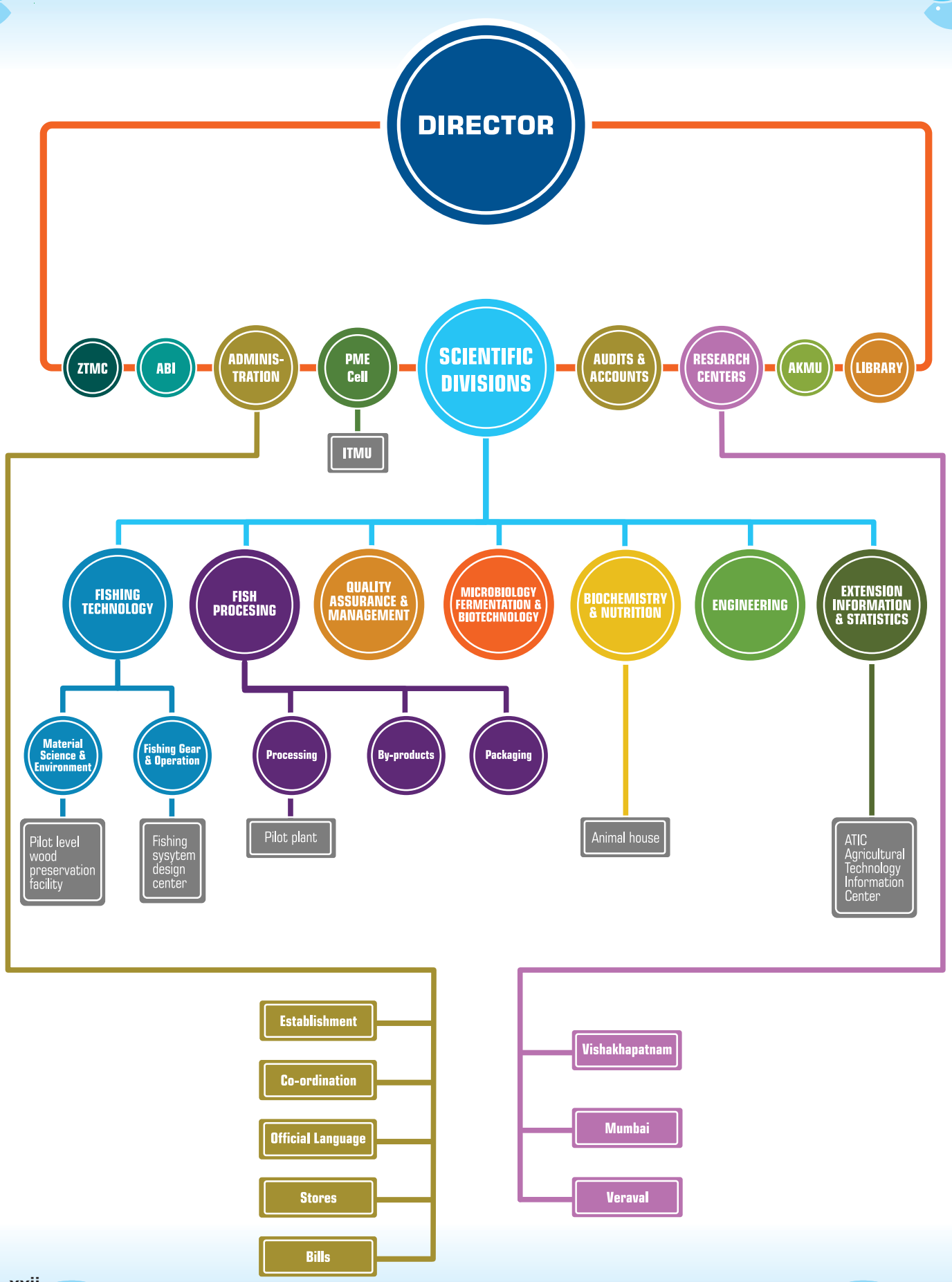
DIRECTOR
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PME Cell
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EXTENSION INFORMATION & STATISTICS
Material Science & Environment
Fishing Gear & Operation
Processing
By-products
Packaging
Pilot level wood preservation facility
Fishing sysytem design center
Pilot plant
Animal house
ATIC Agricultural Technology Information Center
Establishment
Co-ordination
Official Language
Stores
Bills
Vishakhapatnam
Mumbai
Veraval

Research Achievements

Fishing Technology

Research projects handled

Institute projects

- Investigations on fish behavior and responsible fishing system
- Enhancement of life of fishing materials using nanotechnology
- Development of region and species specific pots/traps
- Optimization of harvest and post harvest techniques for Mesopelagic in south western Arabian Sea
- Fishing technological interventions for sustainable marine ecosystem services along the east coast of India
- Studies on fishing operations and energy use for formulation of guidelines for selected small scale marine fisheries of India

Externally funded projects

- Global Warming Potential (GWP) of mechanized fishing methods of India and mitigation strategies: Analysis using Life Cycle Assessment (LCA)-Data Envelopment Analysis (DEA) approach
- Validation and dissemination of ocean state forecast advisories along Gujarat coast
- Investigations on Ghost Fishing by Derelict Traps and Gill Nets in selected areas of Indian waters and mitigation measures

Most significant achievements

- Nano zinc oxide-cerium incorporated phosphating was done over boat building steel coated with different types of graphene and chemically reduced graphene exhibited better corrosion resistance.
- Nano silicon dioxide and zinc oxide mixture (0.01% nano SiO_2+0.02% nano ZnO) coated over the polyaniline coated polyethylene aquaculture cage nets exhibited excellent biofouling resistance even after six month's exposure in marine environments.
- Nano copper oxide fortified cashew nut shell oil showed excellent resistance against boring organisms with concurrent improvement in mechanical properties of treated wood panels.
- Gantry arrangements for simulating trawling movements was installed in the fish behaviour laboratory
- A total of 38 designs of gillnets operated in the states of Tamil Nadu, Kerala, Karnataka and Goa were documented.
- Field trials of four different types of traps (Modified gargoor, Minnow traps, Fold and take model and CIFT Lobster traps), were carried out along Veraval Coast. Modified gargoor traps had the highest catch, both in terms of number and weight of species and also in terms of frequency of catch.

- Data collected from commercial fishing vessels off Kollam showed about 22 species in the catches from bottom trawls operated in the depth range of 300-400 m. Major species caught were cusk eels followed by *Chlorophthalmus corniger* and *Bembrops caudimacula*. CPUE of commercial vessels were approximately 350 Kg/h.
- Structural and operational changes in fishing systems of Andhra Pradesh from Visakhapatnam, Kakinada, Nizampatnam and Machallipatnam were documented by different methods. Design characteristics of trawl nets, gill nets, boat seine, shore seine, hook and line were documented.
- The performance of small and medium trawlers along Andhra Pradesh coast revealed that more than 40 and 50% Decision Making Units (DMUs) respectively operated with high technical efficiency but operated under low economies of scale.
- Evidence of lost gears was assessed by underwater diving in waters off Cochin, Vizhinjam and Enayam. Trap loss rate as revealed from fishers' interview was in the range of 1 to 12 traps per year per person.
- A wave rider buoy to validate the wave height and other oceanographic parameters that aids to disseminate the Ocean State Forecasts to Fishermen was installed off Veraval.
- The L_{50} value (standard errors) for *Trichiurus lepturus* were 48.47 (0.69) and 50.97 (1.28) in diamond and square mesh codend respectively. The optimum mesh size based on the length at first maturity for this species was calculated as 50.5 mm and 48.0 mm for the diamond and square mesh codend respectively.
- Designed, fabricated a serially foldable traps for inland and marine fishing operation. Field trial of the trap nearby a marine cage site caught *Adubefduf vaigiensis* and *Acanthurus mata.*
- A survey of traditional traps being used in inland sector of Manipur was conducted.
- A rapid assessment of losses due to flood in the inland fishing sector of Kerala conducted

Chief findings
Institute projects

Investigations on fish behaviour and responsible fishing system

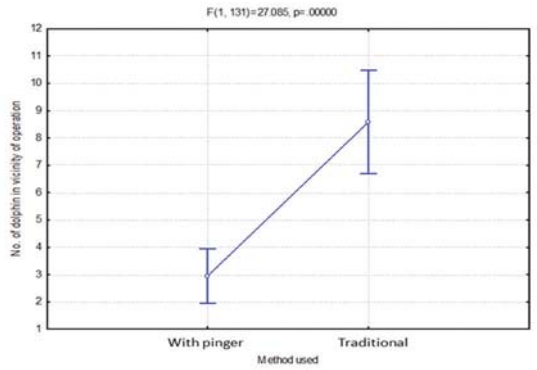
Development of fish behaviour laboratory: A movable gantry system for simulating the movement of trawl was constructed and installed for studies related to swimming speed, escapement and endurance of fish species from trawls.

Gantry system installed for behaviour study

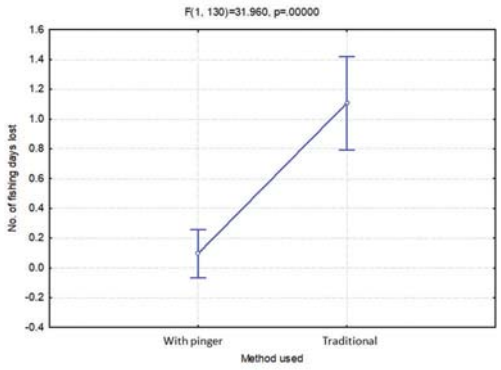
Trawl geometry studies using sensors: The maximum total area of opening (using sensors), was recorded at 1:6 scope ratio with a towing speed of 3.8 kn (96.58 m^2), while the lowest was recorded in 1:8 at 3.0 kn (36.27 m^2) for off-bottom trawls.

The horizontal opening increased and the vertical opening decreased when the bridle length increased. The direction of currents did not have an influence on the trawl geometry. Off-bottom trawls made of Ultra High Molecular Weight Polyethylene (UHMWPE) showed better overall opening when compared to the traditional HDPE trawls at all speeds tested.

Studies using pingers for reducing interaction of cetaceans during ring seine operations: The control vessels operated without pinger had lost 300 kg of webbing valued at ₹ 1.5 lakh as material cost only and an average of 55 days were also lost. The pinger assisted fishery in Kalamukku and Chellanam in Ernakulam Dist., Kerala had shown a significant saving of 40-55% as a result of reduction in cost of webbing material replacement due to dolphin.

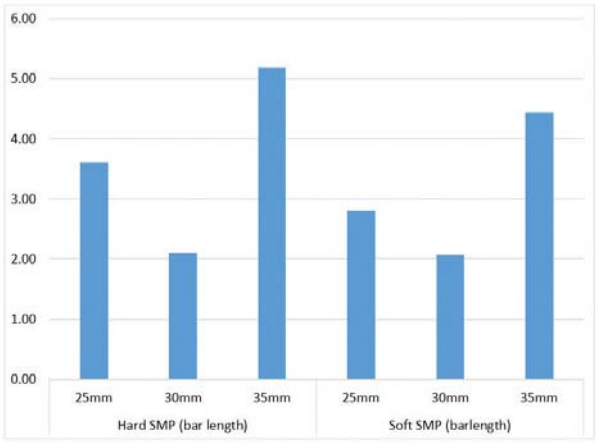


Reduction in the number of dolphins in the vicinity of operations – with and without pingers attached

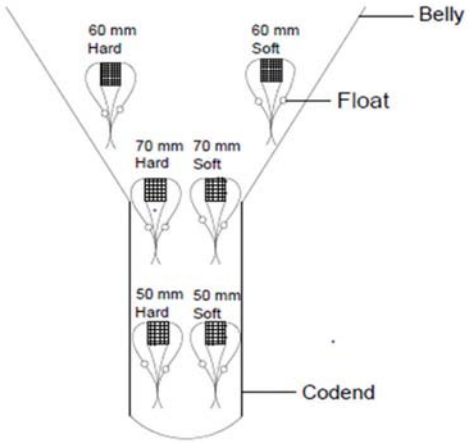


Comparison of fishing days lost with operations with and without pingers in ring seines

Studies using hard and soft square mesh panels in trawls: Experiments were carried out to find the difference in the escapement pattern between the hard and square mesh panels installed in different parts of the trawlnet. Results showed that hard square mesh windows (made of iron), offer better escapement for juveniles of commercially important species than the square mesh windows of the same mesh size made of webbing. The results also highlighted the importance of the location of the square mesh windows in the trawl codend. The mean weight of catch in the codend was 25.97±1.27 kg/h and the mean weight of the excluded catch was found to range from 0.68±0.17 kg/h to 1.69 kg/h depending on the size of the square mesh panel used.



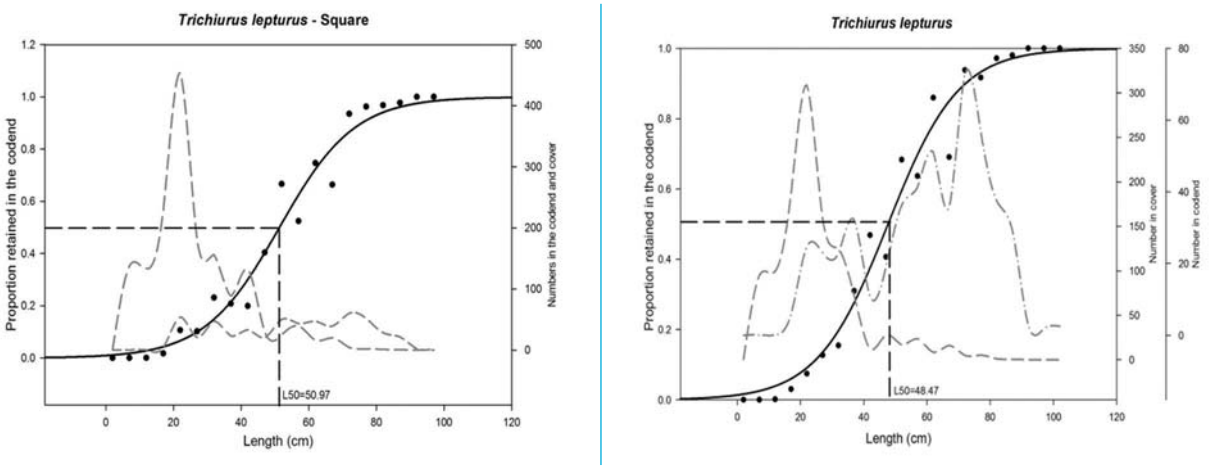
Exclusion (%) in terms of weight from the different Square Mesh Panels (SMP)



Position of the different SMP fixed in the trawl net

Deriving trawl codend selectivity estimates: Trawl codend selectivity estimates for *T. lepturus* in square and diamond mesh codend were derived using covered codend method and the inter haul variations in the estimates were accounted by replication estimation of dispersion. The L_{50} value (standard errors) for the species were 48.47 (0.69) and 50.97 (1.28) in diamond and square mesh codend, respectively. The optimum mesh size based on the length at first maturity for the species was calculated as 50.5 mm and 48.0 mm for the diamond and square mesh codend, respectively.

Deriving whole trawl selectivity estimates for selected species: Shrimp that escaped through wing portion were larger in size than those escaped from belly which indicates that large meshes at wing portion (80 mm) results in escapement of bigger shrimps, which is not desirable. Most of the smaller prawns escaped from the belly region. The percentage of escaped catch to total catch was 1.2% in the study.



Codend selection curve for *T. lepturus* in the square and diamond mesh codends

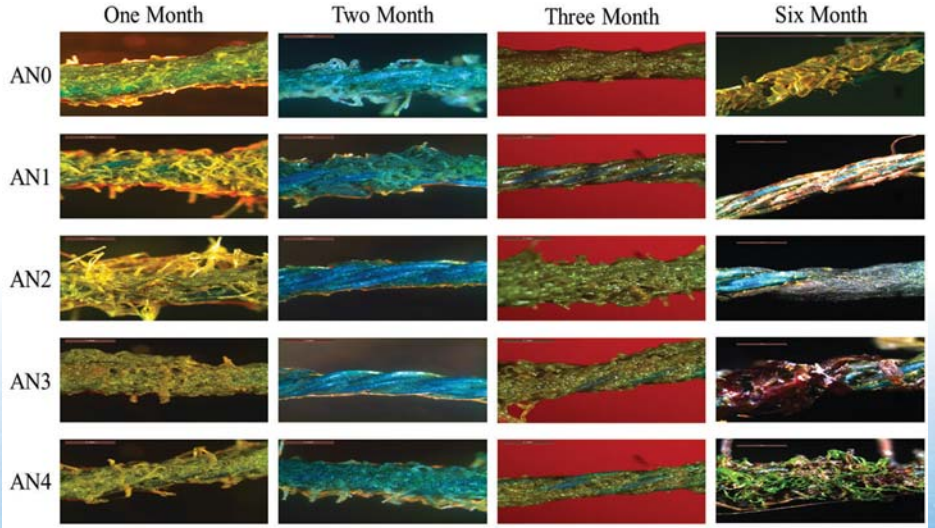
Studies on the efficacy of baited gillnets: Field trials using experimental baited gillnet (210×9×3, hanging coefficient 0.5, mesh size 140 mm and mesh depth 104 nos.) on head rope were conducted onboard F V Sagar Harita showed, significantly higher catches of predators like *Istiophorus platypterus, Scomberomorus commersoni* and tunas, near the baited regions.

Enhancement of life of fishing materials using nanotechnology

Field evaluation of nano copper oxide coated PE-PANI aquaculture nettings: A 3x2x2 m Nano CuO treated polyethylene aquaculture cage net was installed off Vizhinjam coast with the help of ICAR-CMFRI Centre at Vizhinjam, Thiruvananthapuram. The cages exhibited excellent bio fouling resistance compared to untreated control even after seven months of field trials in marine conditions. The average amount of treatment was Rs. 500/m^2 of webbing.

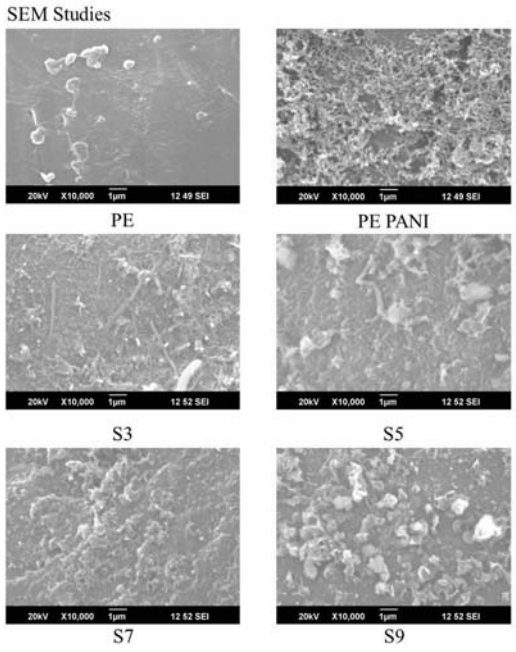
Silica incorporated pseudo zwitterionic polymeric hydrogel over aquaculture cage nets to combat bio fouling: Since copper-based antifouling measures are toxic, a pseudo zwitter ionic hydrogel reinforced with nano silicon oxide over polyaniline coated polyethylene aquaculture cage nets was synthesized and different concentrations used were field tested in marine conditions.

Six months immersion of treated nettings in the estuarine environments showed biofouling inhibition by nano silicon-incorporated polyethylene.

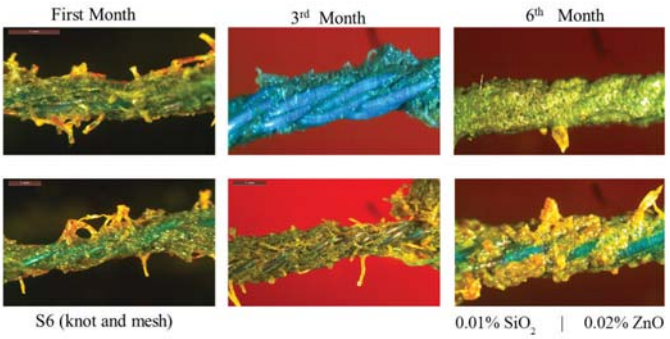


Immersion study of treated nettings for six months

Anti-fouling property on nano silicon dioxide and zinc oxide on aquaculture cage nets: Combinations of nano SiO_2 and ZnO were treated over polyanaline coated PE nets. After five months of exposure to marine conditions, treatment with a very low concentration silicon dioxide and zinc oxide exhibited excellent bio-fouling resistance.



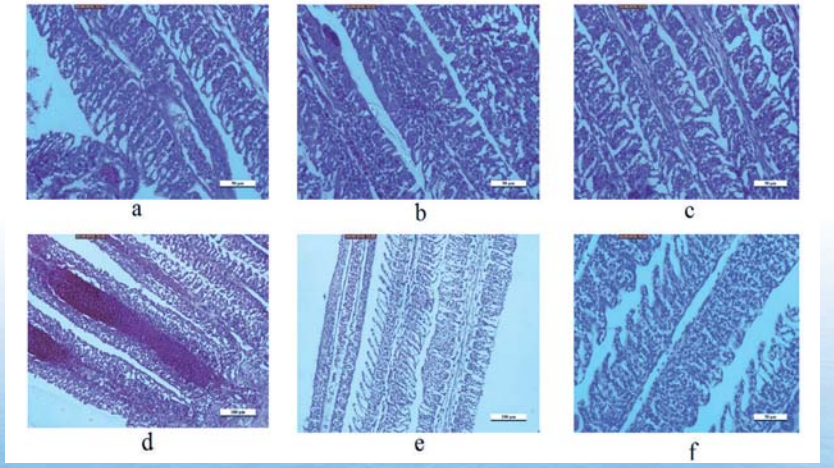
SEM images of treated nets



Treated net exposed to field study

Fortification of indigenous wood preservatives with nano copper oxides against bio-deterioration: Wood panels treated with Cashew Nut Shell Liquid (CSNL) show excellent mechanical properties but are not resistant to bio-fouling and the opposite happens when the panels are treated with CuO only. But the combined use of CSNL and CuO though effective is very toxic and may leach to the environment in sizeable quantities. So studies using nano CuO along with CSNL were carried out and the results show that nano CuO-fortified CNSL treated panels were resistant to fouler attack and also had better mechanical properties.

Effect of TiO_2 NPs on the brackish water fish Etroplus suratensis: Histopathological studies on fishes treated with nano titanium oxide showed that low-level nano TiO_2 treated *E. suratensis* showed no significant histopathological variations, but higher levels exhibited significant damages in the tissue.



Section of the gill of TiO_2 NPs treated *Etroplus suratensis* showing pathological changes

Development of region and species specific pots/traps

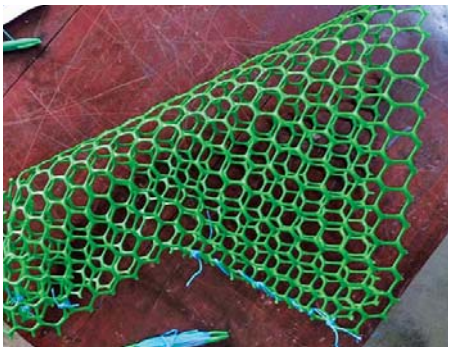
Design and prototype development of pots and traps: A new detachable push net and serially foldable horizontal trap with three chambers was designed, fabricated for operation in inland fisheries sectors of Andhra Pradesh, Odisha and North Eastern states. A rectangular crab trap made of iron chicken mesh was designed and fabricated, for field trials in lakes and esturies of Tamil Nadu and Kerala.

Field trials of modified traps: Modified gargoor, minnow traps, fold and take model and ICAR-CIFT lobster traps were fabricated and field trials were conducted. Eleven operations were carried out in the the vicinity of marine cages off Veraval (20°53'30.1"N 70°23'18.8"E). Modified gargoor traps showed excellent results, with a higher CPUE and also with higher frequency of occurrence of targeted species.

Participatory field trials of modified trap for Pearl spot *(Etroplus suratensis)* with dimensions of 1×0.6×0.6 m fishery along the backwaters of Kerala was conducted. Grouper, snapper and *Siganus* formed the major catch. Catch efficiency was estimated as 0.75 kg /trap in terms of weight.

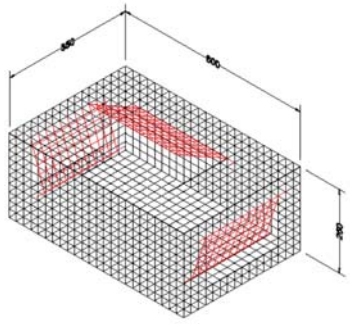
A new vertical serial foldable tarp with four chambers with two funnel type mouths was tested near ICAR-CMFRI cages along Vishakhapatnam coast. *Abudefduf vaigiensis* was the major catch.

Trap design (oval mouth)



Trap design (spherical mouth)

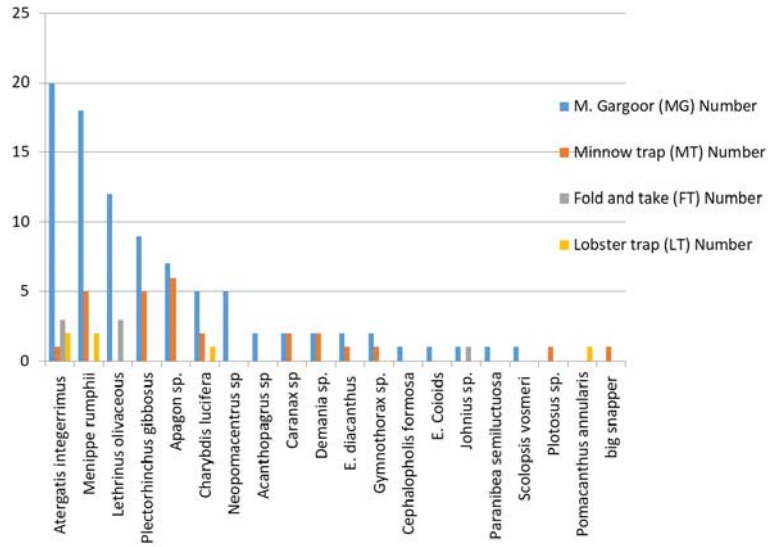
Collapsible trap with improved funnels



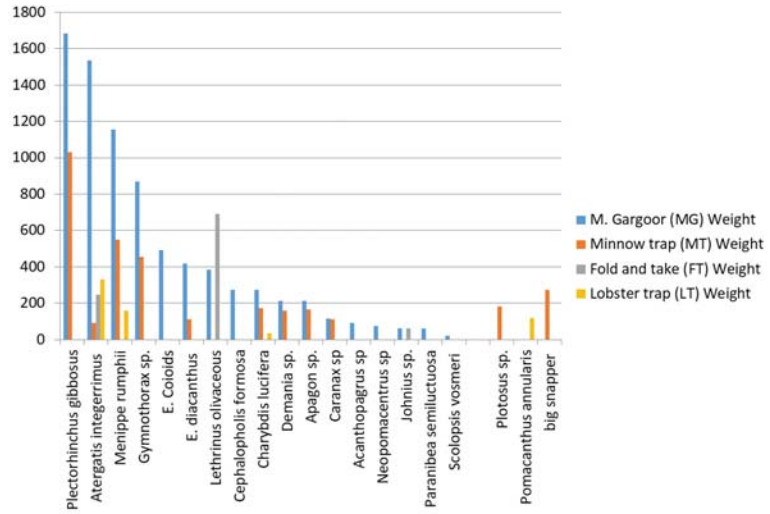
Rectangular crab trap

Experimental fishing traps at Veraval

Operation of fish trap at Veraval



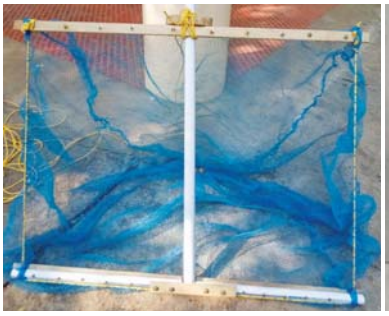
Modified Gragoor traps showed high catch rate compared to other designs.



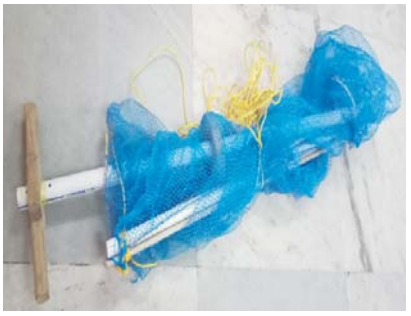
Weight of the catch recorded from various traps

Fishermen with improved collapsible trap

Mobile push trap: A mobile push trap with detachable handle and collapsible square panels made of PVC pipe and in combination of wood was designed and fabricated for using in inland water bodies targeting freshwater fishes. A length and breadth of collapsible part is 41.5X 32 inches. A length of detachable handle of 64 inches was attached with net with mesh size of 20 mm.



Mobile Push Trap in operational condition



Mobile Push Trap after detached

Survey of traps used in Manipur: A survey was conducted in the inland fishing sector (Nambol, Utlou, Ningthoukhong, Kombirei and Loktak lake) of Manipur. *Kaboruh* trap (specification of length - 80.9 cm) is operated in small streams, rivers, paddy field and wetlands targeting Puntius, Murrels, Zebrafish, *Clarias* sp. and *Lepidocephalus* sp. *Chekharuh* trap made of bamboo splits is operated in large fast flowing river during monsoon to catch Carps, Murrels, *Notopterus* sp. etc. *Longthrai/Thelong* is operated in wetlands and lakes of shallow water targeting small fishes such as Puntius, Murrels and Catfishes. Another trap being used in wetlands is *Soraruh/Longhoop* which targets Murrels, Eels, *Mastacembelus* and *Clarias* sp. *Taijab* is mainly operated in lakes, dams and reservoirs. All traps are made with bamboo splits and are mainly operated during the monsoon season.

Kaboruh

Chekharuh

Soraruh

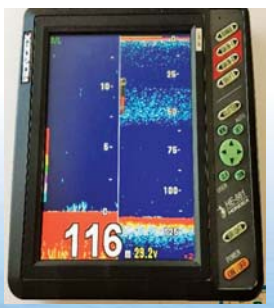
Yaijab

Optimization of harvest and post harvest techniques for Mesopelagics in the South Western Arabian Sea

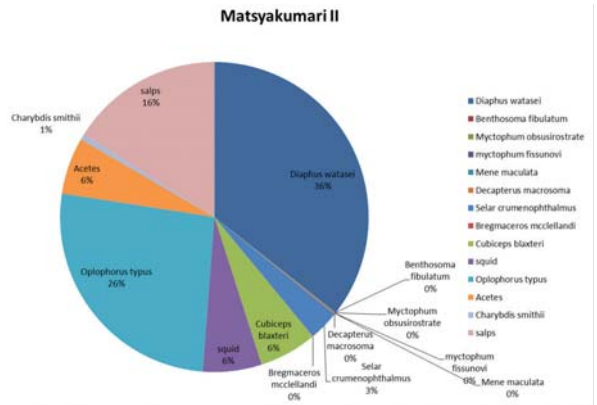
Fishing trials: Deep sea trawling for mesopelagic fishes was attempted off Kollam during August, September and November, 2018. Due to rough sea conditions trawling was restricted to below 100 m depth. Maximum catch/h was 250 kg of *Parapenaeus stylifera* in the month of August. Shells, *Charybdis feriata* and *Loligo* sp. were the other major components.

Preliminary analysis of the fishing trials and the catch characteristics reveal that bigger sized members of the mesopelagic community remained in the bottom and small varieties and juveniles are taking the diurnal migration or bigger varieties are able to avoid the net.

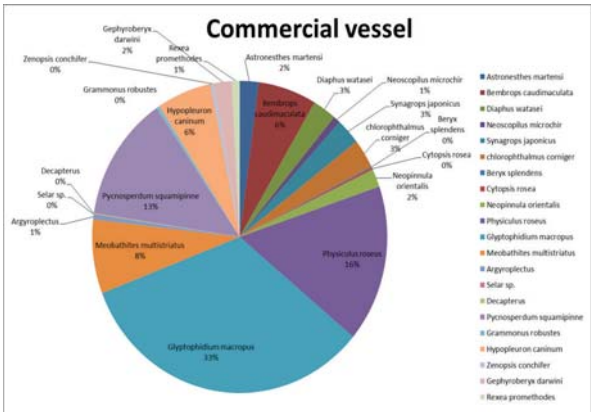
Data collected from commercial fishing vessels off Kollam has shown 22 species from bottom trawl. Major species caught were cusk eels followed by *Chlorophthalmus corniger* and *Bembrops caudimacula*. CPUE of commercial vessels were approximately 350 Kg/h.



Ecosounder display of DSL



Catch details of midwater trawling operation onboard Matsya Kumari - II



Bycatch composition of bottom trawls from commercial fishing vessel

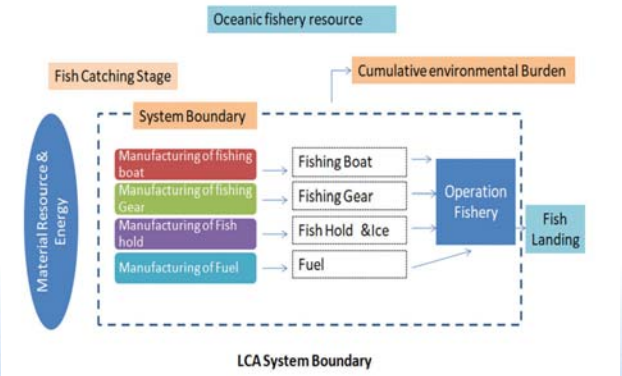
Preliminary trials of midwater trawl and IKMT for Mesopelagics carried out in Kollam bank revealed that the resource potential is insufficient for commercial level operation for Myctophids in this area.

IKMT trials off Kollam for Mesopelagics

Midwater trawl trials during late evening

Fishing technological interventions for sustainable marine ecosystem services along the East Coast of India

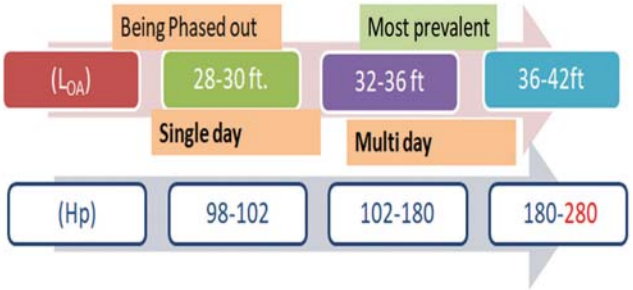
Life Cycle Analysis of fishing systems: Methodology was standardized for LCA in fisheries including system boundaries, functional unit and allocation. Primary and secondary data were collected from fishing systems of Andhra Pradesh using a tested and validated questionnaire for integration of data with GaBi for Life Cycle Analysis.



Study on structural changes in craft and gears: Documented structural and operational changes in fishing systems of Andhra Pradesh from Visakhapatnam, Kakinada, Nizampatnam and Machallipatnam. Design characteristics of gears in marine fishery of trawl nets, gill nets, boat seine, shore seine, hook and line were documented.

Drastic change in the structure of the fishing fleet in terms of size (L_{OA}) and installed engine horsepower among trawlers, long liners and gillnetters operating from Andhra Pradesh were observed.

In mechanized fishing sector a shift from single mode of fishing to combination systems with minor design modifications like installation of gillnet winch, changes in fish hold etc. to enable combination fishing like trawling and gillnetting as well as trawling and longlining. Depth of operation in trawling increased from 50 to 100 m for trawling. The fleet size (L_{OA}) of trawlers varied from 32–42 feet. The engine power varied from 102–180 HP.

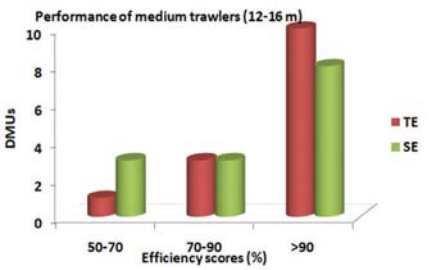


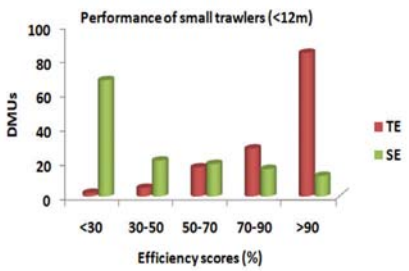
Changes in the trawling sector of Andhra Pradesh

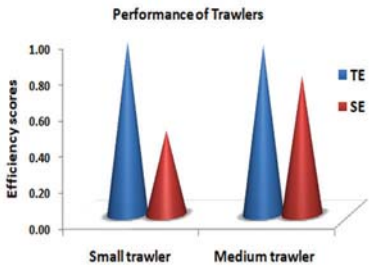
Economic evaluation of fishing systems: The performance of small and medium trawlers revealed that more than 40 and 50% Decision Making Units (DMUs) were operating with high technical efficiency but operate under low economies of scale. Cost is the major factor that determins the TOL and EOL of the selected fishing systems.

The technical optimum (TOL) and economic optimum (EOL) of the trawlers at Kakinada for the small, medium and large trawlers, revealed that medium class trawlers gained 28% more revenue than other two vessel categories.

Small trawlers showed high exploitation of engine power usage followed by medium trawlers. The degree of exploitation was 15 and 6 per cent in small and medium trawlers respectively. The performance of small and medium trawlers revealed that small trawlers had better comparitive efficiency.

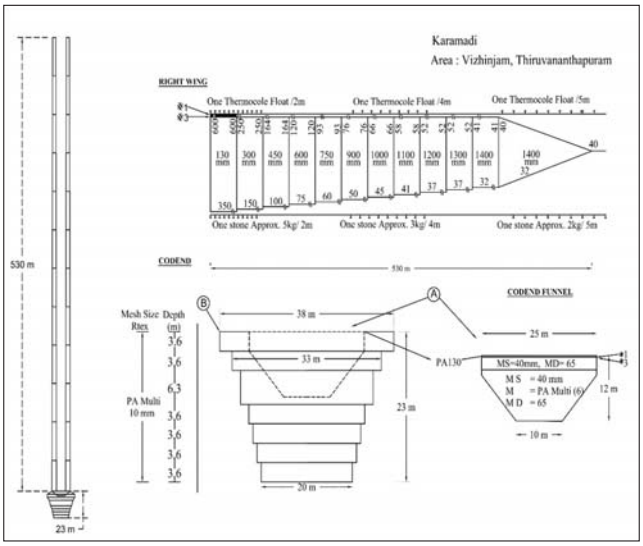






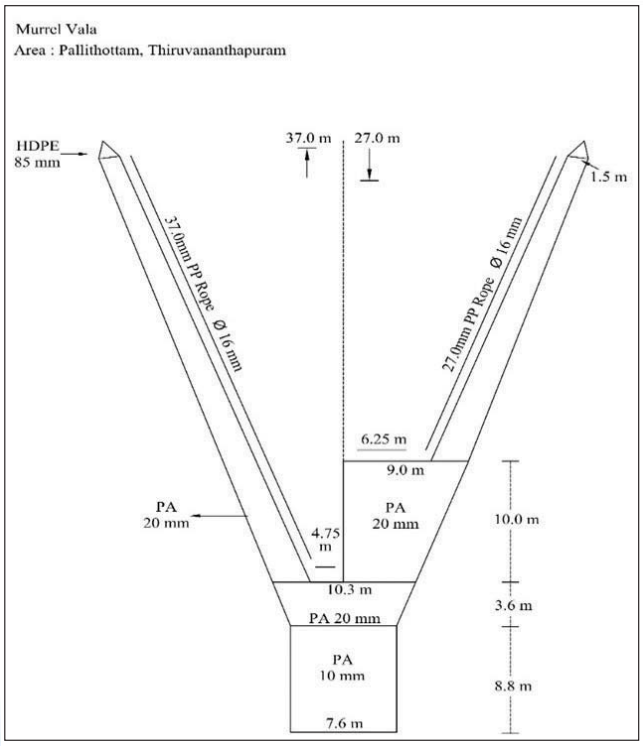
Studies on fishing operations and energy use for formulation of guidelines for selected small scale marine fisheries of India.

Documentation of designs of seines and gillnets: Documentation of the existing designs of seines and gillnets being operated in the states of Kerala, Tamil Nadu, Karnataka and Goa were carried out using structured questionnaire. Information from 45 locations of the four states were collected. The design details and operational parameters of a shore seine locally known as *Karamadi* in Thiruvananthapuram area was studied and documented. The presence of codend with a funnel to prevent the escapement of catch, is a characteristic feature of this gear. Other features of *Karamadi* include limited use of energy, low discards and bycatch and the use of bio-degradable materials for fabrication of the gear.



Structure and design of *Karamadi*

The design and structure of *Karamadi* was found to vary with species targeted and another common design of *Karamadi* from Kollam region, locally known as *Muralvala* was reported. The name is based on the targeted species, *Hyporhamphus* sp. (Half beaks).



Detailed design of the beach seine for *Hyporhamphus sp.*

A total of 38 designs of gillnet operated in the states of Tamil Nadu, Kerala, Karnataka and Goa was studied and the design details were collected for documentation.

Rapid assessment report on the losses due to flood in the fishing sector of Kerala

The "rapid assessment report on the losses due to flood in the fishing sector of Kerala" was conducted by ICAR-CIFT, Cochin by direct survey on the 11 flood affected districts of Kerala during September, 2018. Most of the impact of the disaster was due to the sudden onset of water due to the rising level of water in the rivers and reservoirs due to heavy rainfall, which made the fishers abandon the nets and many of the fishing gear (mostly gillnet and stakenets) and accessories were washed away from the stacking sites due to floods. The fishing vessels were mostly washed away and damaged by hitting against obstacles though very less, there are reports of damage to the engines also during the floods. The estimated financial loss in fishing crafts and gear for the different districts of Kerala due to flood 2018 was ₹1096.09 lakhs in which ₹424.27 was the marine sector and ₹671.82 lakhs from the inland sector.

An inland seine washed away at Pathanamthitta and damaged FRP craft at Alappuzha

Fish Processing

Research projects handled
Institute projects

- Technological interventions for enhancing utilization of secondary raw materials of aquatic origin.
- Interventions in processing and preservation of commercial and unconventional fishery resources.
- Biodegradable packaging materials for fish and fishery products.
- Development of processing protocols for emerging farmed fishery resources.
- Development of active and intelligent packaging system for fish and shellfishes.
- Development of moisture soaker sachets/pads from aquatic weed water hyacinth (*Eichhornia crassipes*) using super absorbent polymers for fish packaging application.
- Development of Chito-Pro product of chitin-protein derivatives as biofunctional supplement using in vitro gastrointestinal digestion process.
- Development of seaweed supplemented bioactive yoghurt.
- Novel approaches for value addition and safety assessment of fishery resources of east coast.
- Specific technological problems and mitigation measures in fish and fishery products of Maharashtra region.

Most significant achievements

- Upscaling of optimized bioactive protein hydrolysate from tuna red meat using enzyme papain was done and its economic feasibility on commercial scale was evaluated.
- Astaxanthin from shrimp head waste was released at the Annual General Body Meeting of ICAR by the Union Minister of Agriculture and Farmers Welfare.
- Standardized the protocol for dietary fiber-incorporated tuna and is commercially transferred to a processing unit in Chennai for domestic production of tuna sausages.
- A demerit score-based fish quality index (FQI) has been developed to assess the quality/freshness of fresh fish.
- Developed PLA-based films and trays and evaluated its suitability for packaging fishery products.
- Bagasse trays are found superior to areca trays and is an ideal biodegradable material for retail packaging of fish meat in low temperature storage
- Among the different organic acids used, combination of ascorbic acid and iron was found to be more effective for oxygen scavenging

- The Ag nanoparticles prepared using trisodium citrate can be used as an indicator to distinguish fresh and frozen stored fish.
- pH sensitive film prepared using red kidney beans can be used as freshness indicator.
- Performance evaluation of live fishes *viz*., Nile tilapia, common tilapia, milk fish and trevally in the ICAR-CIFT designed transportation prototype was carried out.
- For fish packaging application, developed a moisture absorbent pad by combining absorbent and non-absorbent layers prepared from water hyacinth stalks. Carboxymethyl chitosan was selected as the absorbent core.
- A chitin-protein derivative, 'Chito-Pro' was developed as bio-functional supplement.
- Fucoidan was extracted from brown seaweed and was characterized.
- Standardized microwave drying process for marinated and dried tuna chunks
- Evaluated quality changes in cage farmed grouper stored in ice and the shelf life was 22 days.
- Prepared squilla protein concentrate by foam mat drying technique.
- Addition of seaweed dietary fibre in bread as a functional ingredient reduced the loss of moisture content during storage, thus retarded the crumb hardness.
- Dried Bombay duck after pretreating with ginger-garlic had better quality compared to spine mix and control samples.
- Tri-sodium phosphate treatment along with chitosan coating was efficient in extending the shelflife of mackerel to 11 days with very low level of histamine.
- Screening of antibiotic residue such as chloramphenicol and AOZ in Navi Mumbai fish Market indicated that retail market samples had higher level than the recommended limit in shrimp.

Chief findings
Institute projects

Technological interventions for enhancing utilization of secondary raw materials of aquatic origin

Studies on enzymatic hydrolysis of Cuttlefish: Mass-balance studies on enzymatic hydrolysis of Cuttlefish skin using commercial enzymes has shown that alcalase is highly efficient in hydrolysis but papain could be better based on the activity and cost of production. Preservation of hydrolysate using acid indicated 6 months storage life.

Standardization of grow bag mixture: Standardized the protocol for incorporating fish silage into coir pith for formulating a grow bag mixture for plants. The mineral content of the mixture was also estimated. A collaborative research programme was initiated with Krishi Vigyan Kendra (KVK), Kumarakam and KVK, Njarakkal for conducting field trials with fish silage.

Toxicity studies on hydroxy apatite: The toxicity of hydroxy apatite (Hap) on L929 cells was evaluated. There was increasing reduction in metabolic activity across most of the HAP extracts as the treatment period increases.

Feed and foliar spray from fish waste: Conducted 12 market demonstrations on preparation of feed and foliar spray from market waste. Demonstrations were conducted at ICAR-CIFT for several entrepreneurs on request from various parts of the country.

Preparation and quality evaluation of Foliar spray from prawn shell waste and trials are being carried out in cardamom plants showing promising results. The technology has been transferred to M/s. Kallar plantations, Munnar.

Chitin and chitosan production from de-proteinised shell: Chitin and chitosan production from de-proteinised shell was carried out. It was observed that chitosan produced by the modified method had better colour and high viscosity compared to control samples.

Culture media for Pseudomonas: Developed a culture media for *Pseudomonas flourensis* and the survival under different levels of inoculation was evaluated.

Nano fish oil emulsion from fish oil: Nano fish oil emulsion was prepared using fish oil along with plant extracts and emulsifier. Oxidative stability studies revealed that fish oil emulsion prepared with pomegranate extract had lower peroxide value and thiobarbituric acid value than citrus extract. Oxidative stability studies revealed that spray dried encapsulates containing pomegranate extract had a lower TBA value. Fish oil encapsulates incorporated pasta had lower PV and TBA values than fish oil added one.

Fish silage from tilapia head: Fish silage was prepared from tilapia head with three different combinations of formic acid and lime juice. Lowest pH, TVBN and TPC values were found in 1:2, 1:1 and 1:0 respectively.

Feed from aquatic waste: Feed was developed from different sources of aquatic waste and compared with commercial feed and tested for quality parameters. Squid waste meal was found to have high protein content. Feeding study conducted with Tilapia for nutritional evaluation have shown that squid waste meal based feed and sardine waste based feed had high FCR compared to farm feed.

Studies on tuna protein: Variations in the physico-chemical characteristics of tuna protein during enzymatic hydrolysis were assessed. Based on RSM, 13 hydrolysates were prepared from tuna red meat under hydrolytic conditions *viz*., enzyme-substrate ratio and hydrolysis time. Degree of hydrolysis increased proportionately ranging from 14-46% with increase in Enzyme substrate ratio and time. Proteolytic activity also increased with the extent of hydrolysis from 0.196 to 0.505 µmoles tyrosine liberated/mg protein. Yield from hydrolysate solution improved from 6.02 to 12.54%. Viscosity of hydrolysate solution improved from 1.360 to 1.446 cP upon extended hydrolysis.

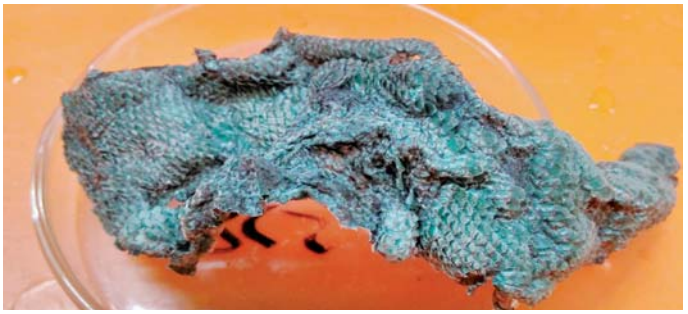
Bacterial growth media from tilapia hydrolysate: Bacterial growth media was prepared using tilapia hydrolysate and compared with commercial media such as Nutrient and Plate count agar. Fish and shrimp samples were used for comparative evaluation. The results showed that, Tilapia Head Hydrolysate Agar (THA) (0.25%) with supplements had the colony count of $8.5x10^5$ cfu/g and 0.5% of THA had the value of $1.3x10^6$ cfu/g, which was higher than the PCA ($1.1x10^6$ cfu/g) and lower than the NA ($1.7x10^6$ cfu/g) in fish samples. In shrimp samples, the bacterial count in THA 0.5% was greater than that of the THA 0.25% and PCA but less than that of NA.

Studies on Tilapia Head Hydrolysate Agar: Three different concentration of Tilapia Head Hydrolysate Agar was developed and tested with *S. aureus*. It was found that, the bacterial colonies were bigger in size and very crowded and transparent.

Effect of pre-treatment processes on the ash and protein profile of croaker skin prior to gelatin extraction: Gelatin was extracted from croaker skin by using salt and acid. SDS-PAGE profile showed that pre-treatment process did not affect the protein profile of the skin. The parameters like temperature, pH, enzyme substrate ratio and time were optimized for getting optimized degree of hydrolysis.

Preparation of fish leather from grouper skin: Preliminary study performed on the preparation of fish leather from grouper skin with two different types of treatment (chemical and vegetable) for tanning practices.

Grouper skin



Grouper skin leather

Studies on tuna protein hydrolysates: Attempts were made to upscale tuna protein hydrolysate, optimized and derived separately for functional antioxidants properties. The yield obtained from raw material after water washing and sodium bicarbonate solution treatment was about 87.5%. On an average the protein content of raw material was about 25% and a recovery of about 48% was observed on conversion to its Functional Tuna Protein hydrolysate (FTPH) whereas the protein recovery was about 56% in Antioxidant Tuna Protein hydrolysate (ATPH). The yields obtained on spray drying of the hydrolysate solution were 5.4% (FTPH) and 7.9% (ATPH).

Studies on chitosan bio-sorbents: Two types of chitosan bio-sorbents were prepared with sodium silicate and used as immobilization matrix. The pH of the matrix was adjusted to 3.3 with acetic acid and mixed with chitosan solution. The substances obtained were dried and cross linked the adsorbed polymer using glutaraldehyde solution. Silica was added to chitosan solution to get chitosan coated silica beads as absorbent. The obtained product was washed and decanted repeatedly and then dried at 50˚C to get a constant mass. Evaluation of performance is being carried out.

Chito-oligosaccharides from different enzymes: Antioxidant properties of chito-oligosaccharides (COS) prepared from different enzymes showed the scavenging activity of (20.8-30.6%) in the concentration of 0.5 mg/ml. The samples at the 10mg/ml concentration showed the scavenging activity of 40.8% for α-amylase, 60.6% for β-amylase and 50.7% for papain. The reducing powers of COS prepared increased with the increasing concentration of samples.

Ready to drink soup: The mineral analysis of clam shuck water was done and found to be a good source of Ca, Mg, Fe, Zn, Mn, Cu, Na and K. A ready to drink soup was prepared using clam shuck water. The standardization of thermal processing of soups were done at 121.1˚C for Fo values of 6,7 and 8.

Zinc nano particles incorporated chito-oligosaccharide: Six different combinations of ZnO nano particles and bulk particles along with Chitosan oligosaccharide were tested for antibacterial activity. Based on the well diffusion assay against Salmonella and MRSA, higher antibacterial activity was observed in 2% ZnO incorporated 2% COS dissolved in water. Not much difference was observed between the nano and bulk ZnO materials. Double concentration of water soluble ZnO-COS having better antimicrobial activity than single concentration of acid soluble COS-ZnO.

Interventions in processing and preservation of commercial and unconventional fishery resources

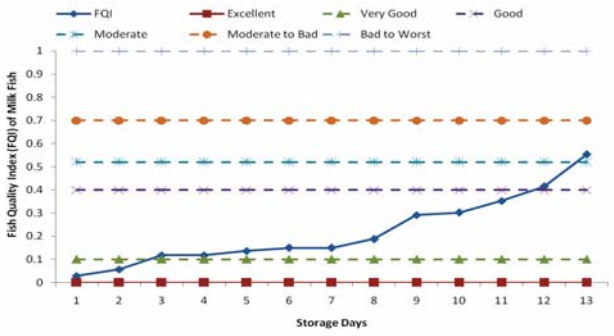
Dietary fiber-incorporated tuna sausage: Optimized the ingredients of tuna mince and dietary fiber for the development of dietary fiber-incorporated tuna sausage using response surface methodology. The protocol is commercially transferred to a processing unit in Chennai for the domestic production of tuna sausages.

Gelatin from puffer fish: Fish Extraction of gelatin from puffer fish with additional treatment of ultrasonication increased the yield and enhanced antioxidant properties of gelatin.

Modified icing system for slow melting of ice: A modified icing system comprising of alternate layers of conventional ice and super chilled ice containing sodium chloride was designed to slow-down the melting rate of conventional ice. The overall shelf life of *Vannamei* shrimp could be enhanced by 10 days in modified icing system compared to conventional icing system.

Demerit score-based fish quality index: A demerit score-based fish quality index (FQI) has been developed to assess the quality/freshness of fresh fish by considering five general characteristics in the demerit score like appearance of fish outer surface, fish eye, gills, belly and vent.

Process protocols for the preparation of ready to fry products: Standardization of process protocols for the preparation of ready to fry



products viz., shrimp and fish pappads were carried out and the technology was transferred to entrepreneurs.

Pasteurization was integrated in the preparation of pickled fish products which reduced the salt and vinegar concentration to half of conventional pickle. The microbiological parameters indicated 25 weeks shelf life for pasteurized samples against 17 weeks for conventional sample, under ambient storage conditions.

Benefit risk ratio of RTE Sardine: Benefit risk ratio of ready to eat sardine in different oils *viz.* olive oil, rice bran oil and sunflower oil was evaluated with respect to essential fatty acid, calorie value, lipid oxidation and biogenic amines. RTE sardine processed in olive oil has more health benefits followed by those processed in sunflower oil and rice bran oil.

Ready to eat prawn: Dried prawn mixed with spice mixture and the protocol for preparation of ready to eat prawn that can be stored at room conditions was developed and the technology was transferred to entrepreneurs.

Drying of *Ariomma indica in* microwave vacuum dryer: *Ariomma indica* was dried in microwave vacuum dryer at three different power levels (500 W, 600 W and 700 W) and evaluated its moisture content, weight loss and lipid oxidation. Drying rate increased with increasing power level. Fifty minutes drying at 600 W was found to be suitable for drying A. *indica.* However, increasing power level has made the fish more susceptible to lipid oxidation as measured by TBARS.

Effect of hydrolcolloids on the functional properties of *Ariomma indica* gel: The effect of guar gum and carboxy methyl cellolose (0.5 and 1%) on the functional property of Ariomma surimi gel was studied. Ariomma mince was washed single time in water (1: 4 w/v for 5 min) Surimi gel was prepared with 0.5 and 1% addition of CMC and guar gum and its properties were evaluated. CMC and guar gum has increased the gel strength, hardness and water holding capacity of the gel. Water holding capacity as measured by expressible moisture content was higher for 1% guar gum added gel followed by 1% CMC added sample.

Effect of low salt level and spices on the quality of dried *Ariomma indica*: Moisture content after brining was reduced from 78.26% in raw fish to 59.12% and 62.73% after brine salting with 25% and 20% salt. Yield after drying varied from 42.7 to 48.73%. Salt content of dried fishes varied from 16-18% (whole body weight).

Only 1% difference was noticed between the salt content of fishes brined with 25 and 20% salt. Lipid oxidation and TVB-N generation was controlled by spice treatment in both the samples. Total plate count was influenced by the salt treatment as the 25% salt brined samples had lower TPC than the 20% salt brined samples.

Development of protein concentrate from Squilla by foam mat drying: An attempt was made to prepare protein concentrate from the under-utilized crustacean, squilla by foam mat drying technique. Squilla protein was collected by hot water extraction method in potable water. It was then filtered and centrifuged. The residue was ground with a whipping agent *(Gum acacia)* and made into foam and dried at 55°C in a hot air oven. The dried protein concentrate has very good solubility and can be used as a protein/flavouring agent in food formulations. Yield of SPC was 12% from raw material. Protein content of squilla and SPC was 13.2 and 36.6%, respectively. SPC had excellent emulsifying and antioxidant properties but poor foaming property.

Preparation and characterization of protein isolate from lean and fatty fishes: Fish protein isolate was prepared from Indian mackerel (*Rastrelliger kanagurta*), rohu (*Labeo rohita*), croaker fish (*Johnius dussumieri*), Nile tilapia (*Oreochromis niloticus*) and Bombay duck (*Harpodon nehereus*) fish mince and its physico-chemical and functional properties were evaluated. Yield of isolate obtained were ranged from 92.45 to 95.60%. Highest protein solubility was observed for mackerel, rohu and croaker at pH and WHC, FAC ranged between 2.45-2.90 g water/g sample and 1.8-2.30 2 g oil/g sample, respectively.

Biodegradable packaging materials for fish and fishery products

Studies on biodegradable packaging films: Incorporation of different types of clays at 1-2% levels enhanced the barrier properties of Poly Lactic Acid (PLA)/Montmorillonite, PLA/Halloysite and PLA/ Bentonite films. The blown films were found suitable for packaging and chilled storage of different fish products. PLA films such as 1% MMT and PLA, 2% MMT and PLA, 2% Halloysite and PLA and 2% Bentonite and PLA showed 100% reduction of S.*aureus* at 72 h.

PLA trays injection moulding

PLA trays of 500 ml capacities were developed by injection moulding. The size of the tray was 11 cm length, 5.5 cm height x 6 cm width at the bottom. The thickness was 0.65 mm. The physical storage properties of the trays were evaluated by keeping at ambient, frozen (-18°C) and chilled (2-4°C) temperature. The trays stored at frozen temperature were found acceptable only up to four months, after which they were found to be brittle and disintegrated into fragments.

Heat sealing of 220 ml capacity trays were possible by using only PLA films. The sealing temperature was around 100°C. The PLA trays were found suitable for chilled storage of fish. The products stored in it were superior to those packed in HDPE and bagasse trays.

PLA films were developed by incorporating different levels of calcium carbonate at PEG 400 as plasticizer. The microbial quality and shelf life of shrimp in LDPE, PLA, PLA calcium carbonate films indicated that the prawns were acceptable up to 14 days of storage in all the films

PLA/Calcium carbonate films

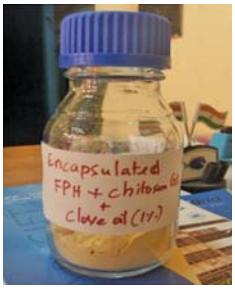
PLA coated palm sheath trays: Physical and mechanical properties of PLA coated palm sheath trays were found superior to plain palm sheath trays. Water absorptiveness from inner and outer surface can be reduced by the polymer coating which will enhance the durability of the trays upon storage at low temperatures. Similarly, the PLA coating improved the thermal efficiency of insulation of the trays at both 28±1°C and 2±1°C.

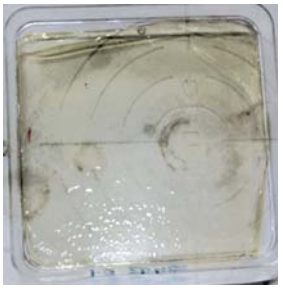
Commercially available bagasse trays were found superior to areca trays with respect to mechanical and physical properties. Both trays were found suitable for packaging of fishery products. Chill storage studies of Milkfish (*Chanos chanos*) in bagasse trays with stretch overwrap demonstrated as an ideal biodegradable material for retail packaging of fish meat in low temperature storage conditions for 12 days.

Bagasse trays

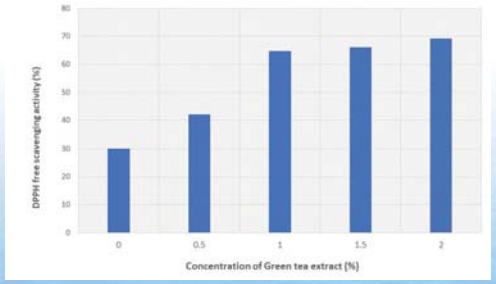
Milkfish packed in bagasse tray

Microencapsulated fish protein hydrolysate: Microencapsulated fish protein hydrolysate powder exhibited good film forming properties and tensile strength. Microencapsulated fish protein hydrolysate powder with chitosan and clove oil exhibited antimicrobial properties towards *Staphyloccus aureus*. Followed by gram-negative bacteria such as *Salmonalla typhi* and *Salmonalla paratyphi*.

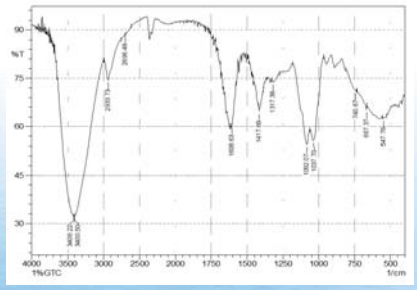




Films of gelatin and chitosan: Films of gelatin and chitosan were prepared with different ratios of solute individually as well as of blend. homogenous and flexible cross linked films indicating good compatibility



DPPH free radical scavenging activity



FTIR spectrum of film incorporated 1% green tea extract

Sodium alginate film incorporated with green tea extract did not show any antibacterial activity against *E. coli* and *Staphylococcus aureus*. Highest DPPH free scavenging activity was found in sodium alginate films incorporated with 2% green tea extract. 1% seaweed incorporated bread wrapped in alginate film with green tea extract had enhanced shelf life when compared to conventional wrapping.

Characterization of PLA-based solvent casted antimicrobial films incorporated with ginger (*Zingiber officinale*) essential oil (GEO) at different concentrations indicated that the incorporation of ginger essential oil resulted in an increase of elongation-at-break of PLA films.

Edible wrappers from fish myofibrillar protein

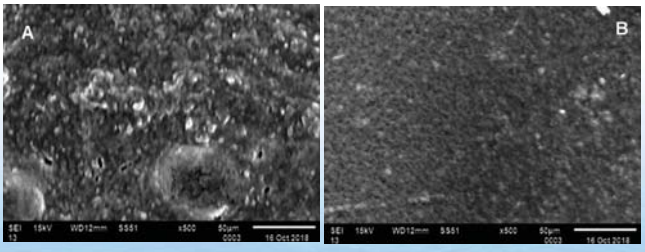
Biodegradable films were developed from extracted fish myofibrillar protein along with sodium alginate, glycerol and microbial transglutaminase. The films were found suitable for edible packaging material. The effect of this composite films on the shelf life of fish-based products was analyzed. The protein-based films were used as edible wrappers which revealed better shelf life and acceptance in fish products.

Chito-oliogmers based biodegradable films were developed from chitosan and SEM analysis showed the biocompatibility of the chito oligosaccharide chitosan film. The films also exhibited higher tensile strength and elongation break. Storage analysis for evaluating the effects of chito oligosaccharide films by wrapping *Aluterus monoceros* fillets showed that wrapped fillets had lower bacterial counts compared to fillets unwrapped.

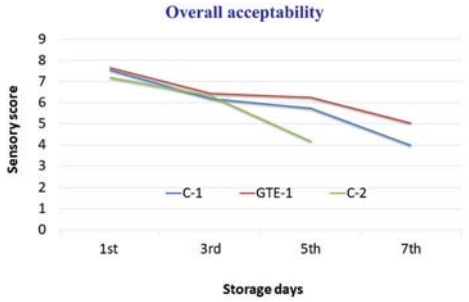
Biodegradable active films were prepared from PLA added with turmeric (*Curcuma longa*) essential oil by solvent casting method. The PLA films without essential oil displayed no antimicrobial activity against the studied microorganisms.

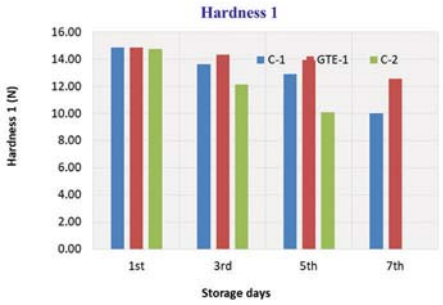
The lactic acid migration from composite films was comparatively less than that of neat PLA films. A low rise for lactic acid migration was observed only after three days of simulation for nanofillers at 5 to 10% in the composite film. Lactic acid migration in 50% ethanol remained well below the specific migration limit of in all films that was tested.

Effect of GTE-Alg film on seaweed incorporated bread during storage at ambient temperature: Seaweed-incorporated breads were wrapped with different types of films such as C-1: seaweed bread wrapped with plastic films, C-2: seaweed bread wrapped with Alg films and GTE-Alg: seaweed bread wrapped with GTE-Alg films. The mean sensory scores showed that green seaweed incorporated bread wrap in GTE-Alg had the highest score for all the attributes tested throughout the storage periods. Mold was not detected during initial storage days in all the sample and on 5th day mold count was $10x10^{-1}$cfu/g, $5x10^{-1}$cfu/g and $5x10^{-1}$ cfu/g for C-1, C-2 and GTE-Alg, respectively.



SEM micrographs of surface-section from sodium alginate films incorporated with GTE. A: pure sodium alginate films; B: sodium alginate films incorporated with 1% GTE





Development of processing protocols for emerging farmed fishery resources

Studies on quality characteristics of fish under different rearing systems: The quality characteristics of cage reared cobia (*Rachycentron canadum*), and cage reared bigeye trevally (*Caranx sexfaciatus*) reared under different culture systems (Cage, Re-circulatory Aquaculture System and Pond) was evaluated under different storage conditions. Maximum shelflife was observed in chilled salt water media compared to 11-12 days in crushed ice.

The quality characteristics of cage reared bigeye trevally (*C. sexfaciatus*) as handling stress and slaughtering method was evaluated. Fish killed by immersing immediately in ice/water slurry) exhibited shorter struggling period of 4-6 minutes compared to 17-19 minutes for fish allowed to struggle till death. Simultaneous measurements of pH values of blood, muscle and gill slime showed distinctly different values.

CR Big eye Trevally (*C. sexfaciatus*)

Cage reared Orange Spotted Grouper (*Epinephelus coioides*)

Freshly harvested grouper (1.2 kg average weight) from sea cage was stored in ice and evaluated its quality changes during storage. Based on sensory evaluation (raw and cooked) and microbiological quality and the shelf life of grouper was 22 days in iced storage.

Nutritional, physical and functional quality of Indian Pompano (*Trachinotus mookalee*) cultured in different aquaculture systems (Cage, Re-circulatory Aquaculture System and Pond) was compared to its wild counterpart. The results indicated superior nutritional and functional quality for farmed pompano compared to its wild counterpart.

Cage reared Indian Pompano (*T. mookalee*)

Studies on processing characteristics of different fishes: The gravads Nile tilapia were packed under air and stored at 0°C and 6±2°C and its biochemical and sensory changes during storage were evaluated. Based on sensory evaluation, the shelf life of gravads is determined as 40 days under chilled storage and 45 days under iced storage.

Fish protein isolate and fish pasta from Nile tilapia: Fish protein isolate was prepared from Nile tilapia fish meat by pH shift process. Further, fish pasta were prepared by incorporating isolate at 5%, 10% and 15%. Pasta prepared without incorporation of fish protein isolate was kept as control. Sensory analysis revealed that incorporation of fish protein isolate up to 10% was comparable with control.

Functional mince products from Nile tilapia: Functional mince products were prepared from Nile tilapia fish mince by incorporating fish oil microencapsulates. To improve the oxidative stability of fish oil essential oil from citrus peel (CT) and pomegranate peel extract (PM) were added in fish oil emulsion and spray dried. TPC reached rejection limit (5 log cfu/g) on 17th day in all the samples.

Fish meat bars: Protocols for the preparation of fish meat bars were standardized and its storage stability under chilled and frozen conditions was analysed. Meat bars showed a shelf life of 110 days under chilled and more than 360 days under frozen conditions.

Fermented fish flavoured marinating mix: Fermented fish flavoured marinating mix was developed from *Puthishidal* by optimizing a suitable combination with other spices/masala. Indian mackerel was used to study the preservative action of fermented fish flavoured marinating mix (40%) at chilled temperature (<4°C) for a period of 15 days. The results indicated that control masala mix and 40% FFF masala mix have effective preservative action and found to be better than control sample (without marination).

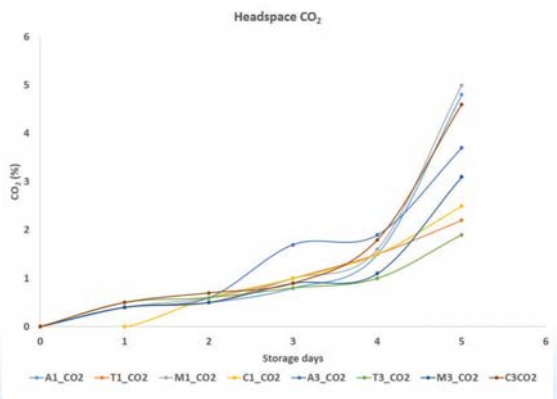
Ready to eat and instant mix: Ready to eat keema, Instant cutlet mix and instant prawn upma mix were developed from emerging species with better shelf life.

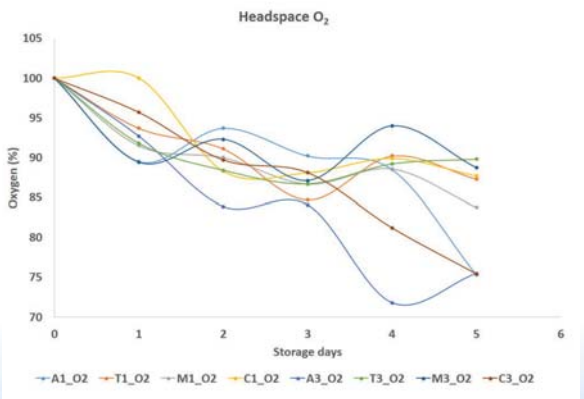
Development of soft-shelled crabs: Attempts were made to develop soft-shelled crab using various chemical agents such as acids, chelating agents and enzyme immobilized in gels. Acid treatments were found to be better in softening the crab shell.

Low cost live fish transport container: A prototype of low cost live fish transport container was developed with Peltier cooling and aeration provisions. Studies on survival rate of Nile tilapia, common tilapia and milkfish in the designed transportation container for 24 h indicated 100% survival.

Development of active and intelligent packaging system for fish and shellfishes

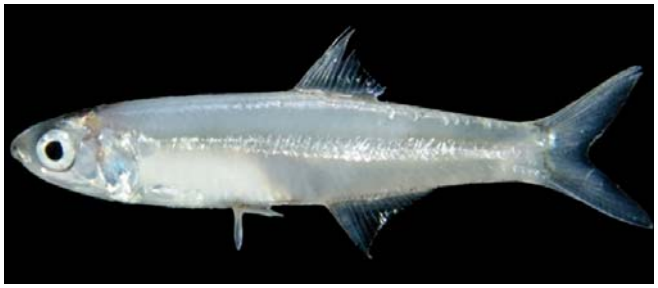
Efficiency of organic acids on oxygen scavenging ability: Efficiency of different organic acids *via*., ascorbic, citric, maleic and tartaric acid in different ratio were evaluated for oxygen scavenging ability. The combination with ascorbic acid and iron powder was found to be more effective than other acids in scavenging oxygen.



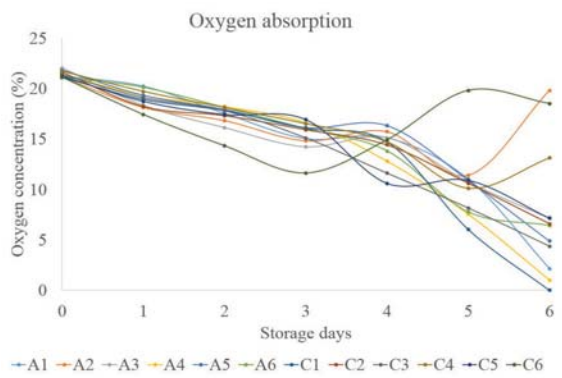


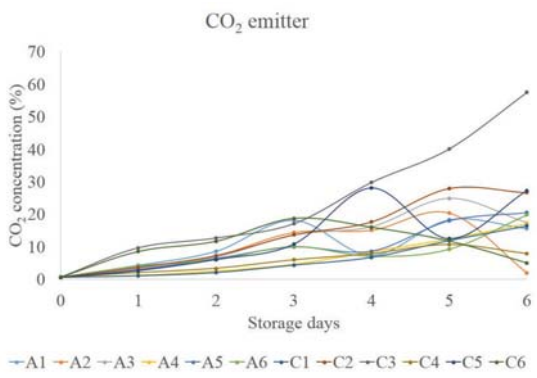
Among the different organic acids used for active packaging studies, combination with ascorbic acid and iron powder improved the quality of anchovy stored under chilled condition (1-2°C). Oxidation and discolouration was the major problem observed for control samples, which were acceptable only up to four days. Packing in oxygen scavenger containing ascorbic acid and iron improved the shelf-life up to 7 days. TBA reactive

substances were observed least for sample packed with ascorbic acid and iron combination compared to other organic acids and vacuum packaging.



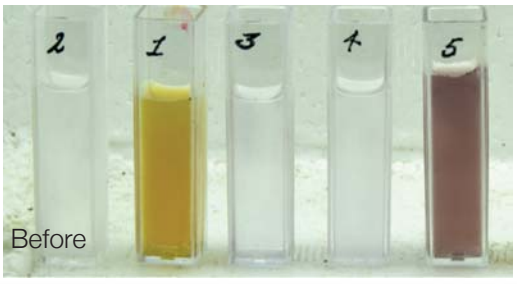
Development of dual action sachet: Twelve different combinations containing sodium bicarbonate, iron, ascorbic acid and citric acid in different ratios were evaluated for developing dual action sachet. Active packaging sachet with sodium bicarbonate, iron powder and citric acid gave better CO_2 emission under chilled condition (1-2°C).

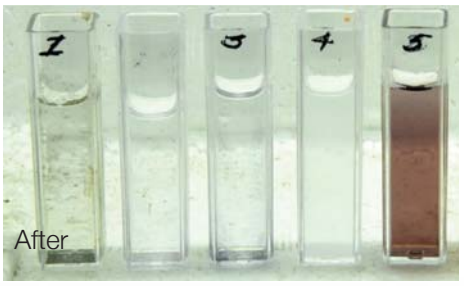




Green synthesis of gold and silver nanoparticles: Green synthesis of gold nanoparticles using chitosan, squid skin protein hydrolysate, carrageenan and clam shuck water was carried out. Studies indicated that the concentration of seed solution used influence the optimum conditions for the synthesis of AuNPs.

Silver nanoparticles prepared with trisodium citrate changed the colour from yellow to colourless on frozen storage which can thus be used as indicator to distinguish fresh and frozen stored fish.





pH sensitive dye was effective in indicating freshness of Indian white shrimp, yellow travelley, milkfish and mackerel with bright yellow to dark purple colour. A very slight greenish yellow and light whitish cream was observed for tilapia and pearl spot, respectively upon spoilage from bright yellow colour.

Gold and silver nanoparticles developed using biomaterials were evaluated for their efficiency to indicate high temperature exposure. UV-visible spectra indicated very high intensity peaks for silver nanoparticles exposed to high temperature (98°C) for 5 and 15 min compared to other temperature studied.

Development of moisture soaker sachets/pads from aquatic weed water hyacinth (*Eichhornia crassipes*) using super absorbent polymers for fish packaging application

Preparation of thin absorbent fiber layer from water hyacinth pulp: A procedure for the preparation of thin absorbent fiber layer from water hyacinth pulp was developed with de-waxing treatment. Absorbent layer with channels along with pressed, plain non-absorbent layer were selected for the combination for moisture soaking pads.

Water hyacinth pulp, non-absorbant fiber layer and absorbant fiber layer

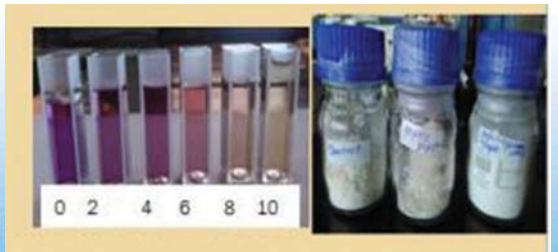
Fish meat packed in vacuum pack, modified atmospheric pack and air pack were analyzed for drip characteristics. The CM-CH sachet was found to hold the drip and quantity was optimized for making a moisture absorbent sachet in 100 g fish packing.

Development of Chito-Pro product of chitin-protein derivatives as bio-functional supplement using in vitro gastrointestinal digestion process

Cooked small size prawns were digested using pepsin and pancreatin sequentially. The solids solubility digestibility increased by pepsin and pancreatin. The major protein fractions were fragmented to low molecular weight peptides.

Chito-Pro

The soluble material obtained from Chito-pro preparation was studied for antioxidant properties and anti-hypertensive property using Angiotensin-I converting enzyme inhibitory properties. The bioactive properties were found to vary between control and digested sample and also found to be dose-dependent.



DPPH free radical scavenging activity

Development of seaweed supplemented bioactive yoghurt

Compatibility of seaweed with milk: To check the compatibility, seaweed-milk mix was prepared at different concentrations and subjected to sensory evaluation. At higher concentrations, seaweed imparted seaweed flavor to the milk and it was not preferred by the sensory panelists. The addition of seaweed led to thickening of the milk system.

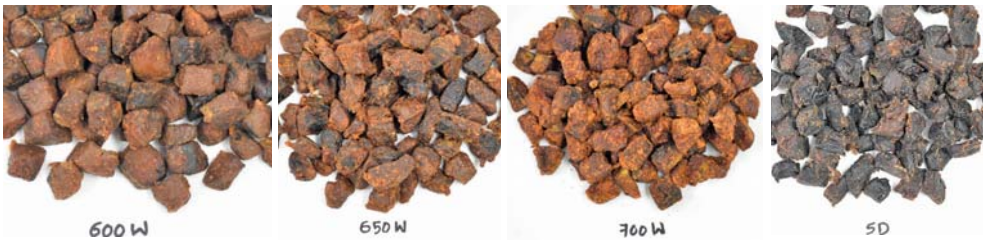
Fucoidan

Fucoidan from the brown seaweed: An attempt was made to extract fucoidan from brown seaweed using hot water and ultrasonic extraction method. Fucose sugar content was more than 60% in the fucoidan obtained. FT-IR spectrum of fucoidan showed typical absorption peak for the presence of sulphated groups.

Recovery of yoghurt bacteria: Three media namely M17 with glycerophophate, de Man, Rogosa and Sharpe (MRS Agar) and bromocresol purple (BCP) agar were tested for recovery of yoghurt bacteria from curds and yoghurts available in the retail markets. MRS agar was found most suitable.

Novel approaches for value addition and safety assessment of fishery resources of East Coast

Effect of microwave vacuum drying on the properties of marinated Tuna chunks: Bone less tuna chunks were marinated using spices and were dried in microwave vacuum dryer at different power levels for 2 h. Increasing microwave power level resulted in reduced moisture but higher hardness in dried tuna chunks. Colour and appearance of sample processed at 650 & 700 W was superior to other treatments.



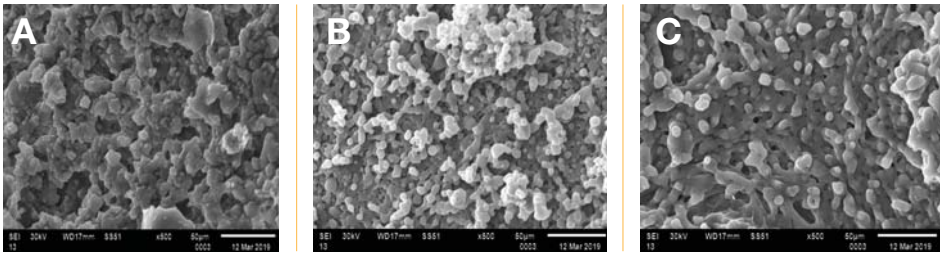
Restructured and dried nuggets from Tuna mince: Tuna mince was restructured with corn starch (1 and 2%) and moulded in to small nuggets and dried in microwave vacuum drier. Rehydration rate of nuggets made from tuna mince alone was significantly lower to that prepared with the addition of 1% and 2% corn starch. Addition of corn starch improved the lightness but reduced the redness of the nuggets.

Effect of carboxy methyl chitosan on the quality of dried anchovy: Effect of CMC as an edible coating for dried anchovy was evaluated. Microbial growth and fungal growth was lower in 1% CMC treated sample. CMC treatment has also controlled lipid oxidation during storage of dried anchovy as the TBARS of control was higher than 0.5% CMC and 1% CMC treated anchovy.

Seafood flavour and analoug products: Seafood flavour from deep sea shrimp was prepared by digestive enzyme such as pepsin and trypsin. Seafood flavour extract was dried in microwave vacuum drier and spray drier and samples are coded as SFm and SFs, respectively. Results shows that microwave vacuum dried seafood flavour had better antioxidant properties as compared to spray dried products. Incorporation of seafood flavour at higher level absorbed more water in shrimp analogue product due to highly hydroscopic nature of flavour.

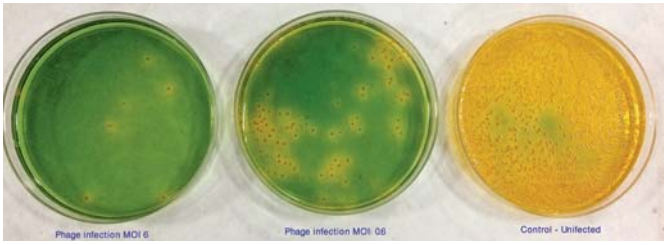
Micro encapsulation of seafood flavour: Emulsions were prepared in different core materials and dried in spray dryer. SFm showed higher antioxidant activity as compared to the non-encapsulated peptides (SF). All

the samples exhibited scavenging ability lower than 50% for DPPH radicals and also had very low metal ion chelating activity.



A) SEM of spray dried SF
B) SEM of encapsulated SF with maltodextrin
C) SEM of encapsulated SF with maltodextrin and sodium casienate

Growth inhibition of *E. coli* by Coliphage at different Multiplicity of Injection (MOI): The study on the growth of *E. coli* in the presence of bacteriophage (at different MOI viz., 0.6 and 6.0) at incubation temperature of 37°C for 6 h in nutrient broth showed inhibition of *E. coli* growth with reduction in viable bacterial counts. Coliphage when used at MOI of 6.0 reduced the *E. coli* counts by 5 logs whereas MOI of 0.6 resulted in 3 log reduction in *E. coli* counts.



Reduction in *E. coli* counts (on Tergitol-7 agar) after 6 h of infection with Coliphage

Batch culture of Coliphage: Coliphages were propagated in a 2 L fermenter, using suitable conditions. After 6 h of fermentation, the Coliphage count increased 2 log with an associated decrease in *E.coli* counts by 3 log indicating sustained lytic activity of *E. coli* by the Coliphage. The ratio of Coliphage (virus) to *E. coli* (bacteria) at the start of the fermentation was 1.0 and after 6 h the ratio increased to 454 clearly indicating the phage replication and lysis of *E.coli.*

Antibiotic susceptibility of bacteria from probiotics used in shrimp farming: Bacillus (n=4) and Gram positive Cocci (n=2) isolated from two commercial probiotics was tested. All the Bacillus isolates were sensitive to gentamicin and norfloxacin but majority of the probiotic Bacillus isolates showed resistance to peniciliin, ampicillin, amoxycillin, oxacillin, tetracycline, cefepime, ceftriaxone, cefoxitin and cefotaxime. The Cocci isolates were sensitive to gentamicin, nitrofurantion, chloromphenicol and oxacillin but were resistant to pencillin, ampicillin, amoxycillin, cefepime, ceftriaxone, cefoxitin and cefotaxime.

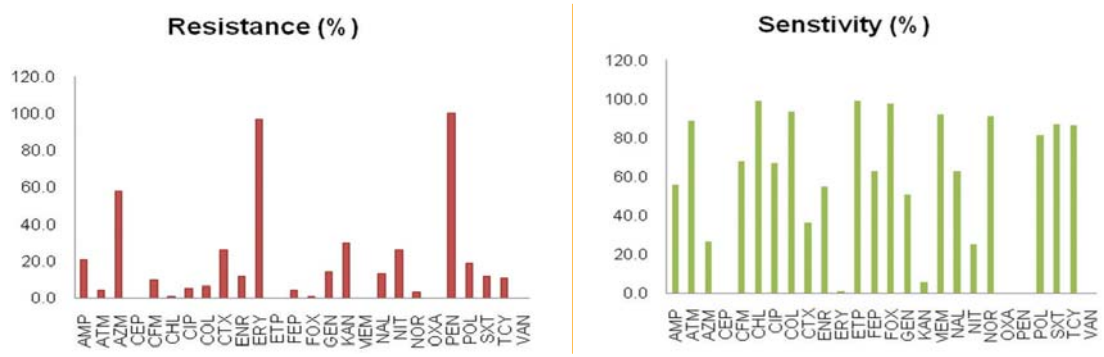
Nutritional composition of farmed fish, farmed shrimp and marine fish and marine shrimp: The nutritional composition of five farmed fish and a farmed shellfish *viz*., *Pangasianodon hypophthalmus*, *Oreochromis niloticus*, *Piaractus brachypomus*, *Labeo rohita*, *Catla catla*, and *Litopenaeus vannamei* was studied. The K:Na ratio of marine fish ranged between 0.26 and 5.9 with a mean ratio of 2.16±1.6.

Screening retail fish for formaldyde adulteration: CIFTest formaledhyde detection kit was employed for screening of 18 fish samples and the results indicated that all the fish samples were negative.

Safety assessment of fish and fishery environment: Fish samples were collected from street side vending unit (S1), whole sale fish market (S2), retail fish (S3), fish farm (S4), modern fish vending unit (S5) for the

enumeration of coliforms. In catla muscle, the highest density (MPN/g) of total coliforms (TC), faecal coliforms (FC), *E. coli* (EC) were observed in S1 and S3 observed highest TC, FC and EC among the catla gut sampled. Ninety five *E. coli* isolates were tested for antibiotic resistance against 26 antibiotics. The bacterial isolates showing highest percentage of resistance were towards erythromycin (97%), azithromycin (58%), kanamycin (30%) nitrofurans (27%), cefotoxime (27%) and ampicillin (21%). The antibiotics showing >90% susceptibility against *E. coli* isolates are chloramphenicol (99%), ertapenem (99%),cefoxitin (98%), cefoxitin (98%), colistin (93%), meropenem (92%), norfloxacin (91%). The multidrug resistance observed in this study is 14.7%.

Percentage of antibiotic resistance among the isolates



Formaldehyde content in domestic market fishes: Freshwater fish samples viz., tilapia, rohu, Pangasius and scampi (fresh water prawn) were collected from Vashi local markets and tested for presence of formaldehyde content and the content were in the range of 4.6 – 35 ppm

Specific Technological Problems and Mitigation Measures in Fish and Fishery Products of Maharashtra Region

Quality of fish meal with and without addition of antioxidant produced in commercial units of Ratnagiri, Maharashtra was evaluated (B) were studied. Significantly lower thiobarbituric acid values were reported in samples added with antioxidant ($p<0.05$) throughout the storage period of 14 months indicating better oxidation stability.

Effect of CMC-Na with nano and bulk ZnO particle coated packaging film on the quality of refrigerated stored fish mince based product: Fish cutlets were prepared and divided into three different groups namely cutlet without coating (CWC), cutlet with ZnO bulk particle coating (CBC) and cutlet with ZnO nanoparticle coating (CNC and increase in expressible moisture content during the storage of CWC was significantly higher than that in CBC and CNC. TBA value was higher in CWC samples. CWC samples were acceptable upto 12 days of storage period whereas, CBC and CNC were acceptable upto 16 days.

Effect of different cooking and packaging methods on quality and shelf-life of lobster (*Panulirus polyphagus*) tails: Fresh raw lobster tails were purchased from a seafood industry was cooked by immersion in hot water by microwave cooking and packed in air and vacuum packed condition and stored under chilled conditions. TBARS values of air packed samples were slightly higher than that of vacuum packed samples irrespective of cooking method. Alpha amino nitrogen content and non-protein nitrogen (NPN) contents of samples showed decreasing trend as a function of storage period. Total plate count of air packed immersion cooked lobster (AICL) exceeded the acceptable limits on 8th day of chilled storage whereas other samples were acceptable upto 12 days.

Effect of electron beam irradiation on the quality of tilapia fish chunk: Quality and shelf life evaluation of electron beam irradiated tilapia fish chunks were studied. Fresh tilapia (*Oreochromis niloticus*) were cut into chunks (3-4 cm thickness) and one batchwas used as control. Electron beam irradiation were given for vacuum packed fish chunks at two different dose level viz. 2.0kGy, 4.0kGy. All the samples were kept in chiller (2°C) for further studies. Highest expressible moisture content observed for 4.0kGy on 22nd day, for 2.0kGy on 26th day, for control on 16th day. PV, TBARS showed gradual increase during storage. TBARS values were within the limit during storage. PV crossed the acceptable limit on 41st day for 2.0kGy and 4.0kGy irradiated fish chunks. Microbial acceptance limit exceeded in 16th & 33rd day of control and 2kGy treated samples respectively. Sample treated with 4kGy did not exceed the microbial limit even after 41st day.

Dip treatment of Bombay duck with clove and cinnamon water extracts and dry inhibited TBARS value compared to control sample

Effect of spice powder mix on the quality of dried Bombay duck: Fresh Bombay duck were split opened, cleaned, treated with 3.5% spice mix , 3.5% garlic and ginger mix and dried. Bombay duck without spice mix treatment was kept as control. PV and TBA values were less in ginger/garlic powder mix treated followed by spice mix control.

Effectiveness of trisodium phosphate in histamine control: Effectiveness of trisodium phosphate treatment at 5 and 10% level on histamine formation during refrigerated storage of Indian mackerel steaks was evaluated. Results indicate that trisodium phosphate treatment can be used along with temperature control to regulate the formation of histamine in case of scombroid fishes. Further combination of trisodium phosphate and chitosan delayed formation of histamine during refrigerated storage.

Screening of antibiotic residue such as chloramphenicol and AOZ in Navi Mumbai fish Market: Presence of CAP and AOZ in aquaculture shrimp and fish marketed in retail fish market of Vashi were tested by Enzyme Linked Immune Sorbent Assay (ELISA). Total 20 shrimp samples and 20 finfish samples were collected and analyzed. Based on the study, it was observed that shrimp had higher levels of CAP (2.64±0.37 ppb) and AOZ (3.160±0.09 ppb). The entire retail market samples had higher level than the recommended limit in shrimp but in finfish CAP and AOZ were found to be absent.

Quality Assurance and Management

Research projects handled
Institute projects

- Food safety hazards of fish and fishery products: Assessment and mitigation measures
- Developing a rapid detection kit for formaldehyde contamination in seafood

Externally funded projects

- Monitoring of heavy metal in finfish and shellfish species along Indian coast and possible mitigation measures

Most significant achievements

- Toxinotyping of *Staphylococcus aureus* was carried out; the most prevalent genotypes detected were SEC (17.44%), SEB (12.2%), SEA (2.9%), TSST-1 (16.2%).
- Natural level of formaldehyde content in fresh fish samples (n=150) ranged from <LoQ to 5.0 mg/Kg
- Legal samples (56) obtained from Food Safety Commissionerate, Govt. Kerala were analyzed for ammonia adulteration. Around 17% of samples were free of ammonia, 13% below detection level and 70% were having ammonia content in the range of 1.32-30.5 mg/Kg.
- Screened and identified allergenic proteins of Brown shrimp (*Metapenaeus monoceros*), Jinga shrimp (*Metapenaeus affinis*) and Kiddi shrimp (*Parapenaeopsis stylifera*). Hypersensitive responses in BALB/c mice due to intra-gastric administration of shrimp allergen, Tropomyosin purified from *Metapenaeus dobsoni* was evaluated.
- Safety of dried and fermented fish products of North Eastern states were evaluated. High concentration of histamine (118.18±1.22 ppm) was recorded from *Phasashidal* of Nagaland. *Bacillus aryabhattai* and *Paenibacillus favisporous* were found to be dominant histamine formers.
- Process evaluation of commercial accelerated freeze drying process of shrimp indicated improper sanitation in post freeze-drying steps contributed to spike in coliform load in the final product.
- Microbiological safety of domestically marketed and ready to eat fish in retail stores and supermarkets was determined. *Listeria monocytogenes* was prevalent at 4.4% level in fish markets.
- Duplex PCR was developed for simultaneous detection of *Listeria monocytogenes* and other *Listeria* spp. Multiplex PCR was developed for detection of Enterohameorrhagic *Escherichia coli* (*E.coli* 0157:H7).
- A highly sensitive PGS-PCR assay was developed for the detection of pandemic strain of *V. parahaemolyticus* (O3:K6) in seafood.

- Evaluation of hygiene status in various primary fish production areas indicated high load of hygiene indicator bacteria in peripheral food contact surfaces and ice used for chilling.
- Analytical methodologies/protocols were developed, validated and accredited as per ISO 17025 requirements for detection of antibiotic residues, pesticide residues, heavy metals, methyl mercury, sodium benzoate, ciguatoxin, ammonia and formaldehyde.

Chief findings

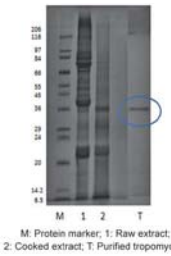
Institute projects

Food safety hazards of fish and fishery products: Assessment and mitigation measures

Toxinotyping of Staphylococcal isolates from fish and fishery products: Incidence of coagulase positive Staphylococci in seafood samples from fish landing centers, retail markets, local markets and supermarkets of Kochi was found to be 45%. Among the Enterotoxicogenic isolates (50), the most prevalent genotypes detected were SEC (17.44%), SEB (12.2%), SEA (2.9%), TSST-1 (16.2%). Methicillin resistance was found in 2.3% of the isolates.

Total number of CPS contaminated samples	SEG	SEH	SEI	TSST
55	11 (9.1%)	5 (4.16%)	8 (6.66%)	34 (16.1%)

Determination of adulterants in fish and fishery products: Natural level of formaldehyde content in fresh fish samples (n=150) ranged from <LoQ to 5.0 mg/Kg. Legal samples (56) obtained from Food Safety Commissionerate, Govt. of Kerala were analyzed for ammonia adulteration. Around 17% of samples were free of ammonia, 13% below detection level and 70% were having ammonia content in the range of 1.32-30.5 mg/Kg.



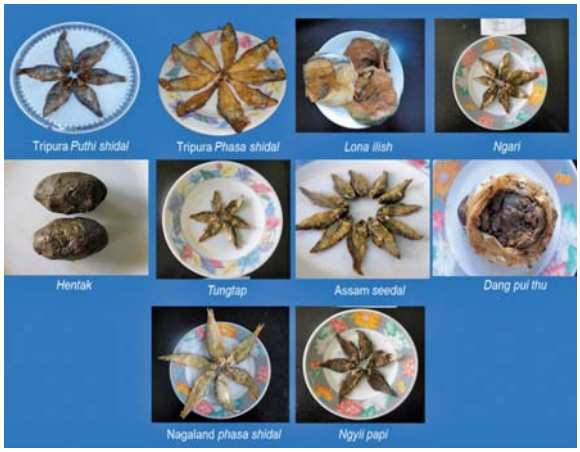
M: Protein marker; 1: Raw extract; 2: Cooked extract; T: Purified tropomyosin

Screening and characterization of allergenic shrimp proteins in different shrimp species: Screened and identified allergenic proteins of Brown shrimp (*Metapenaeus monoceros*), Jinga shrimp (*Metapenaeus affinis*) and Kiddi shrimp (*Parapenaeopsis stylifera*). Both raw and cooked extracts of shrimps showed good IgE binding ability compared to control. In all the shrimp species, proteins of 37 KD were identified as major allergen by immunoblotting technique.

Purified Tropomyosin in SDS PAGE: Hypersensitive responses in BALB/c mice due to intra-gastric administration of shrimp allergen, Tropomyosin purified from *Metapenaeus dobsoni* was evaluated. The treatment group with higher dosage level showed IgE level of 0.33-0.36 and histamine of 0.357-0.408 ppm.

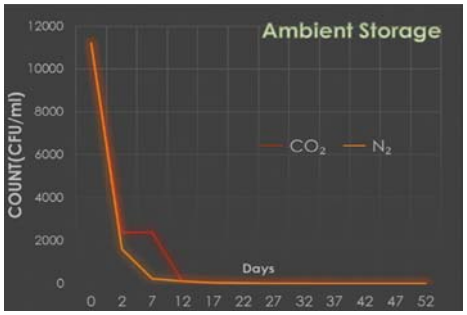
Boiling, microwaving, acid treatment had no effect on shrimp allergenic protein, whereas degradation of allergic protein and absence of immune-sensitive property was recorded after autoclaving. Trypsin hydrolysis at 37°C for 30 and 60 min. had no effect on the allergenic protein, whereas significant loss of property was recorded due to trypsin hydrolysis at 50°C for 30 and 60 min. and chymotrypsin hydrolysis at 37°C and 50°C for 30 and 60 min.

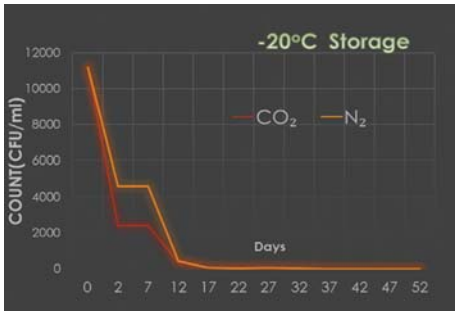
Quality and safety of fermented products of north eastern states of India: Safety of dried and fermented fish products of North Eastern states was evaluated. High concentration of histamine (118.18±1.22 ppm) was recorded from *Phasashidal* of Nagaland. *Bacillus aryabhattai* and *Paenibacillus favisporous* were found to be dominant histamine formers. Quality parameters were TVBN (64.40-450.4 mg/100g), PV (40.13-70.86 meqO_2/Kg lipid), FFA (20.23-32.90 % Oleic acid) and TBARS (0.95-2.95 mg MDA/Kg). Although pathogens like Salmonella and *E.coli* were absent, *Staphylococcus aureus* was present at the levels of 1.42-2.2 log cfu/g.



Evaluation of hygiene status in fishing harbours and aquaculture farms: Evaluation of hygiene status in various primary fish production areas indicated high load of hygiene indicator bacteria in peripheral food contact surfaces and source/operational water in aquaculture farms. The levels of hygiene indicators in food contact surfaces were as follows: mesophilic bacterial count: 3-6 log cfu/cm^2; Total coliforms: <4.0 -1.8 x10^3 cfu/cm^2; Enterobacteriaceae count: <4.0 -1.6 x10^3 cfu/cm^2.

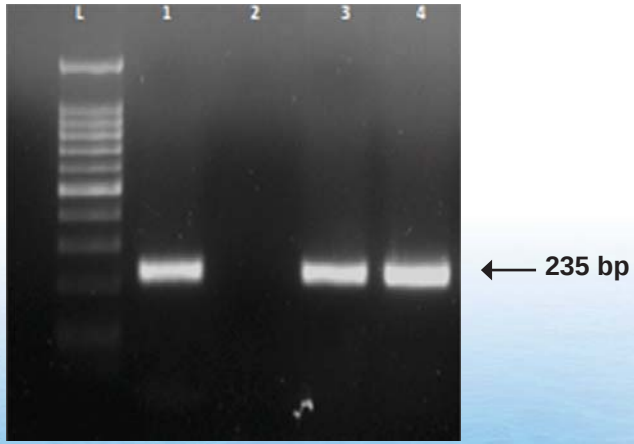
Safety evaluation of freeze-drying process: Process evaluation of commercial accelerated freeze drying process of shrimp indicated improper sanitation in post freeze-drying steps contributed to spike in coliform load in the final product. Online sampling was carried out at 14 different steps in the process (repeated for seven days). Similarly, CO_2 packaging and storage at room temperature was determined to be adequate.





Monitoring of pathogens in fish and fishery products by molecular tools: A highly sensitive PGS-PCR assay was developed for the detection of pandemic strain of *V. parahaemolyticus* (O3:K6) in seafood.

PGS-PCR assay of *Vibrio parahaemolyticus* (O3:K6)



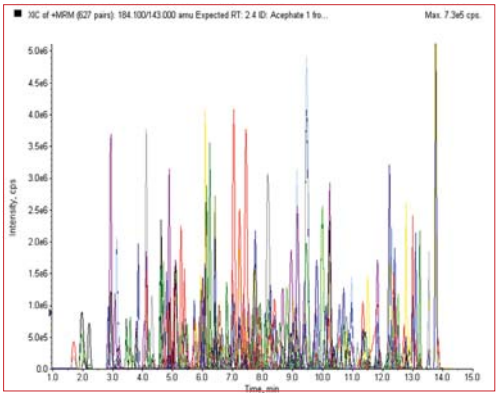
Lane L: GeneRuler 100 bp (Fermentas, USA); Lane 1: Positive control;
Lane 3: R-TSWF5-VP1; Lane 4: R-TSWF5-VP2

Real Time PCR based detection protocol was standardized for detection of *Listeria monocytogenes* using genus specific *iap* gene (131bp amplicon size) and species specific hlyA gene (234 bp amplicon size). Out of 19 samples taken from 5 different market samples, *L. monocytogenes* was detected in two samples.

A sum total of 39 *E. coli* isolated from various sources (fish, shellfish and water) were tested using duplex PCR and multiplex PCR. Duplex PCR was optimized with two genes 16S rRNA (544 bp) and eaeA genes (384 bp). A multiplex PCR was developed targeting *FLICH 7H 7*gene (625 bp), *RFBE O157* gene (213 bp), and *eaeA* gene (384 bp) for detection of Enterohaemorrhagic *E. coli*. Out of the 39 isolates tested, 16 were identified as *E. coli* and none of the isolates were found to be Enterohaemorrhagic.

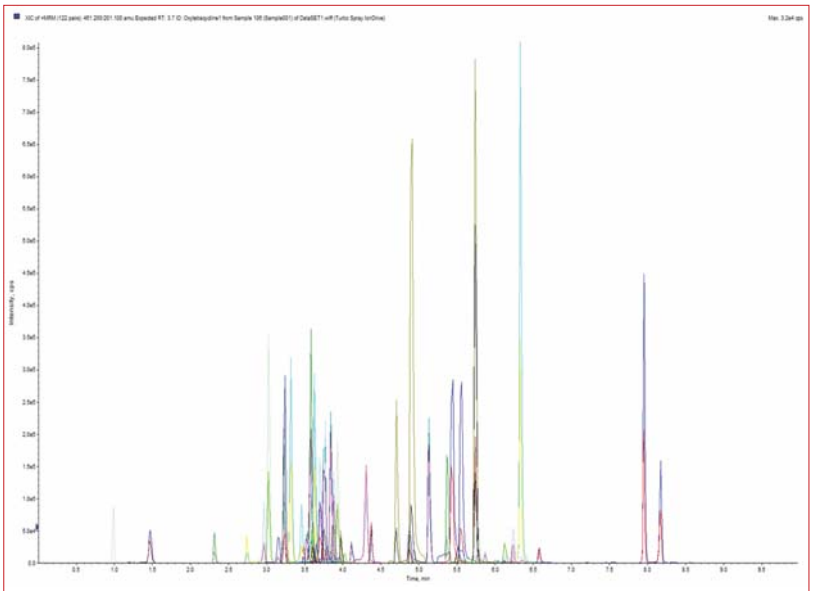
Presence of *Edwardsiella tarda* was screened in 68 samples collected from five different locations across Kerala. Molecular confirmation was done with presence of *GyrB* gene. Although 17 isolates were biochemically positive, none were positive for presence of GyrB gene.

LC-MS/MS method for multi-residue analysis of pesticides: A multi-residue method for determination of 397 pesticides in fish and fishery products was developed and validated as per the SANTE Guidelines (SANTE/11813/2017) given by European Union. Estimation of the residues was performed by retention time dependent 'scheduled multiple reaction monitoring' (sMRM) with two mass transitions for each test pesticide; one for quantification and the other for confirmation. The MRM detection window (MRM DW) was 90s with the target scan time of 1s. A recovery of 80-120% could be achieved for 73% of the compounds.

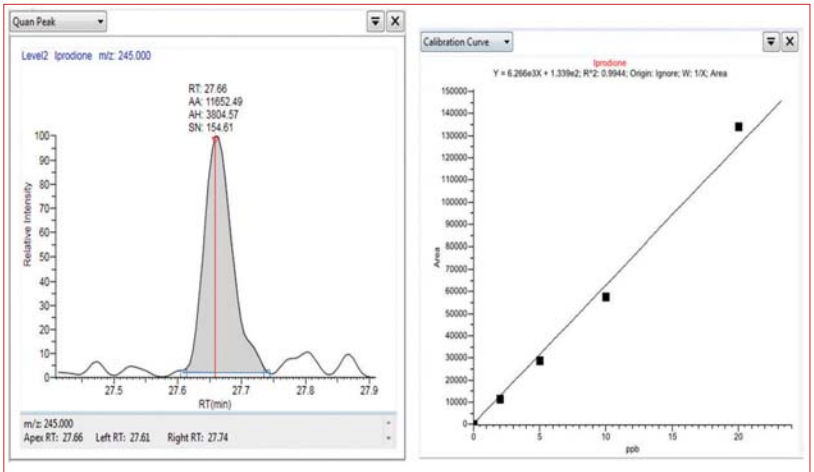


Analytical methodologies/protocols development for determination of contaminants: During the period under report, the following analytical methods were developed, validated and accredited as per ISO:17025 requirements: Heavy metals and Trace Elements (ICP-MS); Methyl mercury (HPLC-ICP-MS); Multi-class and multi-residue detection of antibiotic residues (LC-MS/MS); Multi-class and multi-residue detection of pesticide residues (GC-MS/MS); Formaldehyde (GC-MS and HPLC –DAD); Sodium Benzoate (HPLC-DAD); Ammonia (Electrode based); TVBN (Steam Distillation); Ciguatoxin (mouse bioassay).

Method developed, validated and accredited as per ISO 17025 requirements		
Protocol develooped	**Parameter**	**Matrix**
ICP-MS	Heavy metals and Trace Elements	Fish & fishery products and water
HPLC-ICP-MS	Methyl mercury	Fish & fishery products
LC-MS/MS	Multi-class and multi-residue detection of antibiotic residues	Fish & fishery products
GC-MS/MS	Multi-class and multi-residue detection of pesticide residues	Fish & fishery products and water
GC-MS and HPLC-DAD	Formaldehyde	Fresh fish & other *Aquatic* sp.
HPLC-UV	Sodium Benzoate	Fish & fishery products
Colorimetric	Ammonia	Fish & fishery products
TVBN	Steam Distillation	Fish & fishery products
Mouse Bioassay	Ciguatoxin	Fish & fishery products



LC-MS/MS method for simultaneous analysis of 70 multiclass antibiotic in shrimp



GC-MS/MS instrument method optimization for 242 contaminants including Pesticides, PAHs, PCBs, PBDEs

Development of food safety standards: ICAR-CIFT was involved as a Lead Centre in formulation of various food safety standards in close collaboration with FSSAI, ISO, BIS and Codex. The major activities carried out during 2018-19 are as follows:

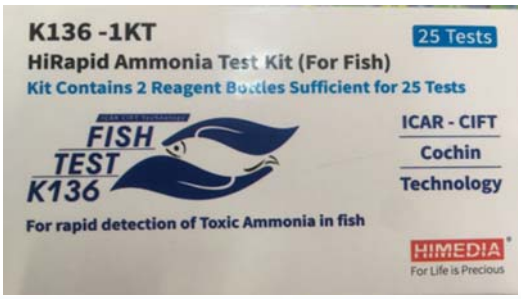
- FSSAI standard on pasteurized crab meat and pasteurized fish sausage
- FSSAI standards on fish oil
- Inclusion of shellac as additive in dried fishery products
- Revision of FSSAI Standards on veterinary drug residues
- Country view points for CCCF 13 meeting on methyl mercury and ciguatoxin
- Affirmation of microbiological standards for FAD15, Bureau of Indian Standards.

Developing a rapid detection kit for formaldehyde contamination in seafood

CIFTest kit for formaldehyde: There was huge requirement for CIFTest kit for checking formaldehyde adulteration in fish from food safety authorities of different states of India and private parties. About 500 formaldehyde kits were produced and delivered to 87 stakeholders including 39 Government and regulatory agencies in the year 2018 by the institute.

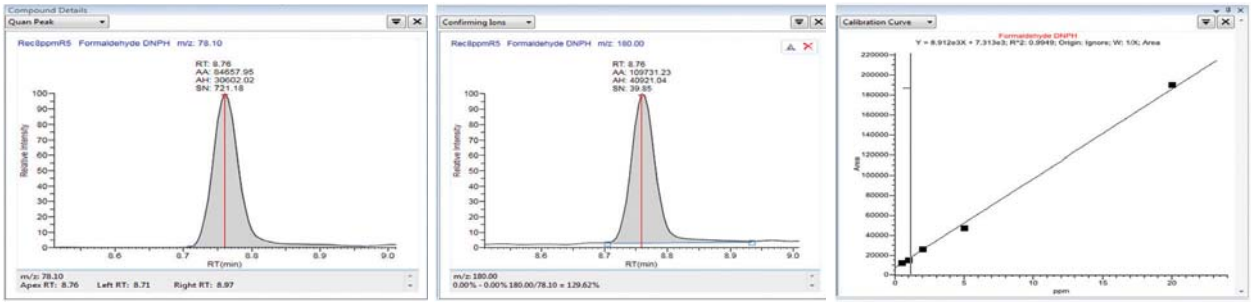
The technology has been licensed to the Mumbai-based M/s. HiMedia Laboratories Pvt. Ltd., and the formal exchange of the MoU was held at a function in ICAR-CIFT, Kochi on 4th July, 2018. The product is now commercially available.

Dr. Ravishankar C.N., Director, ICAR-CIFT handing over the MoU to Mr. Vishnu Warke, Director HiMedia Laboratories

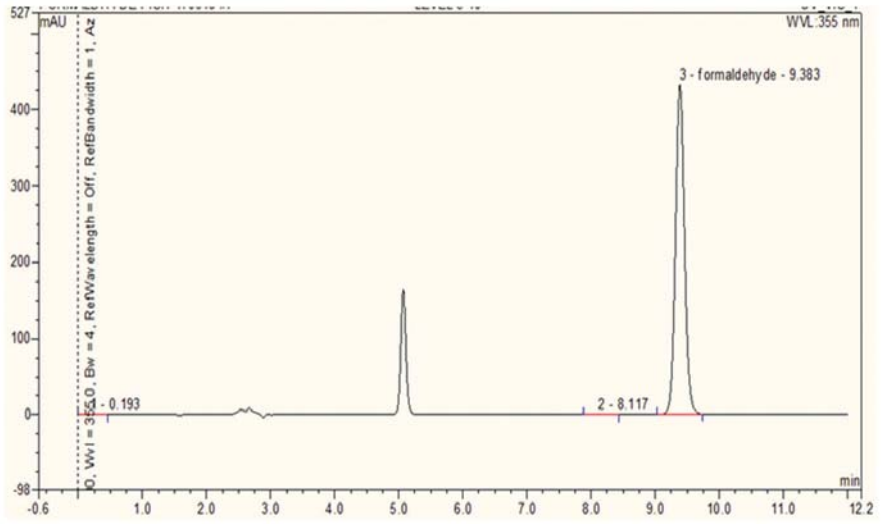


Method development for determination of free formaldehyde: Both HPLC and GC-MS/MS based methods were developed for determination of free formaldehyde in seafood. Formaldehyde was derivatized using 2, 4-dintirophenylhydrazine. In the HPLC method, LOD was 1.0 mg/Kg with an average recovery of 101.93%. In case of GC MS/MS method, the LOD was 0.625 mg/Kg with an average recovery of 85.75%. Out of 55 fish samples analyzed, 20% showed positive result by CIFTest kit. In the free or added formaldehyde

analysis using this instrumental method showed a result of <LoQ in 80% of samples, 20% were found to be in the range of 3-16 except one sample with the highest value of 64 mg/Kg.



Quantifier transition Quantifier transition Matrix based calibration 0.5 to 20 ppm; R2: 0.9949



Chromatogram of 10 mg/L formaldehyde

A demonstration of rapid detection kits for adulterants in fresh fish was given to Shri Vishwajit Rane, Hon'ble Health Minister of Goa in presence of Secretary, Ministry of Health, Director, FDA and FSSAI QA Advisor at a press conference on 24th September, 2018.

Formaldehyde kit demonstration at Goa by Smt. Laly S. J., Scientist and Dr. K. Ashok Kumar, Principal Scientist, ICAR-CIFT

Microbiology, Fermentation and Biotechnology

Research projects handled

Institute projects

- Occurrence, distribution and molecular characteristics of emerging and re-emerging pathogens in seafood and its environment
- Molecular diversity of pathogens associated with aquatic system and harnessing aquatic niche for beneficial bacteria or products
- Development of colorimetric nano-biosensor strips for detection of food borne pathogens.

Externally funded projects

- National surveillance programme on aquatic animal diseases
- Network programme on Assessment of Antimicrobial Resistance (AMR) in microorganisms associated with fisheries and aquaculture in India
- Diagnostics for One Health and User Driven Solutions for AMR (DOSA)
- Does antimicrobial resistance (AMR) in livestock contribute to AMR in people in NE India. An interdisciplinary study investigating antibiotic use, drivers of AMR, and transmission dynamics.

Most significant achievements

- Seventy three samples out of 133 screened harboured *Arcobacter* sp. Molecular characterization was carried out for 96 isolates of Arcobacter by species specific PCR for *Arcobacter butzleri* (401 bp), *A. skirrowii* (641 bp) and *A. cryaerophilus* (257 bp). Fifty one isolates were identified as *A. butzleri*, four isolates as *A. skirrowii*, 26 isolates as *A. cryaerophilus* and 15 isolates were not differentiated by multiplex PCR.
- A total of 1103 (soil-441, water-363 and shrimp-299) bacterial isolates were selected, purified and resistance was studied against five different antibiotics by disc diffusion method. Antibiotic resistance was observed for ciprofloxacin (141; 12.7%), chloramphenicol (48; 4.3%), co-trimoxazole (161; 14.5%), erythromycin (132; 11.9%) and oxytetracycline (460; 41.7%). Sixty eight isolates out of 192 harboured*tetA* gene (387 bp), five isolates out of 25 harboured cat1 gene (349 bp), four isolates out of 50 harboured sul1 gene (433 bp) and four isolates out of 50 harboured sul1 gene (657 bp).
- Four potential sulphur oxidizing bacterial isolates (three from mangrove- SC10, SD6, and SB1 and one from freshwater fish farm-TA-1) were identified by 16 S rDNA sequencing as *Halothiobacillus* sp. and *Thiomonas* sp.
- AuNPs prepared using trisodium citrate gave better colour response upon immobilization with pure enzyme.

- For the colorimetric assay, substrates chlorophenol red β –D-galactopyranoside (CPRG) and 5-Bromo-4-chloro-3-indolyl β-D-glucuronide (X-gluc) were selective to pure enzymes β- galactosidase and β glucoronidase of *E. coli* O: 157 and *E. coli*, respectively.
- Paper-based strip was developed for the detection of pathogens by using filter paper.
- Prominent colour was noticed on paper strips incorporated with gold nanoparticle for the shrimp samples spiked with *E. coli* O:157 and *E. coli* after 9 h and 12 h of enrichment with incubation of 30 min. and 2 h, respectively at 37°C.
- *Chromobacterium violaceum* is one of the biofilm bacteria of Enterobacteriacea garnering wide attention in the clinical cases due to its high mortality rate. While screening the water of retail fish markets, three samples were found contaminated with C. *violaceum*. Ten isolates were purified and confirmed by biochemical and molecular characterization.
- Nano-chitosan-ZnO composite possessed slightly higher antibacterial activity than chitosan–ZnO composite and antibacterial activity of chitosan-ZnO and nano-chitosan ZnO composite is equal to antibacterial activity of H_2O_2 incorporated chitosan/nano-chitosan.
- *Phyllanthus acidus* (Amla) fruit extract incorporated chitosan-ZnO composite enhanced antibacterial activity against food-borne pathogens.
- Pathogenic Vibrio isolates was detected in 5% of seafood samples.
- *V. cholera* non O1 isolates was recovered from 13.3% seafood samples.
- Exo-polysaccharide containing sulphate group was extracted from seaweed associated bacteria-*Bacillus cereus*
- Isolates of *V. parahaemolyticus* harboring variant *tdh* gene were isolated and confirmed by southern blotting and hybridization.
- Process developed for mass propagation of bacteriophages as 1 L batch culture in a fermenter and obtained a yield of 1.8 x 10^{11} bacteriophages (Coliphage to *E.coli* ratio of 454).
- Method developed for preparing phage cocktail (Four different bacteriophages) that showed high lytic activity against 84% of the *E. coli* isolates.
- Studied AMR pattern of the bacteria isolated from farmed *Penaeus vannamei* shrimp (n=32) of Andhra Pradesh and the results indicated higher resistance of *E. coli* towards erythromycin (100%), *Staphylococcus aureus* towards penicillin G (57%) and erythromycin (43%); coagulase negative Staphylocci towards penicillin-G (95%), oxacillin (63%), cefoxitin (63%) and *Vibrio parahaemolyticus towards* ampicillin (25%) and cefoxitin (25%)
- Developed a process for nitrification potential of *Achromobacter xylosoxidans* under laboratory conditions.
- Developed a method for the sequencing of 16S rRNA region using Illumina platform.
- Developed a concept on antibiotic resistant profile of *E. coli* from seafood.

Chief findings

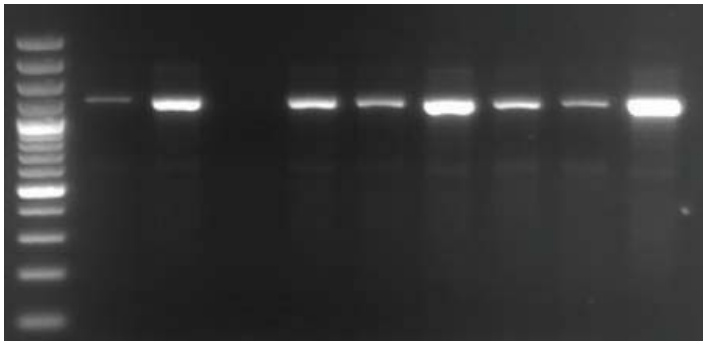
Institute projects

Occurrence, distribution and molecular characteristics of emerging and re-emerging pathogens in seafood and its environment

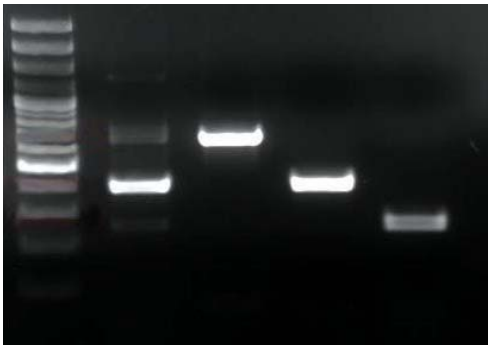
Occurrence and distribution of pathogens: A total of 80 samples were collected from Ernakulum which encompasses fish, shellfish, molluscs, water and ice from selected retail markets, commercial outlets, super markets and from various landing centers. All the samples were tested for the emerging and re-emerging pathogens.

Arcobacter sp. was detected from 73 out of 133 samples screened from Ernakulum and molecularly confirmed by 16S rDNA primers specific to *Arcobacter* spp. and molecular characterization for species-specific PCR for

Arcobacter butzleri (401 bp), *A. skirrowii* (641 bp) and *A. cryaerophilus* (257 bp). Fifty one isolates were identified as *A. butzleri*, four as *A. skirrowii* and 26 as *A. cryaerophilus* (257 bp) while 15 isolates could not be identified to species level. Antimicrobial susceptibility of the Arcobacter isolates (43) was tested against 25 antibiotics. Higher resistance of Arcobacter isolate was observed for amoxyclav (100%) followed by carbenicillin (93%).



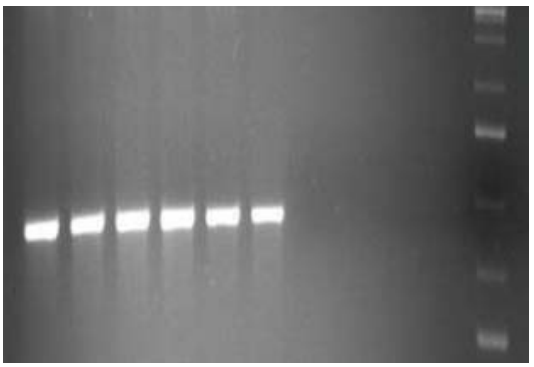
Genusspecific PCR for detection of *Arcobacter* sp. (1200 bp)



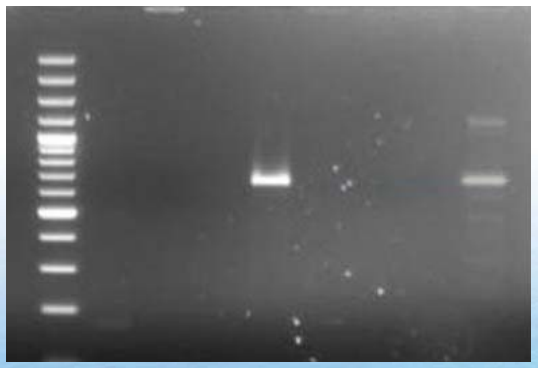
Multiplex PCR for detection of *Arcobacter butzleri* (401 bp), *A. skirrowii* (641 bp) and *A. cryaerophilus* (257 bp)

Antibiotic resistant heteroptrophic bacteria was isolated from soil, water and shrimps from 60 shrimp (*P. vannamei*) farms located in four districts of Andhra Pradesh. A total of 1103 bacterial isolates were studied for antibiotic resistance against five different antibiotics. Antibiotic resistance were observed for ciprofloxacin (12.7%), chloramphenicol (4.3%), co-trimoxazole (14.5%), erythromycin (11.9%) and oxytetracycline (41.7%). Eighty nine were multidrug resistant in nature. Bacteria from aquaculture farms were found to carry tetA gene (387 bp; Fig.3.), cat1 gene (349 bp), sul1 gene (433 bp; Fig.6.), sul II gene (657 bp; Fig.5.) and ermC (Fig.4.) genes for various class antibiotic resistances.

PCR amplification of *tetA* gene



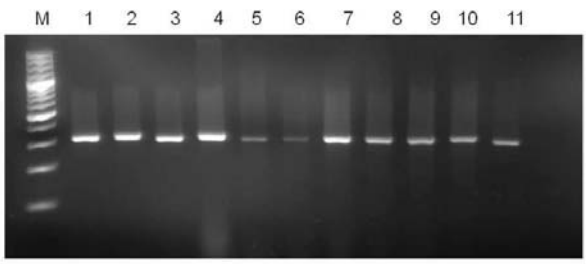
PCR amplification of *erm*C gene



PCR amplification of *sul*2 gene

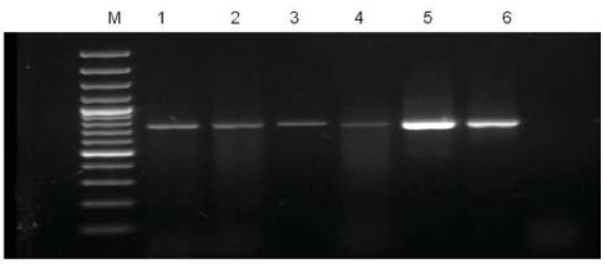
PCR amplification of *sul*1 gene

V. alginolyticus occurred in 12 samples by PCR for *ompk* specific primers and four samples were collagenase gene positive (7 isolates).



PCR amplification of ompk gene of *V. alginolyticus* (308 bp). Lane 1: positive control (ATCC 17744), *Lane 2-11 V.alginolytiucs* isolates

PCR amplification of *ompk* gene of *V. alginolyticus*



PCR amplification of collagenase gene of pathogenic *V. alginolyticus* (732 bp). Lane 1: positive control (ATCC 17744). Lane 2-6: *V.alginolyticus* isolates

PCR amplification of collagenase gene in *V. alginolyticus*

Presumptive *Plesiomonas shigelloides* (388) isolates were tested for biochemical reactions and PCR targeting HugA gene (435bp) and prevalence was 13.24%.

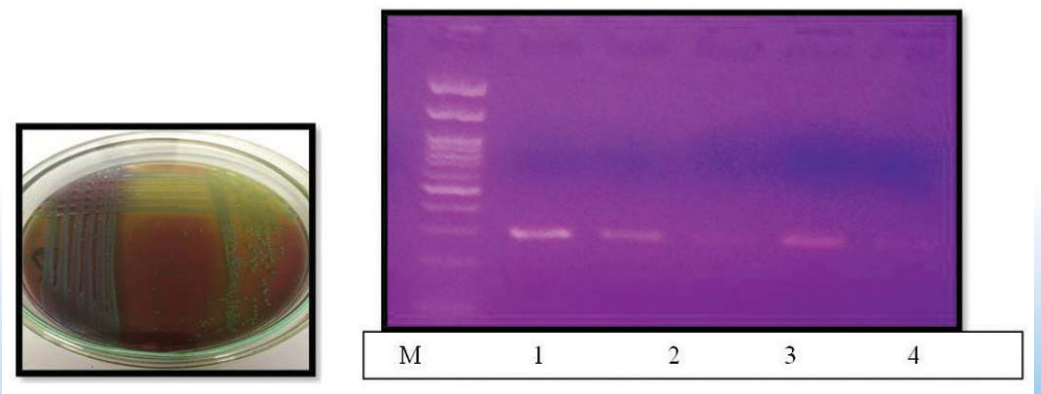
Hygiene indicator bacteria: Hygiene indicators *viz*., total plate count, *Staphylococcus aureus* count and fecal indicators ranged between 7.6 x 10^4 to 1.1 x 10^9, 4 x 10^2 to 1.1 x 10^5 CFU/g and 0.14 to 1100 MPN respectively among the collected samples. There existed a variation in the count of hygiene indicators between monsoon and post-monsoon, landing centre and retail markets of Ernakulam.

In Ernakulam: *Vibrio mimicus* was detected in 4 out of 80 samples; *Plesiomonas shigelloides* was detected in 9 samples confirmed by PCR targeting *HugA* gene; *V. alginolyticus* in 12 samples confirmed by PCR *ompk* & 4 samples were collagenase gene positive. *Photobacterium damselae* was not detected from the samples. *Vibrio vulnificus* was detected from 3 out of 142 samples confirmed by PCR for *vvh* gene.

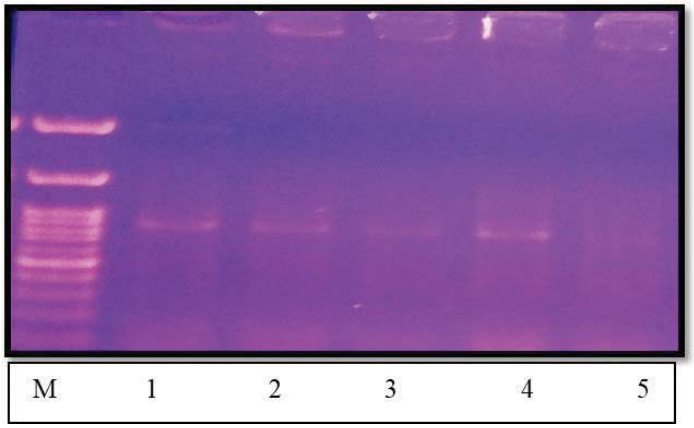
In Navi Mumbai: *C. Sakazakii* was detected in 2 out of 65 seafood samples screened confirmed by *saka gene.*

Twelve out of 18 samples from retail market of Varapuzha region contained higher level of invasive bacteria ranging from 7.3 X 10^4 to 1.21X 10^5 per ml. *E. coli* was isolated from one sample and *Chromobacterium violaceum* was isolated from three samples. 14 retail fish market water samples contained > 10^5 aerobic plate count (APC).

Invasiveness study of 49 (Extended spectrum beta-lactamases) *E. coli* isolated from retail market revealed 73% of them were invasive in nature.



Lane M: Gene Ruler 100bp Ladder (Thermo Scientific, USA); lane 1: Dry shrimp; lane 2: flat fish; lane 3: Dry Mackerel; lane 4: DRY anchovy; lane 5: Pink perch



Lane M: Gene Ruler 100bp Ladder (Thermo Scientific, USA); lane 1: Dry shrimp; lane 2: flat fish; lane 3: Dry Mackerel; lane 4: Dry anchov; lane 5: Pink perch

Molecular diversity of pathogens associated with aquatic system and harnessing aquatic niche for beneficial bacteria or products

Sulphur oxidizing bacteria isolation: Four potential sulphur oxidizing bacterial isolates (three from mangrove-SC10, SD6, and SB1 and one from freshwater fish farm-TA-1) were identified by 16 S rDNA sequencing as *Halothiobacillus* sp. and *Thiomonas* sp. Molecular characterization of SOXB genes of these sulphur oxidizing bacteria are being carried out.

Out of the 30 seafood samples from different brackish water farms, landing centres and fish markets of Kochi, four samples were positive for the presence of *V. cholerae*. All the isolates were negative for *rfbOI* gene which confirms that isolates belonged to non O1 serogroup. Quantitative estimation of biofilm formation by crystal violet assay in *V. cholerae* O139 confirmed as strong biofilm producers, whereas, non-pathogenic *V. cholerae* isolates exhibited weak to medium biofilms. The crude exopolysaccharide fraction from *V. cholerae* O139 was recovered after 10 days of incubation in BHI broth in static condition and the yield was 1.2 mg%.

Aquaculture farm: Twenty six isolates from fish species *viz*; tilapia, mullet, scatophagus, red belly and Pangasius species of different aquaculture farms at Thuravoor, Vaikkom and Perumbavoor were confirmed as Salmonela based on biochemical and molecular characterization and sent for serotyping to ICAR-IVRI, Bareilly. All isolates were identified as *Salmonella typhimurium* which belongs to 0:4 (B) serogroup with antigenic formulae 4,5,12:i:1,2. Along with that 6 Salmonella isolates screened from poultry droppings of Vaikkom farm also confirmed as *Salmonella typhimurium*. The presence of poultry specific *Salmonella typhimurium* in aquaculture as well as in poultry droppings indicates route of Salmonella contamination is through poultry waste.

Seafood: Among165 seafood samples collected from different local markets of Kochi, 202 Salmonella isolates were sent for serotyping. Different serotypes *viz*; *S. urbana* (3.47%), *S. ualamae* (7.9%), *S. virchow* (5.4%), *S. typhimurium* (15.3%), *S. paratyphi*B (10.4%), *S. ohio* (6%), *S. brazaville* (2%) occurred in seafood of Kochi area. 20.8% of Salmonella isolates were serotyped up to grouping of O7 (C1) and 6% were confirmed as Salmonella but couldn't be serotyped. 10.4% of Salmonella isolates were without 'O' antigen (LPS) and confirmed as Salmonella rough. Group B, C1, C2 and E1 represented 3, 2.5, 3 and 4% of the total Salmonella isolates serotyped.

Twenty one out of 73 samples (28.7%) were positive for ESBL producing *E. coli* confirmed by multiplex PCR assay for either of the CTX-M gene families (group 1, 2 and 9), blaTEM, SHV and OXA genes.

Twenty one spore formers were isolated from 42 water samples (Vembanad, deep sea water, fish market), out of which 14 potential tyrosinase producer.

Presumptive bacteriophage against MRSA was identified from water sample collected from aquaculture farms.

Out of 33 samples from aquaculture farms, 3.33% of the samples harboured MRSA and from fish samples of Kottayam retail fish markets and landing centers 12.16% of the samples harboured MRSA.

Seven morphologically distinct collagenase producing bacteria were identified as *Bacillus* sp. by 16s rDNA sequencing analysis.

A multiplex PCR was implemented for differentiating 21 *Listeria* sp. all the *Listeria* sp. isolated in the study belonged to *Listeria innocua* and other species were not detected.

Diversity analysis of the ammonia oxidizing bacteria from chicken slaughter waste revealed that *Achromobacter xylosoxidans*, *A. insolitus* and *Devosia* sp. were identified and the AOB was not detected from formulated feed fed farms.

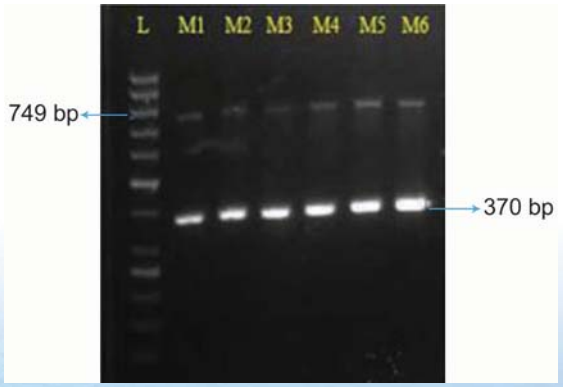
Optimization studies for ammonia oxidation revealed that mineral media with 1% sodium pyruvate gave improved growth as well as ammonia oxidation. Among the *Achromobacter xylosoxidans* and *Devosia* sp. *A. xylosoxidans* has the highest nitrifying ratio.

Metagenomic analysis of soil samples from low and high ammonium farms revealed, low ammonium farms were dominated with phyla Euryarchaeota, Proteobacteria, Fusobacteria, whereas the high ammonium farms were dominated with Euryarchaeota, proteobacteria, Nanoarchaeota, Chloroflexi.

Molecular source tracking of *E. coli* in various geographical points of Vembanad estuary was implemented. AMR performed on 116 isolates of *E. coli* revealed that all the cultures were sensitive to gentamicin, <20% resistance were observed for cotrimoxazole, nalidixic acid, imipenam, amoxycillin, clavulanic acid and >20% resistance was observed for ampicillin, cefotaxime, tetracycline.

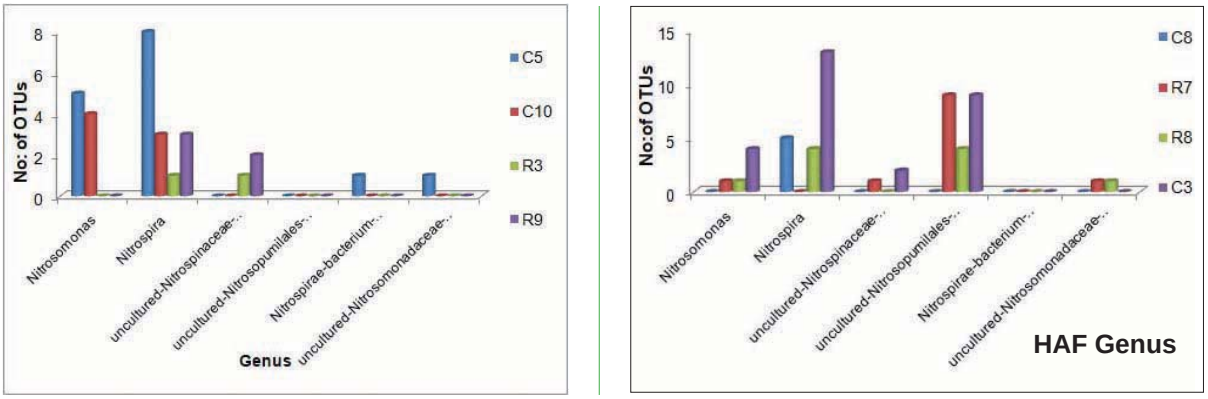
Incidence of Listeria spp. in fish and shell fish environment: A total of 42 suspected colonies were picked from finfish (4), shellfish (4), water (4) and ice (4) were tested for identification of *Listeria* spp. using biochemical tests and further confirmed by PCR. Twentyone out of 42 isolates were amplified at 370 bp and *Listeria* spp. positive isolates were further amplified for species level identification by targeting species-specific genes. Based on the multiplex PCR, 21 isolates were amplified at 749 bp and were identified as *L. innocua*. All the tested isolates were reported to be negative for *L. monocytogenes*. The samples positive for *L. innocua* were mullet, mackerel, ice and water.

Diversity of ammonia oxidizing bacteria in aquaculture farms: Ten finfish farms each fed with chicken slaughter waste (R1-10) and formulated feeds (C1-10) were tested for the diversity of ammonia oxidizing bacteria (AOB). Based on Sanger Sequencing, 11 AOB isolates were identified as belonging to the genus *Achromobacter* (7) and to *Devosia* spp. (4). Nitrification ratio of the *Achromobacter xylosoxidans* (P1-A), was highest at 30°C and pH 7.8. *Devosia* spp. (P2-A) showed the highest nitrifying ration. Low ammonium farms (LAF; <50 µg/gm,C5, C10, R3 and R9) and four high ammonium farms (HAF; >140 µg/gm, C3, C8, R7 and R8) were subjected to amplification of V3-V4 region using Illumina HiSeq 2000. Diversity of the ammonia oxidizer OTUs in sediment samples of low and high ammonium levels. Nitrosomonas was detected in C5, C10 and was not reported in R3 and R9 of LAF groups. In HAF, 4 OTUs of Nitrosomonas were contributed by C3 and C8 was reported negative for Nitrosomonas. The relative abundance of Nitrosomonas in C5 (22 of 4309137 reads) and C10 (21 of 4309137 reads)



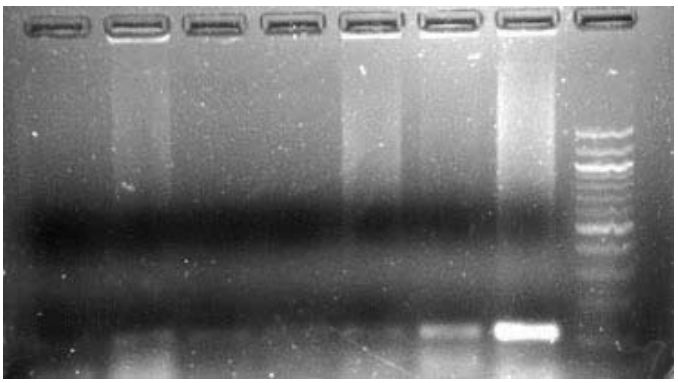
Multiplex PCR detection of Listeria spp., *L. innocua* in fish and ice samples, L: ladder (50 bp); M1 to M6 - *L. innocua* positive isolates.

was much higher than other two farms of LAF. Another nitrifying bacteria, genus Nitrospira was reported in all the eight farm sediments except in R7. The proportion of Nitrospira in C5 (8 of 199274 OTUs) was relatively higher than that in R3, C10 and R9. Nevertheless, the proportion of Nitrospira in C3 (47 of 199274 OTUs) was much higher than that in C8 and R8.



Occurrence of *Campylobacter* spp. from seafood and its environment: A total of 35 fish and shellfish samples were isolated from retail markets and street side vending units of Andhra Pradesh for the incidence of *Campylobacter* spp. Samples were processed following USFDA methodology. Sixty seven suspected isolates were tested for biochemical parameters such as growth at 25°C, 35°C, 37°C, 3% sodium chloride, hydrogen sulfide production, oxidase, catalase, motility and glucose utilization. Based on primary biochemical tests, the results showed that tested isolates were negative for *Campylobacter* spp. Identification of *Campylobacter jejuni* type culture targeting species specific gene through PCR was standardized.

Screening of *Vibrio mimicus*: Twenty four samples of farmed *Litopenaeus vannamei* shrimp were screened for *Vibrio mimicus*. Suspected colonies were tested using *V. mimicus*-specific PCR targeting sodB region and all the shrimp samples were found to be negative for the presence of *V. mimicus* specific 121bp amplicon.



PCR targeting sodB region specific to *V. mimicus* (121bp amplicon) (Lane 1: negative control, Lane 2, 3,4,5 6: Isolates from *L. vannamei* samples, Lane 7: type culture; Lane 8 : 100 bp marker)

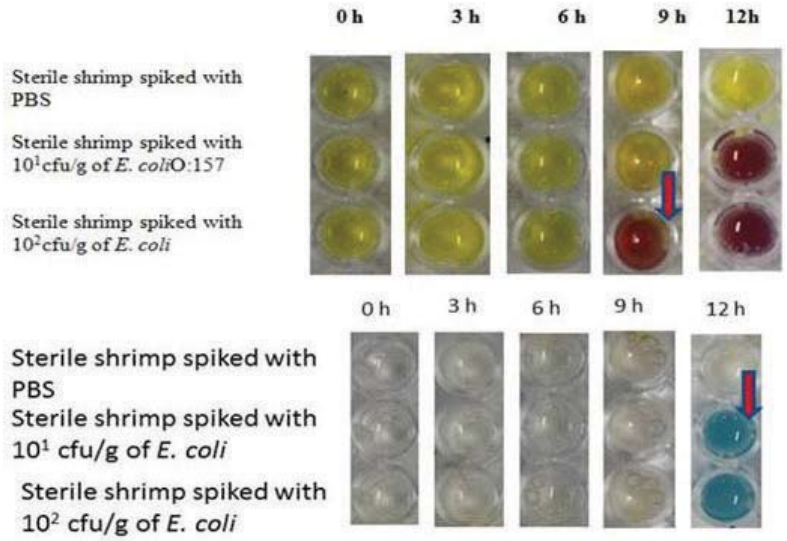
Isolation and identification of *Vibrio* spp.from aquatic environment in Mumbai coast: Total 50 fresh seafood samples including fish, shellfish, molluscs, water and ice from retail markets and super markets from Vashi, Navi Mumbai were screened for *Vibrio* spp. Initially 10 g sample were enriched in alkaline peptone water with 0%, 2%, 3% salt for 24 h and plated to TCBS (0%,2%,3%) agar plates. After 24 h the green and yellow colonies were picked and purified. Biochemical tests were carried out such as Gram staining, oxidase, catalase,

sugar fermentation (mannitol, Glucosamine), Indole, VP test, ONPG and amino acid utilization (Argenine, Lysine and Ornithine) and salt tolerance for the presence of *Vibrio* spp. Total 88 isolates were analyzed. From 50 samples five samples had shown *Vibrio cholera* and three samples of *Vibrio mimicus* were positive as revealed through biochemical examination. But through molecular test none of them showed positive.

Development of colorimetric nano-biosensor strips for detection of food borne pathogens

Development of colorimetric assay by employing enzyme coated nanoparticles and chromogenic substrates for detection of food borne pathogens:

- AuNPs prepared using trisodium citrate gave better colour response upon immobilization with pure enzyme.
- For the colorimetric assay, substrates chlorophenol red β-D-galactopyranoside (CPRG) & 5-Bromo-4-chloro-3-indolyl β-D-glucuronide (X-gluc) were found selective to pure enzymes β-galactosidase & β glucoronidase of *E. coli* O157:H7 and *E. coli* respectively.
- For *E. coli* O157:H7, visible color was detected for 10^1 cfu/g spiked to sterile shrimp meat within 9 h of enrichment.
- Paper based analytical device was developed for the detection of pathogens by using filter paper
- Prominent colour was noticed on paper based analytical device incorporated with gold nanoparticle for the shrimp samples spiked with *E. coli* O157:H7 and *E. coli* after 9 h and 12 h of enrichment.



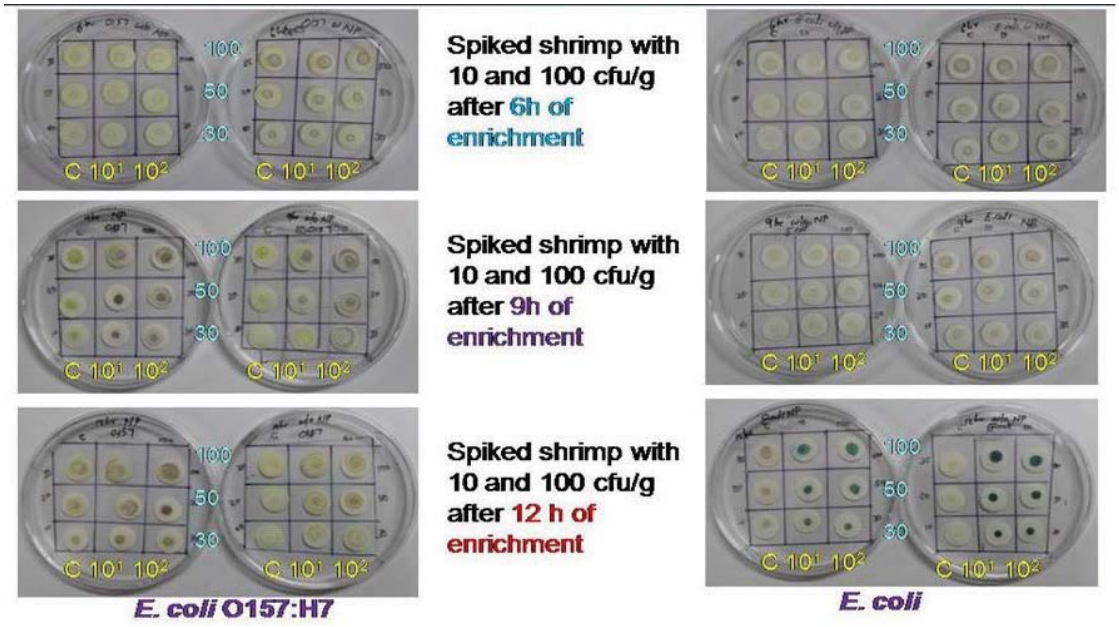
Detection of *E. coli* O157:H7and *E. coli* from spiked shrimp

Does antimicrobial resistance (AMR) in livestock contribute to AMR in people in NE India? An interdisciplinary study investigating antibiotic use, drivers of AMR and transmission dynamics

E.coli, Staphylococcus aureus and *Klebsiella pneumonia* isolated from the fish and its environment were characterized for phenotypic antibiotic resistance. Majority of them were Extended Spectrum Beta-Lactamase producing *E. coli* (ESBL) and Methicillin Resistant *Staphylococci* (MRS) strains and were multi drug resistant

(MDR) . These strains were checked for the presence of AMR genes (Beta lactam genes- CTXM groups 1, 2, 9 & 25, TEM, OXA and SHV, Tetracyclines, chloramphenicol, sulphonamides, aminoglycosides, macrolides, fluoroquiolonesetc). Most of them were either CTX-M group 1 followed by TEM and OXA and tetA and dfrA1 or their combination.

Detection of *E. coli* and *E coli* O157:H7 using paper-based analytical device: Sterile shrimp samples were spiked with 0, 10 and 100 cfu/g of *E. coli* and *E. coli* O157:H7 gave prominent color change on paper-based analytical device after 9 h and 12 h of enrichment.



Detection of *E. coli* O157:H7 and *E. coli* from spiked shrimp by using paper strip

Biochemistry and Nutrition

Research projects handled
Institute projects

- Seaweeds of Indian coast as source of bioactive compounds for developing nutraceuticals/ functional foods
- Novel bio-molecules for food and nutraceutical applications from marine resources
- Evaluating FTIR spectroscopy and chemometric models in high-throughput authentication of species and geographical origin of shrimp

Externally funded projects

- Bio-modulation of marine biopolymers for the preparation of biomaterials of healthcare importance
- Establishing value chain for coastal and small indigenous freshwater fish species: Towards nutritionalsecurity for rural population

Most significant achievements

- A FTIR fingerprinting and chemometrics based rapid method was developed for detection of economically motivated mislabelling of species identity of shrimp.
- A FTIR fingerprinting and chemometrics based rapid method was developed for screening of methicillin resistantStaphylococcusaureus.
- A GC-MS/MS multi-residue method was developed for ultra-trace level quantification of 141 chemical contaminants in seaweed based nutraceutical powders in e-retail.
- A 'Green Chemistry Process' was developed for extraction of fucoidan from seaweed. The process and the product have been commercialized to M/s. Amalgam Foods Pvt. Ltd.
- A method has been optimized for the extraction of high value nutraceutical fucoxanthin from brown seaweed using a novel RSM based supercritical carbon dioxide extraction. The content of fucoxanthin was significantly higher than all literature reported values.
- Analytical facility for fat soluble vitamin, water-soluble vitamin including vitamin B12 and folic acid has been established.
- The dietary supplementation of seaweed waste as fish-feed-ingredient at 25% inclusion level was found to enhance the growth performance and survival rate of experimental animals.
- Studies on antimicrobial property of brown seaweed (*Padina gymnospora*) extracted through supercritical fluid extraction method showed highest activity against all the strains tested as compared to methanol, ethanol and water extraction methods.

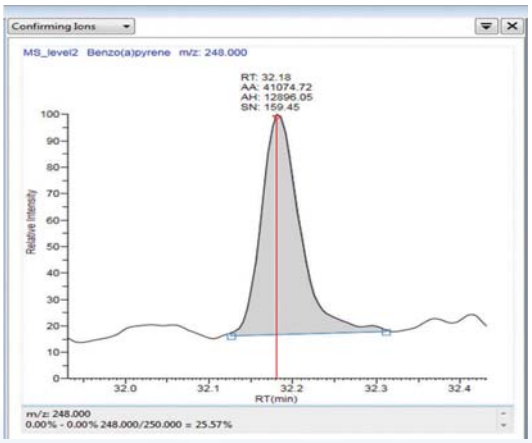
- Chondroitin sulphate purified from shark cartilage powder has possible application in nutrient and drug delivery.
- Ulvan purified from *Ulva lactuca* formed hydrocolloids at 1.6% solutions which showed pseudo-elastic behavior. Ulvan was acetylated to yield acetyl-Ulvan (Ac-U) to increase its water solubility and improve its mechanical strength for use as biomaterials.
- Method has been developed for the separation and quantification of isomers of tocopherols in marine oils.
- A simple and cost effective HPLC pre-column derivatization method has been developed for the determination of amino acid content in fish collagen/gelatine hydrolysates.
- Experimental investigation set in a re-circulatory system has indicated that Indian coastal seaweed *Ulva lactuca* is having potential for bioremediation capability in removal of organochlorine pesticides present in water.

Chief findings
Institute projects

Seaweeds of Indian coast as source of bioactive compounds for developing nutraceuticals/ functional Foods

Optimization of a process for extraction of fucoxanthin from brown seaweed: A supercritical fluid extraction process was optimized using RSM for extraction of fucoxanthin from brown seaweed, Sargassum. Complete biochemical profiling of the extract was carried out. Fucoxanthin content in the extract was determined by LC-MS/MS and found to be 131 mg/g of extract. The extract was particularly rich in poly unsaturated fatty acids.

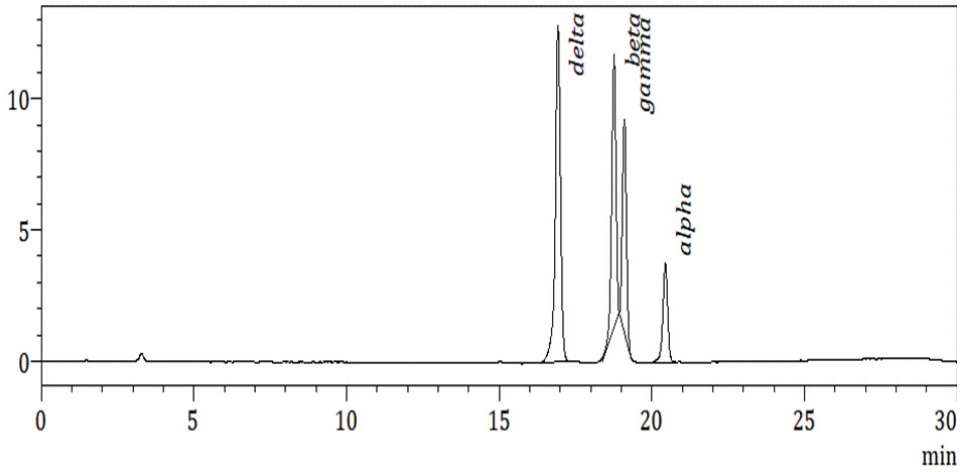
Development of multi-residue method for detection of contaminants: A plethora of seaweed- based nutraceuticals and functional food products are available in e-commerce websites. However, there is no available method or system for safety evaluation of such products. A GC-MS/MS multi-residue method was developed for analysis of more than 200 chemical contaminants in edible seaweed based functional foods



Ultra trace level quantification of Benzo(a)pyrene in seaweed based nutraceutical powders

Separation and quantification of isomers of tocopherols in marine oils: Vitamin E is the important lipid-soluble component in the cell antioxidant defense system which is found as eight forms, encompassing α-, β-, γ- and δ-tocopherols, and four tocotrienols. A simple and sensitive RP-HPLC method has been developed

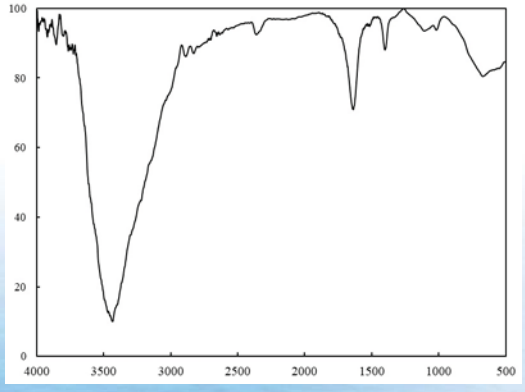
for the estimation of all four isomers of tocopherols in marine oils. High-performance liquid chromatography (HPLC) analyses of tocopherols were performed on 3µ PFP stationary phase (150 × 4.60 mm, Phenomenex) with a column temperature of 25°C and a flow rate of 1.3 mL/min. Elution was carried out using the following gradient of methanol/water (85:15, v/v). Isomers of tocopherols were separated, detected and quantified at 295 nm excitation and 330 nm emission wavelengths. The total separation time was 22 min. and the gradient elution was run for 30 min. to ensure full separation.



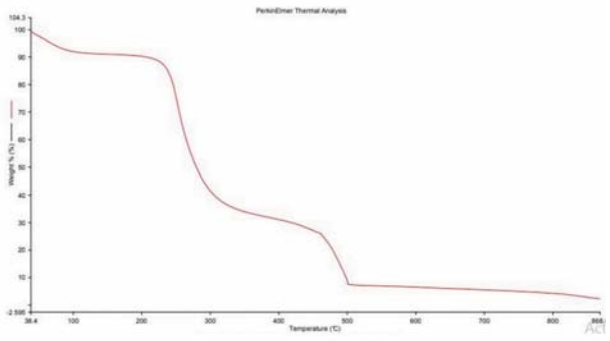
Chromatographic separation and quantification of isomers of tocopherols

Preparation, characterization and biocompatibility evaluation of bilayer scaffold consisting of chitosan, alginate and PVA: A bilayer scaffold has been fabricated by freeze drying method using 2% chitosan solution, 2% alginate solution and 4% PVA solution. Swelling study in PBS revealed that the scaffold can hold water up to 900% of its initial weight. The material was also found consistent in the PBS after 24 h of treatment. Porosity of the scaffold materials was measured by solvent displacement method using ethanol. Approximately 85% porosity was measured for the prepared scaffold. The peak at 3435 cm^{-1} in FTIR spectra of the scaffold represents the O-H stretching vibrations of alginate, chitosan or PVA. The peaks at 2887 cm^{-1} and 2828 cm^{-1} might be due to the C-H stretching vibrations of alkyl groups in PVA. The wave number 1637 cm^{-1} and 1400 cm^{-1} reveals the presence of asymmetric and symmetric carbons respectively in alginate. The bands at 1106 cm^{-1} and 1017 cm^{-1} might be due to the C-O stretching vibrations of chitosan. Three degradation patterns were observed in the TGA curve of the scaffold. The first weight loss up to 100°C corresponds to the dehydration. This was followed by a steep transition between 250 and 300°C. Maximum weight loss observed in this phase was 22%. The third weight loss was observed around 500°C and the maximum weight loss at this phase was 13%. SEM image of the surface reveals the porous nature of the scaffold, which is essential for the attachment of cells to the scaffold.

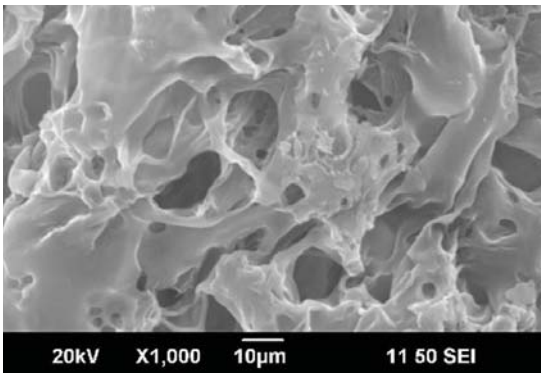
Bilayered scaffold



FTIR spectrum of bilayer scaffold

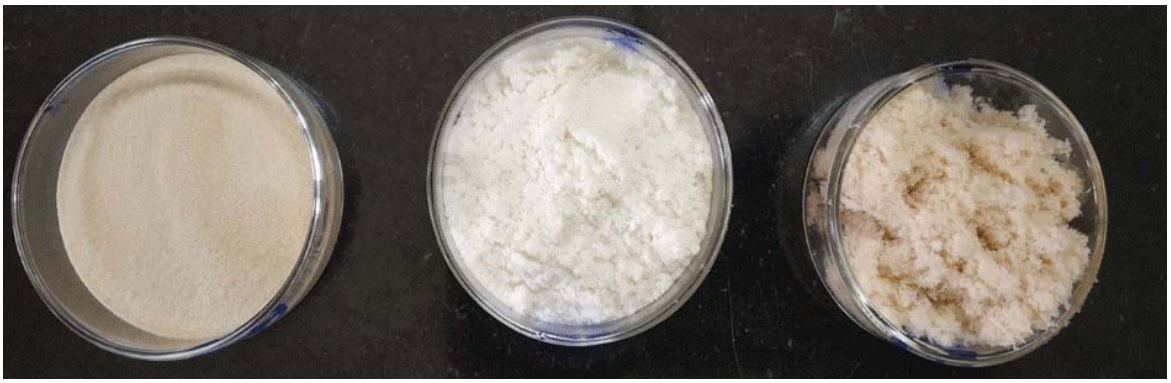


TGA curve of bilayer scaffold



SEM of scaffold surface

Extraction of sodium alginate from seaweeds: Sodium alginate from two brown seaweeds *Sargassum wightii* and *Lobophora variegata* was extracted and its characterization was done for its potential future use by the food industry. In terms of rheological behaviour, sodium alginate from *L. variegate*, *S. wightii* and commercial sodium alginate possess dilatant behaviour. Viscosity of commercial sodium alginate was 3.81cP, whereas the sodium alginate prepared from *L. variegata* and *S. wightii* was 11.4 and 11.7cP, respectively. In case of commercial sodium alginate zeta potential was -25.2 and zeta potential of *L. variegata* and *S. wightii* was -64.3 and -60.6 respectively. This indicates that the sodium alginate prepared from *L. variegata* and *S. wightii* have higher stability than that of commercial sodium alginate.

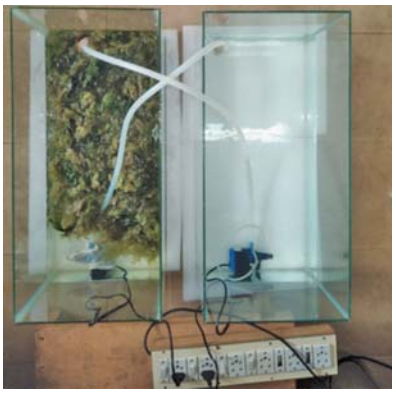


Commercial Sodium alginate | Sodium alginate from *Sargassum wightii* | Sodium alginate from *Lobophora variegata*

Ulvan Polysaccharide from *Ulva lactuca*: Ulvan was extracted from *Ulva lactuca*. Proximate composition, protein, ash, uronic acid, sulphate and minerals were determined. Auto-hydrolysis of Ulvan was carried out with treatment with hydrogen peroxide. Antioxidant assays (metal chelating assay and hydroxyl radical chelating assay) carried out showed that the lower molecular weight fractions of Ulvan had higher antioxidant activity. The Ulvan solutions prepared (1.6% on a dry weight basis) formed hydrocolloids which demonstrated a pseudo-plastic behavior. Viscoelastic behavior was carried out at a concentration of 1.6% (w/v) in the presence of 7 mM sodium tetraborate and at pH 7.5 -conditions in which Ulvan polysaccharides formed a gel. FTIR characterization of Ulvan gel was carried out and compared with that of Ulvan polymer.SEM images of the Ulvan gel were obtained. Ulvan was acetylated to yield acetyl-Ulvan (Ac-U) to increase its water solubility and improve its mechanical strength for use as biomaterials for biomedical use.

Determination of potential for bioremediation by using Indian marine seaweeds: A method has been developed to study the potentiality of Indian seaweeds in bioremediation of contaminants present in water. In this study *Ulva lactuca* was selected which was then set in a re-circulatory system to analyze the quenching power of seaweeds on the pollutants present in the water body. The study was conducted by using three

pesticides, α-BHC, heptachlor isomer-epoxide, OP-DDT which was spiked to water and introduced into the re-circulatory system. Water sample was periodically withdrawn (weekly) for analysis. Finally the seaweed sample was collected from the system to determine the pesticides that were absorbed into the seaweeds.



Re-circulatory system to determine bioremediation potential

Seaweed dietary fibre as functional ingredient in bread: Bread was prepared by adding dietary fibre from *Gracilaria edulis* at 0.1%, 0.5%, 1% and 2%. Water absorption of dough was increased by addition of seaweed dietary fibre. Highest absorption was observed at 2% addition of dietary fibre. The stability of dough was undoubtedly affected by dietary fibre. Reduction of dough stability was observed at the lowest dietary fibre concentration of 0.1% and control sample, while an increase of the dough stability was noticed with addition of 0.5-2% dietary fibre. The specific volume index of bread improved with the addition of seaweed dietary fibre and significant improvement was observed even with the lowest dietary fibre concentration (0.1%). In addition, dietary fibre also increased moisture content of the fresh bread and height was observed at 2% dietary fibre concentration. However, dietary fibre reduced the hardness and given softer crumb of fresh bread as compared to control. Bread with 0.5% and 1% dietary fibre had higher sensory score in terms of appearance, taste and crunchiness, while, a 0.1% concentration yielded higher score regarding colour attributes of fresh bread. Addition of dietary fibre in bread can reduce the loss of moisture content during storage, thus, reducing the dehydration rate of crumb and retarding the crumb hardening.

Novel Bio-molecules for Food and Nutraceutical Applications from Marine Resources

Development of stable Vitamin C: Vitamin C plays an important role in fish feed industry as an essential supplement. Two forms of chitosan such as low molecular weight and high molecular weight chitosan were selected. In the laboratory condition, vitamin C was encapsulated by chitosan with cross-linker sodium tripolyphospahte.

Development of stable water-soluble vitamins: Vitamin has its specific role, to keep the body healthy. These water soluble vitamins are not stored in the body for longer period, they need to be replenished at regular interval through diet or other sources. Hence, an attempt has been made to synthesis stable water soluble vitamins by using commercial chitosan.

Feed prepared with seaweed waste as a fish-feed-ingredient: The role of seaweed waste as a fish-feed ingredient was assessed in terms of growth performance, survival and mortality. The study revealed that the dietary supplementation of seaweed waste as fish-feed ingredient at 25% inclusion level improves the growth performance and survival rate.

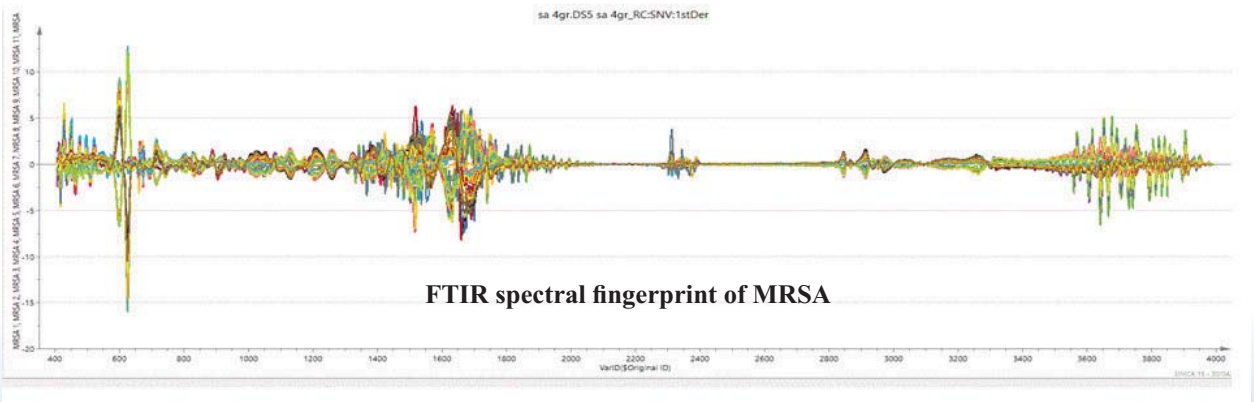
Feed acceptability and behavioural study by using a Y-maze: An experiential study was conducted to assess the feed acceptability of feed prepared by using seaweed waste as fish-feed ingredient. From the preliminary study using Y-maze shows that the incorporation of seaweed waste to the commercial feed as fish-feed ingredient at 25 % improves acceptability of fish feed.

Biochemical composition of shark cartilage powder and separation and characterization of chondroitin sulphate: Shark cartilage was pulverised into powder which was free flowing and cream coloured with the aroma of dried seafood and having mild seafood flavour. The powder was assayed for its biochemical composition and was found to be rich in protein and ash content. pH of the powder was found to be slightly alkaline. Mineral content was rich in the shark cartilage powder with calcium and phosphorous available at 17.9 and 8.68 g% while potassium was at 2.4 g per kg of the powder. The powder also showed significant content of zinc. The powder was also tested for heavy metals, either found in negligible amounts or undetected. Chondroitin sulphate (CS) was isolated and the lyophilized extract was purified by DEAE Sepharose column and CS was recovered by elution with NaCl solution. Based on the dry weight, the CS yield obtained from shark cartilage extraction was 7.14%. Structural configurationof purified chondroitin sulphate was studied by UV absorption spectrum that revealed absorption maxima of 200 nm which is typical of polysaccharides. Chemical modification of CS to make hydrogels has been attempted by acetylation to form Ac-CS hydrogels.

Evaluating FTIR spectroscopy and chemometric models in high-throughput authentication of species and geographical origin of shrimp

FTIR Spectroscopy and chemometricmodels in high-throughput authentication of species of shrimp: A high-throughput method has been developed based on FTIR spectral fingerprinting and predictive chemometric modelling for species authentication of commercially important shrimps. The method was aimed at detecting economically motivated mislabelling of low value shrimp as high value shrimp species. Globally shrimp fraud is an issue of socio economic importance and the method developed is towards tackling such fraudulent activity in seafood supply chain.

Discrimination of methicillin resistant *Staphylococcus aureus* (MRSA) from *S. aureus*: Another rapid method based on FTIR spectral fingerprinting and predictive chemometrics modelling has been developed for discrimination of MRSA from *Staphylococcus aureus*. Antibiotic resistance is a huge problem globally and this method will help in rapid screen methicillin resistant *S. aureus*.



FTIR spectral fingerprint of MRSA

Engineering

Research projects handled
Institute projects

- Design and development of tools and technologies for energy and water use optimization in fish processing industries

Externally funded projects

- Design and development of hot air assisted continuous Infrared drying system for high value fish and fishery products

Most significant achievements

- Designed and developed a low cost, energy efficient and walk-in type solar tent dryer for bulk drying of fish and fishery products.
- Developed a prototype of portable non-invasive fish freshness sensor for mackerel.
- Designed and developed a low cost and user-friendly button operated mini fish descaling machine.
- Performance evaluation study of modified solar-LPG hybrid dryer was conducted using fish and other agricultural products.
- Improvised the design and evaluated the performance of batch-type in frared dryer
- Studies carried out on smart dryers with mobile alert system which send information on the extent of drying to the user and automate the operations.
- Collected and analyzed the historical data on energy and water consumption for seafood industries.
- Collected and analyzed real time data of energy consumption of seafood industries
- Optimized the specific energy consumption of one factory with respect to the production for the year 2018.

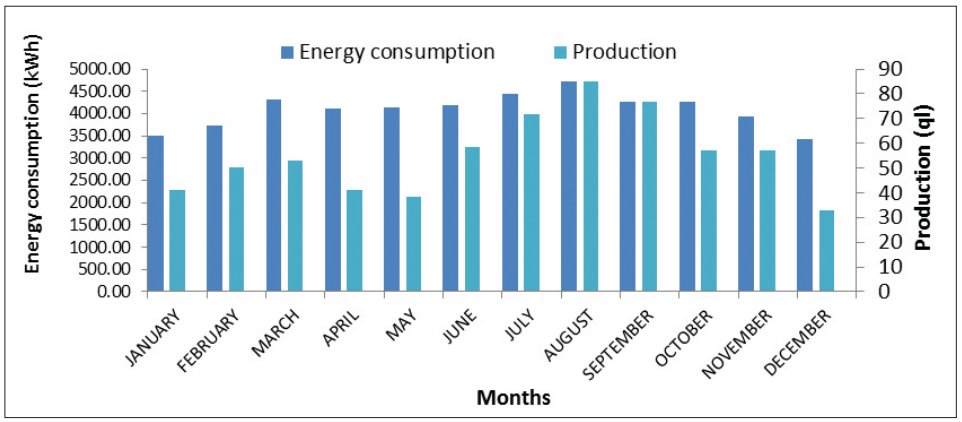
Institute project

Chief findings

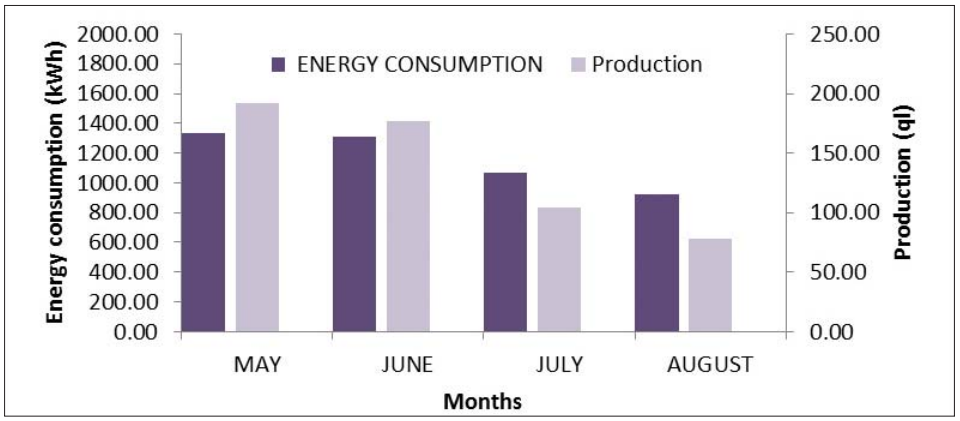
Design and development of tools and technologies for energy and water use optimization in fish processing industries

Historical data collection and analysis: Historical data was collected from Kochi based sea food companies and analyzed to fix the base line energy consumption of these industries. The plots of energy consumption

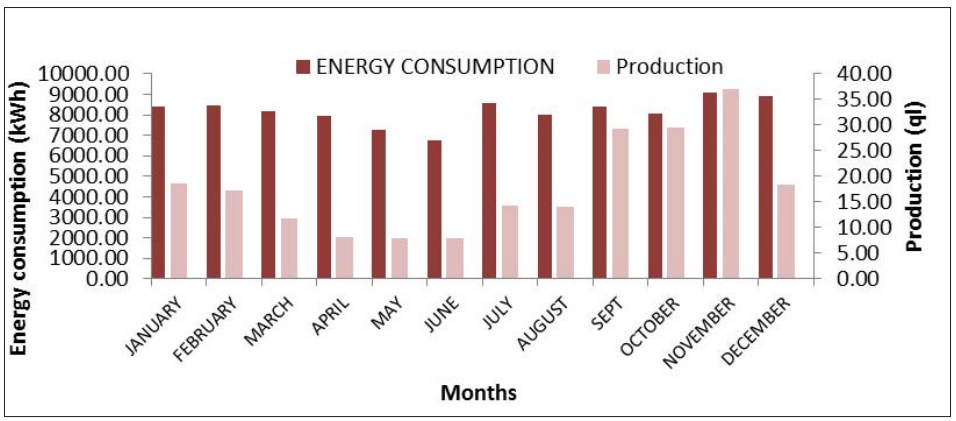
against production showed significant scattering, hinting the huge wastage of energy in these industries.



Monthly energy consumption against production of company I

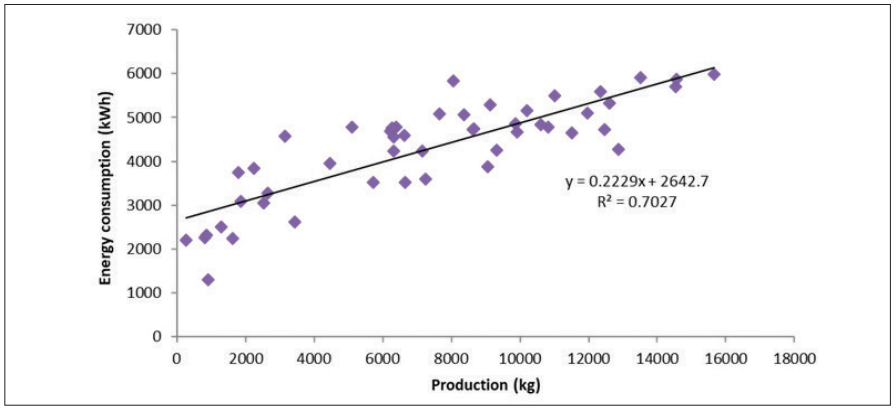


Monthly energy consumption against production of Company II

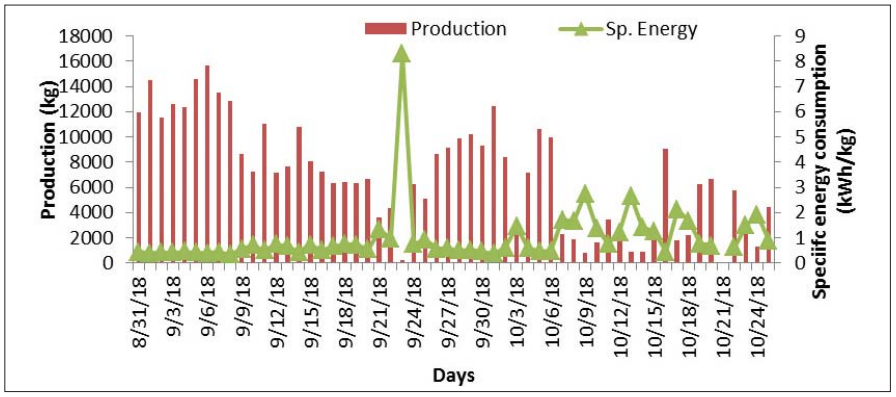


Monthly energy consumption against production of Company III

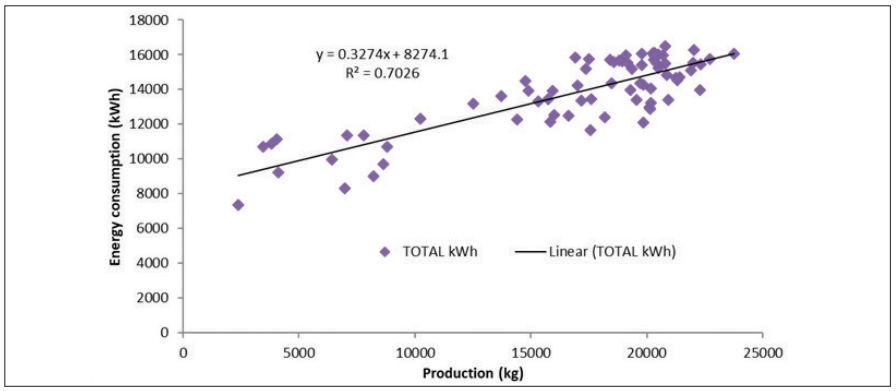
Software access and real time monitoring of the plants: The data was collected using hardware-software system - Remote Energy Optimization & Sustainability Services (REOSS) developed by the research partner M/s. Datamatrix Pvt. Ltd., Pune. The online energy data, energy use in oil equivalents and energy usage graphs were collected in real time basis through REOSS from these industries. Using the software, the daily production and energy consumption of these industries were monitored along with their daily specific energy values. Energy consumption for various zones in the process line was also obtained from the readings of each sensor installed.



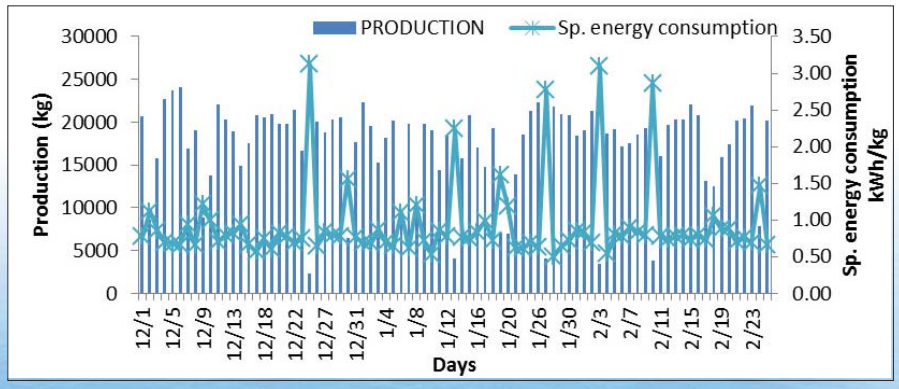
Energy consumption Vs production of Company I



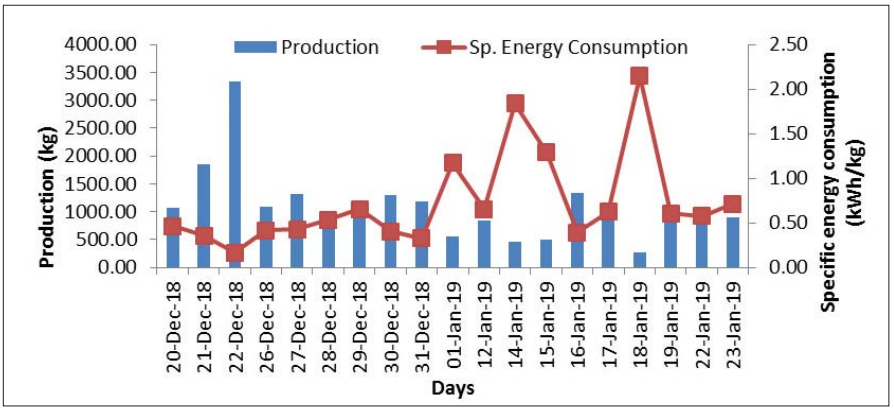
Specific energy consumption Vs production of Company II



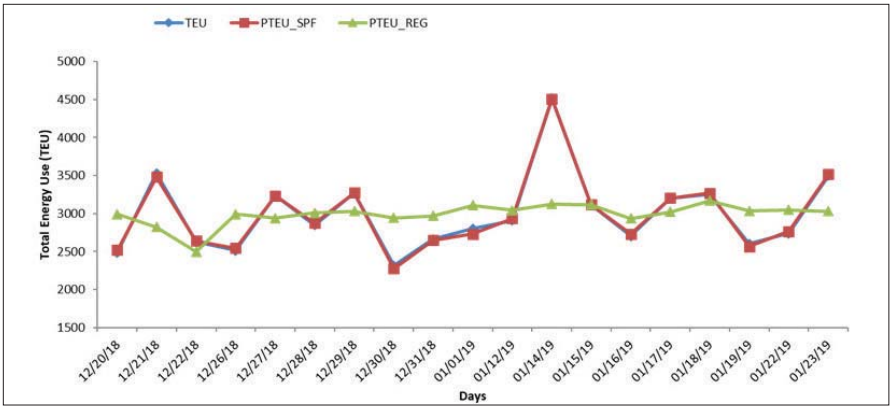
Energy consumption Vs production of Company III



Specific energy consumption Vs production of Company I

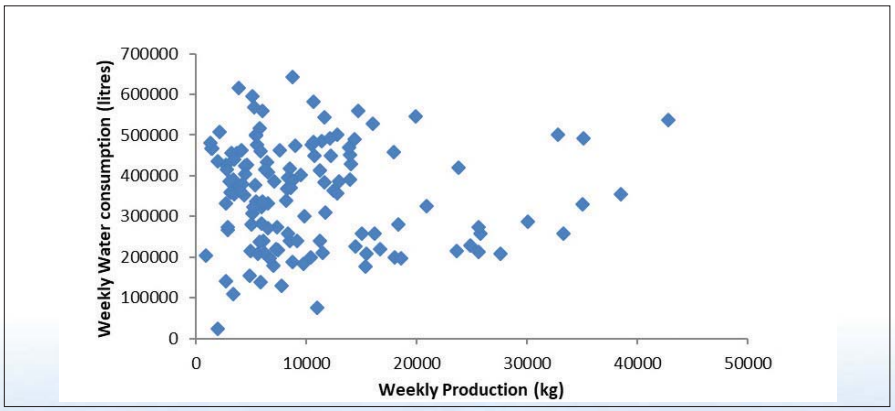


Specific energy consumption Vs production of Company III



Total energy use per month of Company III

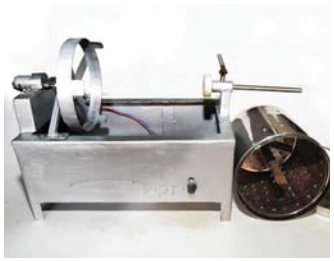
Water consumption data and water use optimization: To analyze the relation between water consumption and production, water use data for the past three years was collected. The historical data analysis reveals that water usage with respect to production varies dramatically implying that more scope exists for optimization of water use in seafood industries. To start with water meters and solenoid valves were installed at selected factory to collect real time water usage data.



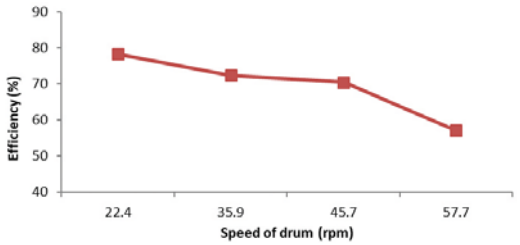
Weekly water consumption Vs production of Company III.

Design, development and performance evaluation of mini-fish descaling machine: A motorized version of 1 kg capacity fish descaling machine was developed to cater household needs related to fish descaling. The equipment consists of a rotating drum, a motor and frame to support the assembly. Cleaning of the machine

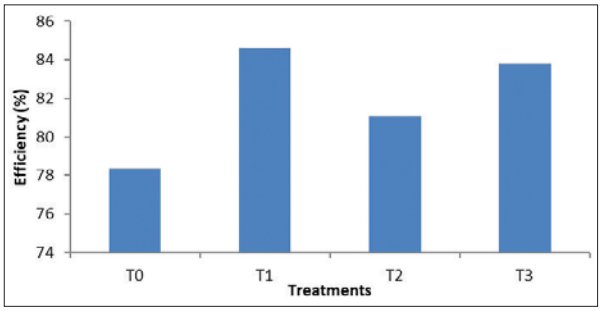
can be done easily by detaching the drum with perforations inside. The system is ergonomically designed and suitable for home makers for removing fish scales without any difficulty.



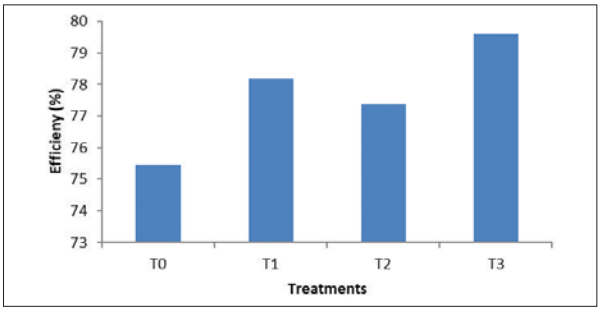
Mini-fish descaling machine



Optimisation of drum speed of descaling machine

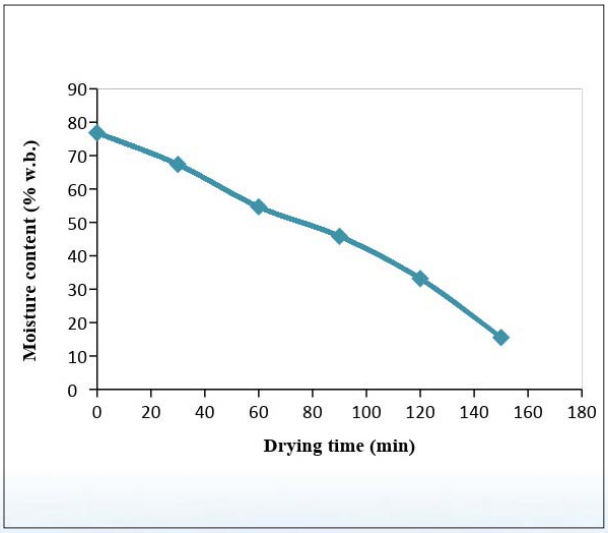


Descaling efficiency for sardines



Descaling efficiency for tilapia

Improvisation and performance evaluation of batch type infrared dryer prototype: Modified the existing prototype of infrared dryer with provisions for uniform heat flow, heating element and temperature sensor. Moisture content of shrimp reduced from 76.8% to 15.5% within three hours of hot air assisted infrared drying under a temperature of 55°C, infrared power of 1000 W and air velocity of 1 m/s. Biochemical and quality parameters were analysed and found to be better compared to the traditionally dried products.



Prototype of hot air assisted infrared dryer and drying curve for shrimps

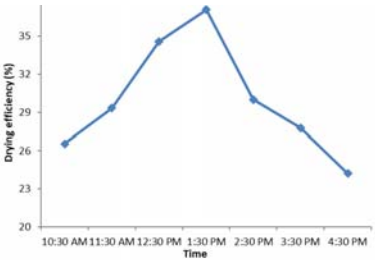
Development of prototype of portable non-invasive fish freshness sensor for mackerel: Freshness studies were carried out in mackerel fish by analyzing the colour variations of the fish eye during storage. Images were captured using webcam and isolation of eye region in the fish image was done by image

Portable fish freshness sensor

processing technique using Raspberry Pi as platform. Hough transform circle detection, drawing contours, converting RGB to HSV and defining pupil region were executed as part of the work. Two replications were carried out with fresh mackerel fish under different storage conditions. Simultaneously, cross validation was carried out by analyzing K-value, TPC and TFC during storage.

Smart dryers with mobile alert system: A portable device was developed for sending information of drying conditions automatically. The device sends an SMS with the percentage of moisture. This will give an indication about the level of drying whether drying is completed or not and ready for packaging or not. This device can be integrated into any dryer to automatically control the drying operation.

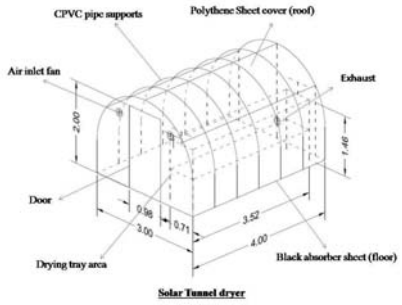

Automatic information system to the dryer



Drying curve of shrimp in solar LPG hybrid dryer

Performance evaluation studies on renovated solar LPG hybrid dryer: Performance evaluation was carried out with anchovy, silver belly, sole fish, glassfish and shrimp by utilizing full capacity of the dryer (50-60Kg). The initial moisture content of shrimp was 78.25% (w.b.) which reduced to the required final moisture content of 15.36% (w.b.) in 6 h of drying in solar-LPG hybrid dryer. The collector efficiency and drying efficiency of solar – LPG hybrid dryer was estimated to be about 42.37% and 39.07% for shrimp.

Design and development of low-cost energy efficient walk-in type solar tent dryer: A low-cost solar tunnel dryer was designed and developed with a capacity of 50 kg and floor area of 12 m^2. This prototype dryer is intended for drying of seasonal higher catch/landing of fish. The materials of construction are UV stabilized transparent polythene sheet for roof cover, black absorber sheet for floor, supporting frames of CPVC and GI rod. Three ventilator fans of 0.5 hp for air inlet and exhaust are included in the design. The new dryer can be constructed in larger size for drying bulk quantity of fish in a single batch. It is also of affordable cost and expected to be suitable to sea coast and for low income fishermen community.



SS Schematic diagram of Solar tunnel dryer


Solar tunnel dryer under loaded conditions

Extension, Information and Statistics

Research projects handled
Institute projects

- Evolving SMART EDP module for livelihood security of small scale fisherfolk through fish-preneurship
- Economic evaluation of resource use efficiency and management of reservoir ecosystem
- Occupational structure, labour productivity and labour migration in fisheries sector
- Assessing input and service delivery system for marine fisheries in Kerala
- A study of dynamics of fish consumption in Kerala with reference to emerging health, safety and quality issues

Externally funded projects

- Development of clam cluster for clam processing facility at Perumbalam village, Thycattussery block, Cherthala taluk, Alappuzha

Most significant achievements

- Methodology for (i) assessment of gender disparity on role perception with regard to entrepreneurial development in Kerala fisheries, (ii) assessing input and service delivery system for fish vendors in Kerala, (iii) assessing dynamics of fish consumption in Kerala with reference to emerging health, safety and quality issues was developed based on three separate baseline surveys and literature review.
- Problem prioritization and need analysis with respect to fish entrepreneurship development was carried out at Kadamakudy in Ernakulam, Veraval and Mangmaripeta in Visakhapatnam, by using SWOT-AHP technique followed by a comparative analysis of SWOT in all three study locales to know whether the priorities are common or not in respect of the fishpreneurship development.
- Variables like personal attitude, entrepreneurial capacity and professional option have significant relationship with entrepreneurial intention with C.R. value of 5.524, 2.604 and 3.051; respectively, that showed that personal attitude of the students contributing for maximum prediction (55.24%) for assessing the entrepreneurial intention followed by professional option (30.5%) for career choice
- Bio-economic models (Fox, 1970 and Schnute, 1977) were employed to time-series data on weekly catch of Mrigal from Aliyar reservoir. The estimated parameters of the two models considered were Intrinsic Growth (r) 0.89; 0.645, Carrying capacity (K) 155.05; 195.03 ton, Catchability Coefficient (q) 0.00002; 0.0000007, and Adj. R^2 was 58.9 and 21.3 respectively.
- The per unit investment towards a fishing unit at Aliyar reservoir ranged from ₹ 0.55 to ₹ 2 lakh whereas the economics of fishing operation were worked out as BCR = 1.23, NPV = ₹1.75 lakh and IRR as 66% indicating sustainability.

- The socio-economic conditions of Aliyar fishers was evaluated and it was found to be poor and the household livelihood security index worked out using economic, health, food and education domains was worked out as 0.176, 0.537, 0.361 & 0.285.
- Market price method adopted to estimate use value for fisheries at Aliyar reservoir ecosystem which accounted for ₹ 42.44 Lakh of about 41 tonnes of fish which is more that their targeted 39 tonnes per annum. Fee collected from dam visitors was computed to estimate use value of tourism for the year 2018 (₹ 35.07 Lakh).
- Trend in capital formation in fisheries (1990-91 to 2014-15) and responsiveness of the sector to capital formation analyzed which revealed that the incremental capital output ratio (ICOR) increased denoting decline of the efficiency of capital. This could be due to over-capitalization of some segments of this sub-sector, particularly marine fisheries, characterized by a large number of mechanized fishing vessels.
- The incremental capital output ratio (ICOR) in fisheries sector for the period of 1990-91 to 2014-15, was found to have increased denoting decline of the efficiency of capital. This could be due to over-capitalization of some segments of this sub-sector, particularly marine fisheries, characterized by a large number of mechanized fishing vessels
- The pattern of expenditure on fisheries extension for the period of 1974-2014 reveal that though the trend is impressive, it is thinly spread, considering the vast coast line and increasing aquaculture. In the past decade (2005-06 to 2013-14), growth rate in extension expenditure (Centre plus State governments) in fisheries sector was found to be 4%.
- Preliminary analysis from two case studies on fish silage manufacturing units has revealed a benefit-cost ratio ranging between 2.0 and 2.6.
- An analysis of 15 online fish vendors operating in Ernakulam district, Kerala with respect to their products menu, price range, quality and safety guarantees, delivery systems and consumer accessibility over online, mobile and social media platforms revealed that wide range of options provided by online portals was the major attraction for consumers. The online portals focused on convenience and easy availability of variety of products/dressing options.
- As regard to hybrid media marketing done by all the online vendors, it was observed that 'e-mail+website' was the most popular mode adopted closely followed by 'Facebook+mobile' mode.
- Clam processing facility was set up at Perumpalam village under the DST-SEED project.

Evolving SMART EDP module for livelihood security of small scale fisherfolk through fish-preneurship

Need analysis and problem prioritization with respect to fish-prenureship through SWOT-AHP: Problem prioritization and need analysis with respect to fish entrepreneurship development was carried out in all the three study locales namely, Kadamakudy in Ernakulam, Kerala, Mangmaripetta in Visakhapatnam, A.P. and Jamburi in Veraval, Gujrat through paired comparison method by using SWOT-AHP technique followed by a comparative analysis of SWOT factors in all three study locales to find out the common and individual priorities with respect to fish-preneurship development where common ones signified as the problems with sectoral priority and the individual ones indicated as factors with local priority. It was found that in case of strength, institutional support and strong family support were the common sectoral priorities as viewed by the expert groups in all the three locations; whereas in case of weaknesses, lack of managerial skill and marketing problems were commonly ranked as the sectoral priorities. Similarly, as far as opportunities in fish entrepreneurship are concerned, in all the three study locales common priorities were found with respect to linkage with public institutions working in the sector and presence of govt. funded developmental schemes; whereas labour migration, lack of chilling/storage facilities and failing of group dynamics were found to be common priorities in case of threats.

Study on gender role perception in entrepreneurship development in fisheries: Gender role perception was studied with respect to entrepreneurship development in fisheries among the small scale fishers. In the study undertaken in Kadamakudy village of Ernakulam district in Kerala, the analysis of data showed that major skills related to fisheries were possessed by women in the area of prawn peeling (67.86%), fish sorting (32.14%), fishing (21.43%) and value added product development (11.76%).

Significant difference in perception was found with respect to statements such as "Complimentary role played by both men and women is important for success of any entrepreneurship, "Women can add to family income through their involvement in business enterprise", "Women participation is undervalued in any social organizations/institutions", "Existing social values and norms, favour men and discourage women to take up any business enterprise" etc.

Stakeholders' feasibility analysis studies: Under the stakeholder feasibility analysis towards establishing fish based enterprise at Kadamakudy village, Ernakulam, Kerala the work on identification and determination of stakeholders were carried out. The stakeholders' *viz*., end users and service providers were contacted for the study. The determination of stakeholders (service providers) was done using three attributes *viz*., power, legitimacy and urgency as per salience model. Based on the willingness, interest possession and ability to support, the stakeholders were determined into latent or expectant stakeholders. Based on the level of interest and their roles, the classification of stakeholders was further classified into demanding. disruptive, dominating and definitive.

SWOT survey of Mangamaripetta village: SWOT survey of Mangamaripetta village, Andhra Pradesh has been conducted. Information was collected from fisherwomen, fishermen, village elders, students and NGO representatives who has influence on the village. Major strengths identified are: Availability of raw materials, trained man power for value addition, access to urban market, strong NGO support, high economic motivation and strong family support. Major weaknesses identified are: lack of cost effective entrepreneurial technologies, problem in marketing of traditional fish products and poor post harvest techniques.

Start up of small scale entrepreneurship activity: Three members from the Samudra Fish Worker's Society of the selected village have started a small scale entrepreneurship activity by selling value added products like fish balls and fish cutlets from the locally available fish like tuna and sell to the Nutri Cart, a mobile vending Unit operating in the Visakhapatnam beach road. On an average they make products worth of ₹ 1000/- with a profit of ₹ 200/- per day.

Economic evaluation of resource use efficiency and management of reservoir ecosystem

Socio-economic status of fishers: The per unit investment towards a fishing unit at Aliyar reservoir ranged from ₹ 0.55 to ₹ 2 lakh whereas the economics of fishing operation were worked out as BCR =1.23, NPV = ₹1.75 lakh and IRR as 66% indicating sustainability. The fishing tools such as coracles (bamboo and FRP) and gillnet of various mesh sizes ranging from 100 mm to 260 mm made up of nylon monofilament was used in the fishery. The average catch per day per fishing unit was 20 kg. The marketing of the fish catch was done through Tamil Nadu Fisheries Development Corporation (TNFDC) which sources the fish for ₹ 90/Kg.

Total economic valuation of reservoir ecosystem: For valuation of reservoir ecosystem, specification of the boundaries of ecosystem to be valued was carried out (spatial definition). Further, assessment of services supplied by the ecosystem was done apart from collection of preliminary data from Aliyar ecosystem on previously identified direct and indirect use values.

Market price method adopted to estimate use value for fisheries which accounted for ₹ 42.44 Lakhs for about 41 tonnes of fish which is more than their targeted 39 tonnes per annum. Fee collected from dam visitors was computed to estimate use value of tourism for the year 2018 (₹ 35.07 Lakhs). Irrigation was identified as a indirect use and annual total area irrigated under the Aliyar irrigation project is 41,388 acre for the period of 85 days.

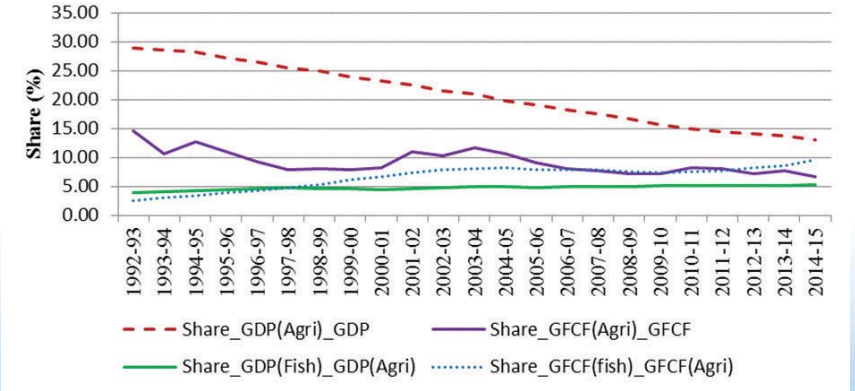
Analysis of data on length-weight of IMC stocked at Aliyar reservoir: Secondary data collected on length and weight of Catla, Rohu and Mrigal from Aliyar reservoir was analyzed. Based on the total length of Mrigal, six groups could be formed namely G1:150 to 170 mm, G2:170 to 190 mm, G3:190 to 210 mm, G4:210 to 230 mm, G5: above 230 mm. Based on the log transformed data on length-weight measured from selected samples, the 'b' value in the length-weight relationship was estimated as 3.17 and significant at $p<0.05$.

Length frequency data pertaining to Catla and Mrigal was analyzed for estimating population parameters. Analysis indicates the Catla and Mrigal support the fishery in a major way. K-coefficient was estimated at 0.90 and 1.09 whereas $L\infty$ was computed as 763 mm and 875 mm respectively. The length class of 270 mm to 310 mm was found dominant during all months for Mrigal. The VPA analysis by Jones Cohort predicted biomass available for exploitation for Mrigal as 39.7 t at mid-length 560 mm. The analysis shows that the fishery at Aliyar was Mrigal based fishery, there is more scope for the exploitation of Catla and the Rohu recapture was poor discouraging additional stocking.

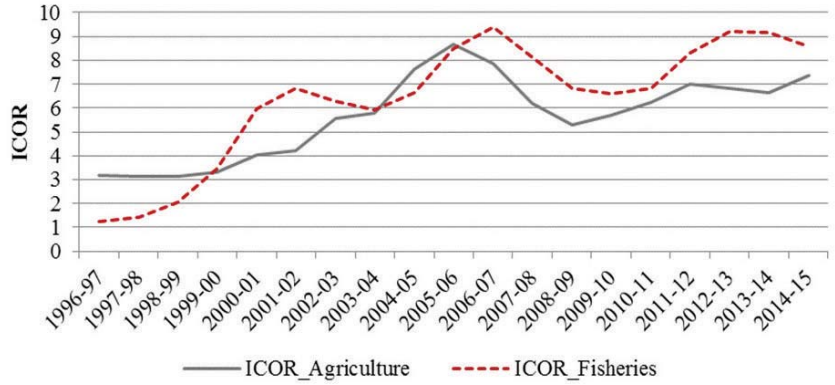
Assessing input and service delivery system for marine fisheries in Kerala

Structural changes in fishery sector: The structural change has occurred due to the differential growth of inland and marine fisheries (1.1% per year in marine fisheries and 5.2% per year in case of inland fisheries for the period of 1990-91 to 2017-18). The sub-period growth rates also depicted large difference between marine and inland fishes. The period of 1990-91 to 1999-00 showed growth of 3.1 and 7.0% per year, for marine and inland fisheries, and the growth-differential widened over years.

Capital formation in fisheries sector: The study found structural breaks in the capital formation, coinciding with major macro-economic policy changes. There has been a deceleration in capital formation immediate post-liberalization of the economy. The share of fisheries sub-sector in agricultural gross domestic product (GDP) has gradually increased, from 4.3% in 1994-95 to 5.4% in 2014-15. Correspondingly, the share of fisheries sub-sector in gross fixed capital formation (GFCF) in agricultural sector has increased from 3.4% to 9.7%. The efficiency of investment in the fisheries sub-sector has declined as indicated by the incremental capital output ratio (ICOR), which increased from 3.2 to 8.3 during this period. The fast decline of the efficiency of capital could be attributed to over-capitalization of some segments, particularly marine fisheries characterized by a large number of mechanized fishing vessels. The public capital formation in the fisheries as a share of the total pubic capital formation is very low. Improving the capital productivity could warrants implementation of norms of sustainable fisheries.

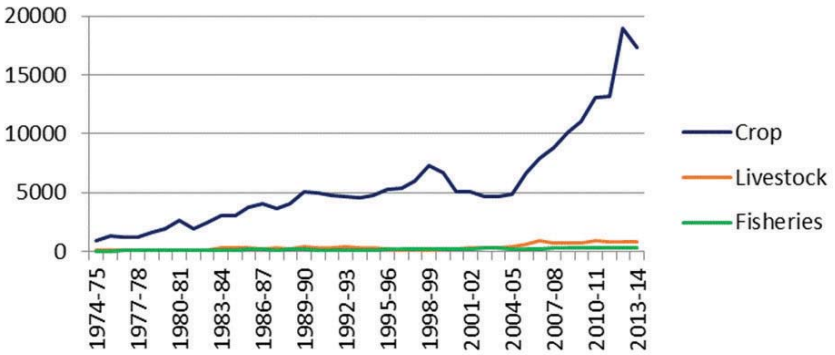


Trends in the share of GDP (agriculture) in total GDP, GFCF (agriculture) to total GFCF, GDP (fisheries) to GDP (agriculture) and GFCF (fisheries) to GFCF (agriculture) (2004-05 constant prices), 1990-91 to 2014-15



Movement of ICOR based on five year ending average, 1996-97 to 2014-15, across agriculture and allied sectors and fisheries sub-sector

Investment in fisheries extension: A vibrant extension system is essential to address the emerging challenges in the fisheries sector and to augment its development. Performance of such a system depends on policy support in terms of budgetary allocation. During the year, an attempt is made to analyze the pattern of expenditure on fisheries extension based on information collected from combined revenue and finance account of Comptroller and Auditor General of India (1974-2014). Trends in expenditure (Centre plus State governments) on fisheries extension point to its steady rise except for the reversals during 1990-91 to 1994-95 and 2002-03 to 2004-05. Though the trend is impressive, it appears to be thinly spread, considering the vast coast line and increasing aquaculture. In the past decade (2005-06 to 2013-14), growth rate in extension expenditure (Centre plus State governments) in fisheries sector was found to be 4%. As a policy prescription, the study calls for increased expenditure on fisheries extension.



Trend in expenditure on extension in India,1974-75 to 2013-14, real price (2004-05 base)

A study of dynamics of fish consumption in Kerala with reference to emerging health, safety and quality issues

Fish consumption – Drivers and barriers: Review of important drivers and barriers of fish consumption in the context of emerging health, safety and quality challenges was done using theory of planned behaviour (TPB) as an underlying concept. The study revealed factors like availability, price, market, eating habits, health beliefs, safety and quality concerns and sensory and convenience perception as determinants of fish consumption influencing nutritional security.

Online fish vending: An analysis of 15 online fish vendors operating in Ernakulam district, Kerala with respect to their products menu, price range, quality and safety guarantees, delivery systems and consumer accessibility

over online, mobile and social media platforms revealed that wide range of options provided by online portals was the major attraction for consumers with 3 to 40 fish varieties made available on online platform. The choice included marine, freshwater and farmed fish and other products like shrimps, squids, crabs and mussels.

The online portals focused on convenience and easy availability of variety of products/dressing options (2-8) like whole, whole cleaned, steaks, curry cut, fillets, skinless cubes, marinated, tail-on, peeled, peeled deveined and peeled un-deveined which was hardly possible in case of traditional markets. However it was found that prices on portals were 20-25% more than local vendors. While consumers perceive better safety and quality for fish with online sellers, the claims are yet to be ascertained through lab tests. Unlike traditional vending, online vendors provided 2-3 time slots for delivery in a day thus providing great convenience to consumers. Besides, portals charged an additional amount between ₹ 29-50 for delivery depending on size of the order.

As regard to hybrid media marketing done by all the online vendors, it was observed that 'e-mail+website' was the most popular mode adopted closely followed by 'Facebook+mobile' mode. 24x7 consumer engagements was made possible through dedicated Facebook pages by seven out of 15 vendors thus providing latest update about stock position and immediate response to consumers.

Occupational structure, labour productivity and labour migration in the fisheries sector

Systemic review approach was used in order to systematically identify, appraise and synthesize all the empirical evidence on employment in the fisheries sector as well as labour issues pertinent to the project like migration, occupational issues and wages. 113 articles have been sourced using key search terms used ("labour" AND "fisheries" AND/OR "India", "fish processing", "seafood processing", "fishing", "Standards", "Policy") which were screened. Two exclusion criteria have been applied. The cut off year has been fixed at 1950 and the topical relevance has been considered as only literature relevant to labour was considered. 60 references have been screened. 85.96% of the literature belonged to the time period 2000 to present. Further filters based on other criteria will be applied for screening.

ILO occupational classification framework will be adapted for classifying information obtained on labour in fishing and fish processing. Harbour based work was assessed and occupational description attempted which involved description of the main tasks of a particular occupation or a group of occupations. It is observed that the work is divided into 13 different types/ sections based on the activity performed. There are barriers to entry in each activity type. Migrant labour are observed in selected activities. Regular organised Trade Unions control activities and sub-contract work to migrant labour for lesser wages.

Externally Funded Projects

I. Indian Council of Agricultural Research (ICAR) Projects

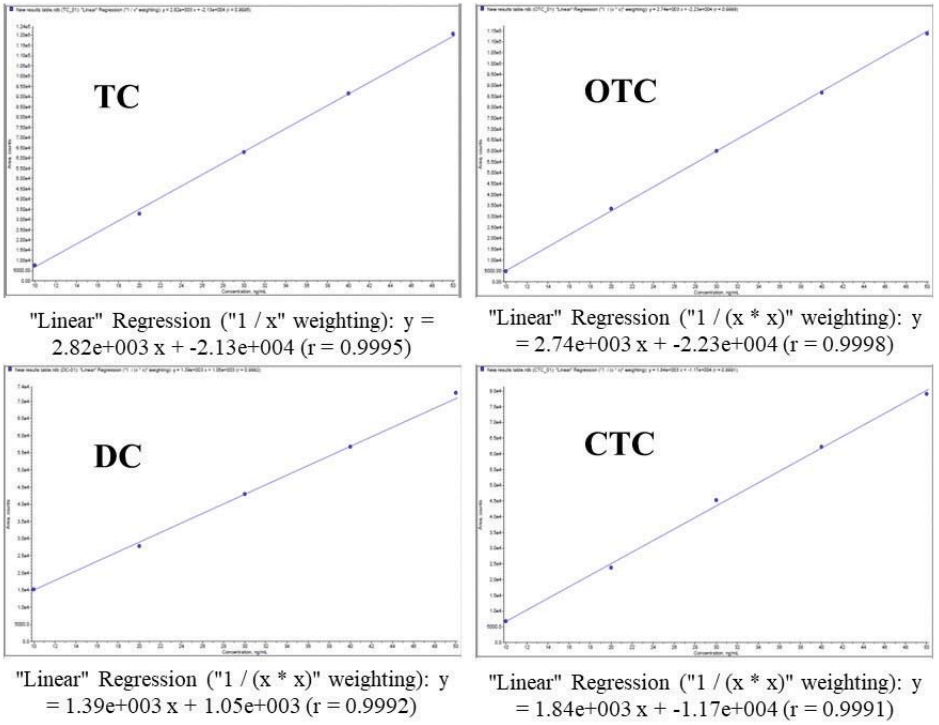
1. AGRI-BUSINESS INCUBATION

SNo:	ACTIVITIES	
1.	Entrepreneurs enrolled as Incubatees	40 Entrepreneurs
2.	Consultancy Agreements	7
3.	Technology Transfer	21
4.	Contract Research	6
5.	Contract Service	7
6.	Trainings imparted to incubatees for product development / upscaling	6 Trainings
7.	Product Brands developed by incubatees	**25 New Product Brands** • **Fish Pickle (4)** – Vanitha Entreprises, Travancore Pickles, Vypeen Seafood Wonders, Homemade • **Dry Fish Products (10)** – Chef 'N' Kitchen, Village Traders, Fresh Pack, Emma Foods, Aabbaa, Vaikans Fisheries, JJ Food Products, ISRA, Mr.Fish, Ohio Foods • **Fresh Fish Retail Outlets (4)** – Dharmoos Fish Hub, Town Harbour, Fresh Pack, Santhom Fish Mart • **Value Added Products (4)** – Nanma, Baby Marine, Coral Exports, Mejillon Foods • **Seaweed based products (1)** – Smile & Take Cookies • **Retort processed foods (2)** – Foo Foods, HiQ -Plantzaa
8.	IPRs	Copyright for CIFTFISHPRO: Mobile Application (Registration No: SW-11745/2018)
9.	Industry Meets	1 Industry Interface programme 4 B2B Meets for the promotion of Engineering Technologies
10.	Revenue generated through technology transfer / professional service functions	Agreements / contracts worth ₹ 79.045 lakh has been signed during 2018-19

2. All India Network project on Fish health

Determination of Four Tetracycline Antibiotics Residues in Fish by Ultra-High-Performance Liquid Chromatography coupled with Triple Quadrupole Mass Spectrometry

A multiresidue method for the determination of tetracycline antibiotics (Tetracycline (TC), Oxytetracycline (OTC), Chlortetracycline (CTC) and Doxycycline (DOC)) in fish samples by LC/MS/MS was developed. Separation was carried out by gradient elution technique using mobile phase A (0.1% formic acid in water) and mobile phase B (0.1% formic acid in acetonitrile), at a flow rate of 0.5 ml/min and injection volume 10 µl. The % recoveries of analyzed drugs were in between 80 and 101.



Calibration lines for all four compounds analyzed in this study

Extraction and Quantification of Emamectin Benzoate (EB) and Oxytetracycline (OTC) from fish samples from collaborating Institutes under All India Network Project

West Bengal University of Animal and Fishery Sciences, Kolkata - 40 numbers of samples analyzed for OTC. The dietary influences of Oxytetracycline (OTC) administered to Nile tilapia *Oreochromis niloticus* at 0, 80 and 800 mg/kg biomass/day and tested for OTC residue depletion in Oxytetracycline-fed tilapia. No residue was found in the control group. The levels of OTC-residues present in edible muscle tissues of 1X OTC-feed fed tilapia were 0, 54, 161.4, 135, 16.23, 5.7, 17.73 and 8.97 ng/g, on day 0, 1 and 10 OTC dosing and day 4, 11, 25, 32 and 42 post-OTC dosing, respectively. Traces of OTC residues in nanogram levels were noted till day 42 post-OTC dosing. However, the linear regression analysis ensured complete elimination of residues on the 40th day of cessation of OTC dosing based on the LC-MS/MS residue accrual and depletion data.

Fish samples (178) from ICAR-CIFRI, Barrackpore were analyzed to detect the presence of OTC. Fish *Pangasianodon hypophthalmus* were analysed for concentration of residual OTC and Emamectin Benzoate. Samples were evaluated for safety of OTC in *P. hypophthalmus*. Fishes were daily fed OTC @ 80mg (1x), 3x, 5x, 10x for 30 days, followed by 10 days post-drug observation. Drug concentration was measured in flesh,

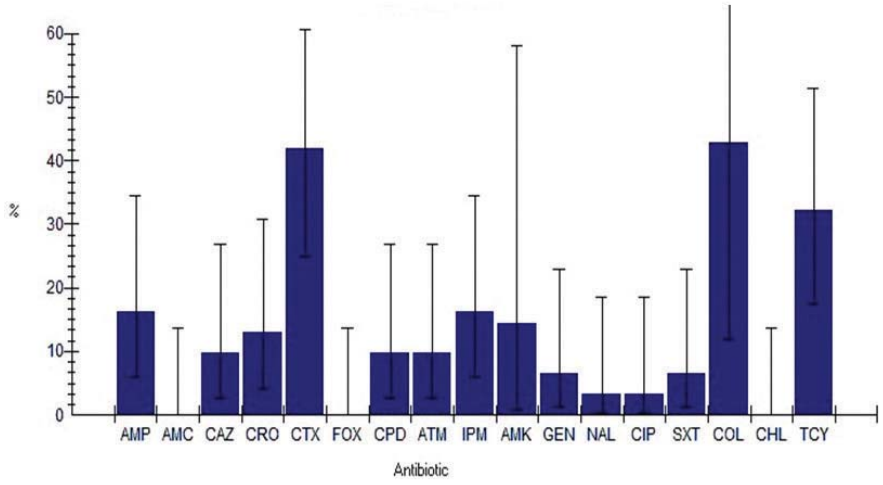
serum and other internal organs on 5, 10, 20, 30 and 40th day and correlated with fish health parameters and examines body clearance of the drug. Results showed that the drug is cleared from body very rapidly.

Analysis of Emamectin Benzoate - 40 numbers of fish samples from WBUAFS, 25 numbers of fish samples from ICAR - CIFA, Odisha, 24 numbers of fish samples from ICAR –CMFRI, Cochin and 120 numbers of fish samples from ICAR CIFRI, Barrackpore were analyzed to detect the presence of Emamectin Benzoate.

3. Network Programme on Assessment of Antimicrobial Resistance (AMR) in Microorganisms Associated with Fisheries and Aquaculture in India

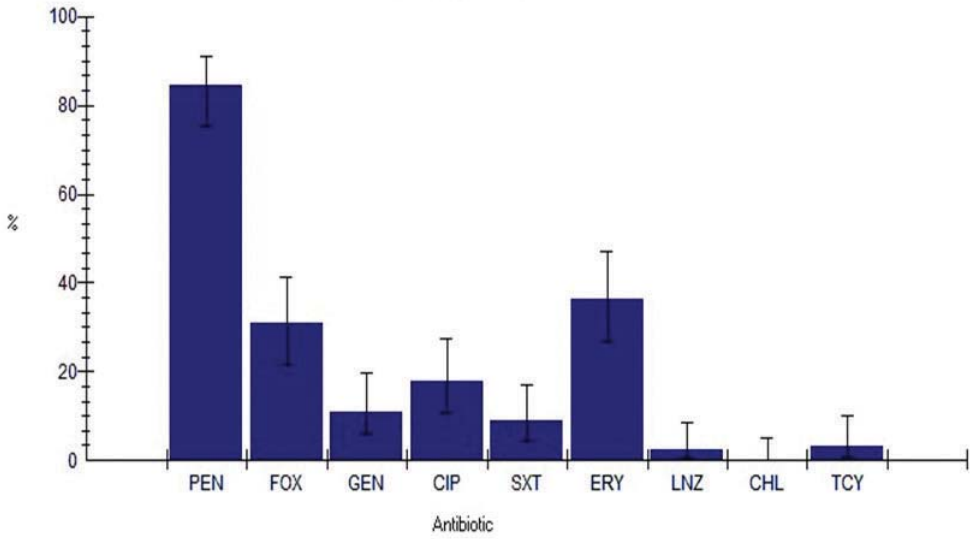
Seventy samples were collected from 24 aquaculture farms (20 from Thrissur and four from Alappuzha) and 337 isolates were selected for further studies. Out of 21 shrimp farms, six farms harboured *E. coli* and a total of 31 strains were obtained (total 46 screened). Out of 18 shrimp farms, 17 farms harboured *Staphylococcus* spp. and a total of 95 strains were isolated (total 154 screened). Out of 21 shrimp farms, 14 farms harboured *Vibrio* sp. and a total of 71 strains were isolated (total 137 screened). Water and sediment samples were collected from three shrimp farms of Alappuzha district (farming activities started in March 2019 after flood) and isolation, identification and assessment of antibiotic resistances in the microorganisms were monitored.

Antibiotic resistance profile of *E. coli* strains were tested for following 17 antibiotics; Ampicillin (AMP 10), Amoxicillin- Clavulanic acid (AMC 20/10), Ceftazidime (CAZ 30), Cefriaxone (CRO 30), Cefotaxime (CTX 5), Cefoxitin (FOX 30), Cefpodoxime (CPD 10), Aztreonam (ATM 30), Imipenem (IPM 10), Amikacin (AMK 30), Gentamicin (GEN 10), Nalidixic acid (NAL 30), Ciprofloxacin (CIP 5), Trimetho- Sulfamethoxazole (SXT 25), Colistin (COL 10), Chloramphenicol (CHL 30), Tetracycline (TCY 30). Percentage resistance of *E. coli* strains to the antibiotics tested are as shown in the Figure. Among the antibiotics tested, 42.9% of the *E. coli* strains had reduced susceptibility to colistin followed by cefotaxime (41.9%), tetracycline (32.3%) and amikacin (28.6). At the same time, all strains were also sensitive to cefoxitin, chloramphenicol and amoxicillin/clavulanic acid.



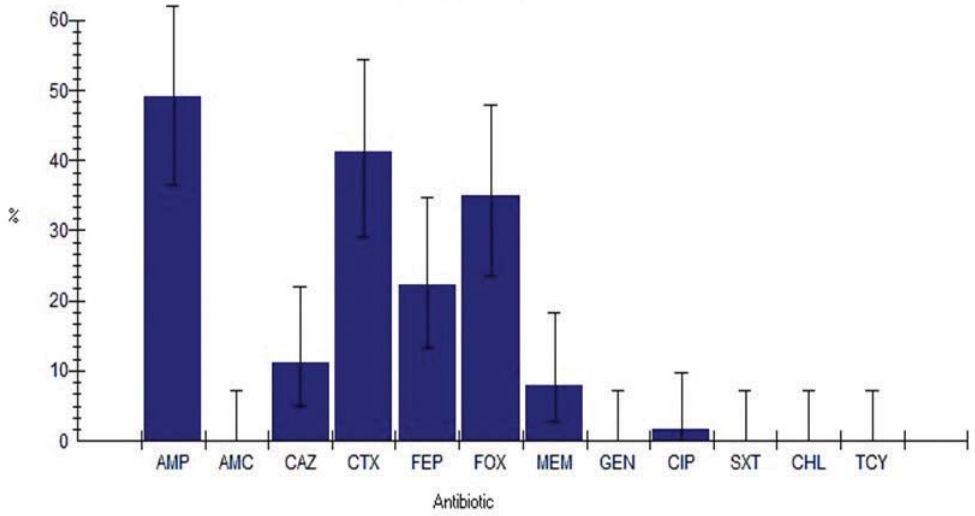
Antibiotic resistant profile of *E.coli* isolated from aquaculture farm of Kerala

Antibiotic resistance profile of *Staphylococcus* spp. strains were tested for following 9 antibiotics; Benzyl Penicillin (PEN 10), Cefoxitin (FOX 30), Gentamicin (GEN 10), Ciprofloxacin (CIP 5), Trimetho- Sulfamethoxazole (SXT 25), Erythromycin (ERY 10) Linezolid (LZ 30), Chloramphenicol (CHL 30) & Tetracycline (TCY 30). Among *Staphylococcus* spp., 85% of the isolates were resistant to Penicillin G; 36% to erythromycin; 31% to cefoxitin and 18% to ciprofolxacin. Least resistance observed togentamicin (11%); tetracycline (3%); trimethoprim/ sulfamethoxazole (9%) and linezolid (2%). 96.7% of the strains were sensitive to chloramphenicol (3.3% intermediate sensitive).



Antibiotic resistant profile of *Staphylococus* sp. isolated from aquaculture farm of Kerala

Antibiotic resistance profile of *Vibrio* spp. strains were tested for following 12 antibiotics; Ampicillin (AMP 10), Amoxicillin- Clavulanic acid (AMC 20/10), Ceftazidime (CAZ 30), Cefotaxime (CTX 30), Cefepime (FEP 30). Cefoxitin (FOX 30), Meropenem (MEM 10), Gentamicin (GEN 10), Ciprofloxacin (CIP 5), Trimetho-Sulfamethoxazole (SXT 25), Chloramphenicol (CHL 30), Tetracycline (TCY 30). 49.2% of the *Vibrio* spp. depicted reduced susceptibility to ampicillin followed by cefotaxime (41.3%), cefoxitin (34.9%) and cefepime (22.2%). All strains were sensitive to chloramphenicol, gentamicin, tetracycline and trimethoprim/sulfamethoxazole.

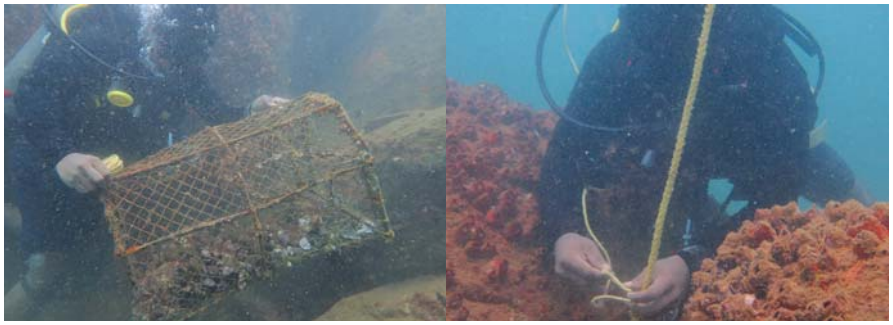


Antibiotic resistant profile of *vibrio* sp. isolated from aquaculture farms of Kerala

4. Investigations on ghost fishing by derelict traps and gillnets in selected areas of Indian waters and mitigations measures

Trap and gillnet loss and reasons for loss were assessed using structured questionnaire among fishers of Tamil Nadu, Kerala, and Maharashtra. Evidence of lost gears was assessed by underwater diving in waters off Kochi, Vizhinjam and Enayam. Trap loss rate as assessed from fishers' interview was in the range of 1 to 12 traps per year per person. Underwater diving at Enayam retrieved three traps (one fish trap and two lobster

traps) along with panels of gillnets, pieces of monofilament lines and squid jigs at a depth range of 16 to 22 m during 64 minutes diving. Similarly, derelict gear retrieval diving at Vizhinjam recovered a few panels of gillnets and a trap.



Underwater survey at the trap fishing ground at Enayam
Retrieving lost trap from Enayam

Lost gillnet on the seabed at Vizhinjam

Retrieving lost gillnet from Vizhinjam

II. National Innovations in Climate Resilient Agriculture (NICRA) Project

5. Global Warming Potential (GWP) of mechanized fishing methods of India and mitigation strategies: Analysis using Life Cycle Assessment (LCA) – Data Envelopment Analysis (DEA) approach

NICRA project at ICAR-CIFT was initiated in October 2018. The fishing systems studied were trawler, purse seiner and gillnet/longliner along the west and east coasts of India. Study areas identified are Veraval (Gujarat), Betul and Vasco (Goa), Cochin (Kerala), Thengapattanam (Tamil Nadu) and Visakhapatnam (Andhra Pradesh). Sampling size was in proportion to the number of fishing units operated in the area and the selection of fishing vessels was based on ICAR-CIFT classification into small, medium, large and very large. Five stakeholders meetings conducted at Gujarat, Goa, Kerala and Tamil Nadu. Data collection initiated from January 2019. Preliminary estimates showed trawlers had higher carbon emission per kg of fish landed whereas it was least for gillnetter/longliner.

III. Department of Biotechnology (DBT) Projects

6. Evaluating cost and benefits of prophylactic health products and novel alternatives on small holder aquaculture farmers in Asia and Africa

A probiotic product is said to be reliable by the existence of the declared probiotic species. Quality of five selected aquaculture probiotics was assessed with traditional microbiology techniques, 16S rRNA sequencing and Next Generation Sequencing (NGS). With the culture dependent enumeration methods, it was found that only one product out of the 60 probiotics sampled (1.7%), follows a standard labelling criterion of microbial composition at species level with respective concentration and contained the same microbial content with the declared microbial load. A great batch to batch variation in microbial load was observed for three products. *Bacillus subtilis* is the most occurring probiont among the sampled products. With NGS to determine bacterial genetic diversity of the products, it is revealed that all the samples possessed bacterial species other than the labeled and exposed a common misalliance between the label claims and exact contents of the product. Presence of different levels of human infectious, faecal and contaminant bacteria were also observed in all the products. Culture based identification and metagenomics sequencing pointed that, among the five products only two products contained all the named probiotic organisms. It is understood that, most of the brands do not fulfil the basic requirement of labeling the exact contents of the probiotic product, moreover the occurrence of unlabeled hazardous organisms inside the product is an added concern to consumer group. This directs the absence of proper regulatory authorities to monitor the manufacture and quality control of probiotic products and the need of implementing a legislation system in the industry. Antimicrobial susceptibility testing of 150 Bacillus isolates, comprising ten isolates from fifteen different products having claim to contain Bacillus, by strip based Minimum Inhibitory Concentration (MIC) assay was performed. Only 4% isolates was susceptible to all antimicrobials agents tested and 94% isolates showed resistance against pencillins group.

Microbiological analysis of PHPs

◆ Microbial Qualitative Analysis of Selected Probiotics

- Microbial qualitative assessment was performed for five products with declaration of microbial composition, by traditional microbiological techniques. The results were then confirmed with 16S rRNA sequencing.
- All the five products sampled had claim for *Bacillus subtilis* and contained the same.
- Batch to batch variation in bacterial load was observed for product 13, 29 and 33. The bacterial count was same in batch 1 and 2 for product 40 and 46.
- Product with code 13 found to have both the declared microorganisms, *Bacillus subtilis* and *Pediococcus acidilactici*.
- For product 29 other than *Bacillus subtilis*, *Bacillus coagulans* was also present. Count of both *Bacillus subtilis* was one log higher than the claim and *Bacillus coagulans* load was nearly in the range of the label claim for both batches.
- Product 33 found to contain a non-declared bacterial species, *Enterococcus faeciumas* its major component. Out of the five declared organisms only *Bacillus subtilis* was present and its count was three log lower than the claimed concentration.
- Product with code 46 claimed 10 different microorganisms, but presence of only one strain was observed and its load was in the same log of specification.
- Only one product, product with code 40, out of the 58 probiotics sampled (1.7%), was found to follow a standard labelling criterion of microbial composition at species level with respective concentration and contained the same microbial content with the declared microbial load.

◆ Microbiome Analysis of Commercial Probiotics

- Since monotonous microbial enumeration trails with vast types of culture media may not detect all the variant kind of microorganisms present in a probiotic product, a culture independent method was adapted.
- Next generation sequencing (NGS) analysis of 16S rRNA metagenomics data was performed to explore all bacteria present in the products.
- 16S ribosomal RNA Amplicon Sequencing of V3 region performed using Illumina MiSeq platform for five products.
- Sequencing reads ranged from 38484 to 446988 for different products
- All the samples possessed bacterial species other than the labeled and exposed a common misalliance between the label claims and exact contents of the product (Table 2).

Bacterial species as per product label vs observed species by sequencing

Product code	Bacterial Species as per label	Bacterial Species Observed in Abundance (> 0.1%)
13	*Bacillus subtilis, Pediococcus acidilactici*	*Bacillus subtilis, Pediococcus acidilactici, Propionibacterium acne, Brevundimonas diminuta*
29	*Bacillus subtilis, Bacillus licheniformis, Bacillus coagulans, Lactobacillus acidophilus*	*Bacillus coagulans, Bacillus licheniformis, Arthospira platensis, Escherichia coli*
33	*Bacillus subtilis, Bacillus licheniformis, Bacillus coagulans, Nitrobacter* sp., *Nitrosomona* ssp.	*Bacillus subtilis, Bacillus diminuta, Propionibacterium acne,uncultured Staphylococcus* sp., *uncultured Streptococcus* sp.
40	*Bacillus subtilis*	*Bacillus subtilis, Propionibacterium acne, Streptococcus thermophiles*
46	*Bacillus subtilis, Bacillus amyloliquefaciens, Bacillus polymyxa, Bacillus pumilus, Bacillus megaterium, Bacillus licheniformis, Alcaligenesfaecalis, Nitrobacter* sp., *Nitrosomonas* sp.	*Bacillus subtilis, Bacillus pumilus, Bacillus licheniformis, Pediococcus acidilactici, Enterococcus faecium*

- Among the five products only two products (product 13 and product 40) contained all the mentioned probiotic bacteria
- All the probiotics tested had other bacterial species than those mentioned in label
- Presence of different levels of human infectious, faecal and contaminant bacteria were also observed in all the products.
- Current study raises concerns regarding the interest of the consumers for improving the quality of aquaculture probiotics and potential biosafety issues.

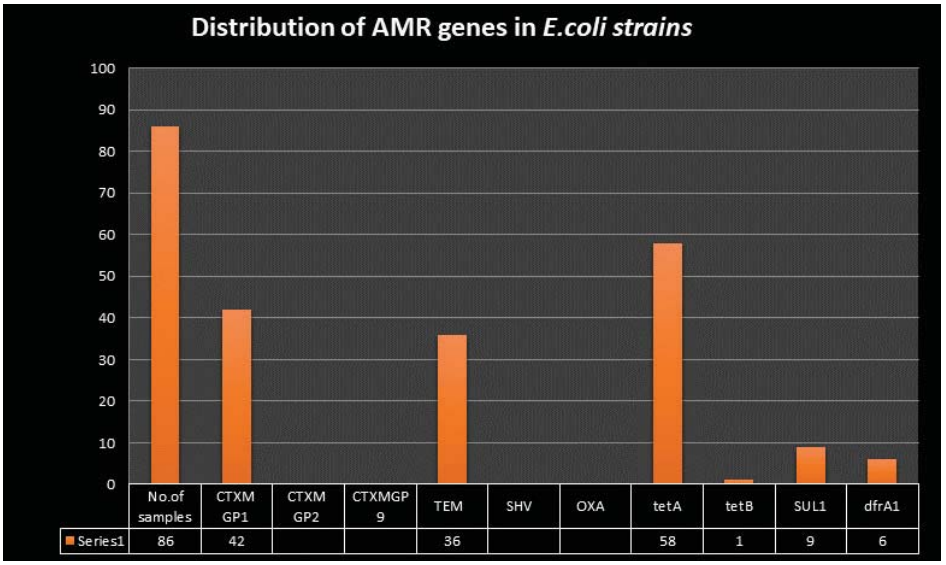
Evaluation of the microbiological safety of probiotic strains

- Antimicrobial susceptibility testing is carried out for 150 Bacillus isolates, comprising ten isolates from fifteen different products having claim to contain Bacillus, by strip based Minimum Inhibitory Concentration (MIC) assay.
- Fifteen antimicrobial agents under eleven antimicrobial classes were selected based guidelines from the Clinical and Laboratory Standards Institute (CLSI).
- Production of beta lactamase enzyme was characterized by chromogenic detection with nitrocefin discs.

- Only 4% isolates was susceptible to all antimicrobials agents tested.
- 94% isolates showed resistance against pencillins group.
- 47.5% pencillins resistant *Bacillus* were beta lactamse positive.
- All isolates were susceptible to penems, glycopeptides and quinolones tested.
- Under aminoglycosides, 100% susceptibility observed for gentamicin but 2% of isolates fall under intermediate category for amikacin.
- MIC ranges for penicillin, ampicillin, trimethoprim and cholramphenicol were very wide and the upper limit crossed 256 µg/ml

7. Diagnostics for one health and user driven solutions for AMR (DOSA)

User mapping studies on the use of antibiotics and baseline assessment of resistance pathogens profile from aquaculture environment setting *viz*., shrimp farm (35), hatchery (2), feed (35), water (35) and processing industries (2) were carried out. Less than 4% of the aquaculture setting samples revealed the presence of AMR pathogens such as Extended-Spectrum Beta Lactamase producing *E.coli* and Methicillin Resistant Staphylococci (MRS). These strains were phenotypically assessed for the resistant to more than nine classes of antimicrobial agents. The distribution of AMR genes among of ESBL producing *E.coli* strains are shown in the Figure given below.



8. Does antimicrobial resistance (AMR) in livestock contribute to AMR in people in NE India? An inter-disciplinary study investigating antibiotic use, drivers of AMR and transmission dynamics

The Project on AMR surveillance in North East Regions was sanctioned jointly by Indo-UK Collaboration project of DST, New Delhi in November, 2018 with an outlay budget of ₹ 74.312 Lakh. During the period under report, a user mapping and ethnography study was conducted in four places in Guwahati, Assam and aquaculture samples (n= 22) was collected for the study of AMR pathogens viz., MRSA, ESBL producing *E.coli*, *Klebsiella* spp. and *Salmonella* spp. It was found that *E.coli* was the dominant bacterial flora followed by Klebsiela and Staphylococci. These strains were screened for the antimicrobial activity against different classes for antimicrobial agents and the *E.coli* strain (n=26) were found to be resistant to cephems antibiotic and suspected for the ESBL producing *E.coli*. Whereas, only three number of Staphylococci showed resistant to oxacillin and others were coagulase negative Staphylococci (n=20). These strains were preserved for further confirmation for the presence of any AMR genes.

9. Screening lytic phages from diverse marine and aquatic niche for controlling bacterial pathogens associated with aquaculture and post harvest fish quality

Occurrence and Isolation of bacteriophages

Ten water samples from Visakhapatnam comprising of 7 marine water samples from the Bay of Bengal and 3 water samples from sewage treatment plant were collected and analysed for the presence of bacteriophages (Φ) active against *E.coli*. Coliphages were detected in two marine water samples with counts 9 pfu/ml (Vm1-Visakhapatnam Fishing harbour) and 14 pfu/ml (Vm2-Ramakrishna beach). Coliphages were detected in all the three water samples from sewage treatment plant with counts ranging from 50 pfu/mlto 143 pfu/ml with a mean count of 95 pfu/ml ± 47 pfu/ml.

Sampling sites for collection of water samples for isolation of coliphages

Occurrence of bacteriophages in marine water samples

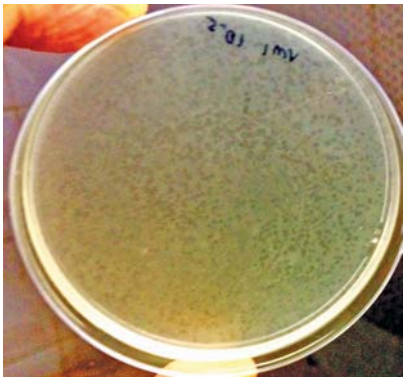
S.No.	Sample collection sites	Code	Location	Count (pfu/ml)
1.	Harbor water	Vm1	17°41'48"N; 83°18'1"E	9
2.	R.K beach drain canal	Vm2	17°42'38"N; 83°19'5"E	14
3.	Ocean drive layout (Gudlavanipalem)	Vm3	17°45'35"N; 83°21'25"E	Nil
4.	Mangamaripeta	Vm4	17°49'41"N; 83°24'55"E	Nil
5.	Thippadipalem	Vm5	17°50'38"N; 83°24'27"E	Nil
6.	Gokartina	Vm6	17°50'29"N; 83°24'23"E	Nil
7.	Sagarnagar	Vm7	17°45'48"N; 83°21'45"E	Nil

Density of bacteriophages in water from Sewage Treatment Plant

S.No.	Sample collection site	Code	Location	Count (pfu/ml)
1.	Appugar site 1	Vs1	17°44'31"N; 83°20'39"E	92
2.	Appugar site 2	Vs2	17°41'31"N; 83°20'29"E	50
3.	Shanthiashramam	Vs3	17°43'51"N; 83°20'4"E	143

Forty five water samples collected from Vembanad lake, sewage and brackish water were screened for the presence of lytic bacteriophage against *E. coli*. Thirteen different coliphages (separate phage plaques) were isolated from marine niche of Cochin and stored in -80 freezer. Concentration of phage from large volume of marine water (Vembanad lake - 3 litres) were standardized using Tangential flow filtration system. Quantification of individual plaques for viral concentration revealed that concentration ranged from 10^4 to 10^7 pfu/ml.

a) Enrichment and lytic activity of bacteriophages isolated using *E.coli* 2089 as host: A single isolated phage was purified from each water sample, enriched to 100 ml quantity, treated with chloroform, filtered (0.2 µ) and preserved for further studies. The phages purified from the marine samples were enriched to $8.1x10^6$ pfu/ml (ΦVm-2) to 3.9×10^7pfu/ml (ΦVm-1). The purified phages from the sewage waters were enriched to $1.1x10^7$ pfu/ml (ΦVs-1), $1.5x10^7$ pfu/ml (ΦVs-2) and $5.8x10^7$pfu/ml (ΦVs-3). The coliphages were found to be active at pH of 5,7 and 9, temperatures of 22°C and 37°C and at 0.5%, 1% and 2% salt concentration. The lytic activity of the enriched phages were tested on 19 isolates of *E.coli* by spotting method. The results indicated that all the five bacteriophages namely ΦVm-1, ΦVm-2, ΦVs-1, ΦVs-2 and ΦVs-3 exhibited lytic activity only on the host strain *E.coli* 2089 but not on the field isolates of *E.coli* indicating narrow spectrum of activity of these five phages.

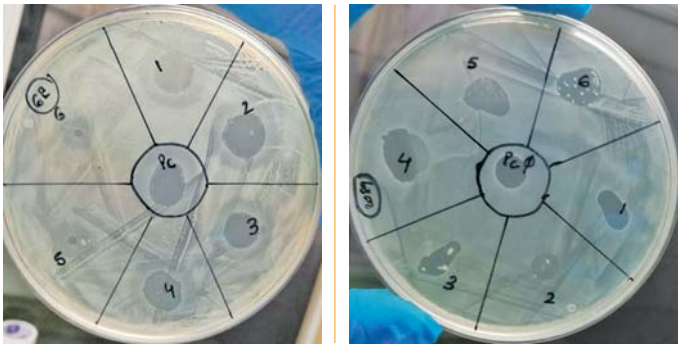


Lytic activity of enriched phages ΦVm-1, ΦVm-2, ΦVs-1, ΦVs-2 and ΦVs-3 on different *E.coli* isolates and host strain *E.coli* 2089

E.coli host strains	ΦVm-1	ΦVm-2	ΦVs-1	ΦVs-2	ΦVs-3
NCIM 2089	++	++	++	++	++
EC-1	-	-	-	-	-
EC-2	-	-	-	-	-
EC-3	-	-	-	-	-
EC-4	-	-	-	-	-
EC-5	-	-	-	-	-
EC-6	-	-	-	-	-
EC-7	-	-	-	-	-
EC-8	-	-	-	-	-
EC-9	-	-	-	-	-
EC-10	-	-	-	-	-
EC-11	-	-	-	-	-
EC-12	-	-	-	-	-
EC-13	-	-	-	-	-
EC-14	-	-	-	-	-
EC-15	-	-	-	-	-
EC-16	-	-	-	-	-
EC-17	-	-	-	-	-
EC-18	-	-	-	-	-

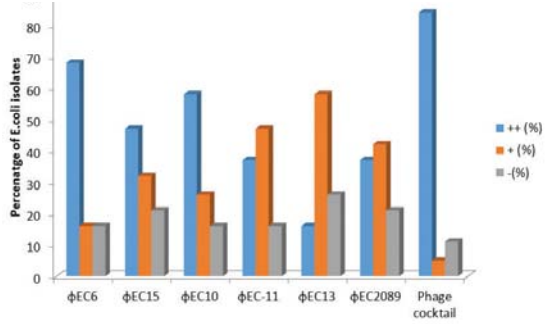
b) Lytic activity of bacteriophages isolated using different strains of *E.coli*: Water collected from a sewage treatment plant, Visakhapatnam was used for isolating phages by employing single agar assay method using 19 different *E.coli* isolates (EC1 to 18 & EC 2089) as host strains. Eighteen *E.coli* strains

(EC-1 to EC-18) were field strains isolated from fish and fishery environment and EC-2089 is type culture obtained from NCIM, Pune. Single clear plaque from EC-6, EC-15, EC-10, EC-11, EC-13 and EC-2089 plates were purified, enriched, chloroform treated and used for further studies. ΦEC6, ΦEC15, ΦEC10 ΦEC11, ΦEC13 and ΦEC2089 showed high lytic activity (++) against 68%, 47%, 58%, 37%, 16% and 37% of *E. coli* isolates. Weak lytic activity (+) was exhibited by ΦEC6, ΦEC15, ΦEC10 ΦEC11, ΦEC13 and ΦEC2089 towards 16%, 32%, 26%, 47%, 58% and 42% of *E. coli* isolates. A phage cocktail was prepared by mixing ΦEC6, ΦEC15, ΦEC11 and ΦEC2089 in a ratio of 1:1:1:2 with a strategy to lyse maximum *E. coli* showed high lytic activity (++) against 84% of *E. coli* isolates.



1: ΦEC6; 2: ΦEC15; 3: ΦEC10; 4: ΦEC11; 5: ΦEC13;
6: ΦEC2089; PC: Phage cocktail

Lytic activity of single bacteriophages and phage cocktail against different *E.coli* isolates.



++: High lytic activity; +: weak lytic activity; - :
No lytic activity

Lytic activity of bacteriophages (individual and phage cock tail) on different *E.coli* isolates

Host specificity of the isolated coliphages

All the eleven coliphages (ΦEC6, ΦEC15, ΦEC10 ΦEC11, ΦEC13, ΦEC 2089, ΦVm-1, ΦVm-2, ΦVs-1, ΦVs-2 and ΦVs-3) and phage cocktail showed specific lytic activity towards *E.coli* NCIM 2089 and failed to lyse other Gram negative bacteria (*Salmonella typhi* ATCC 51812, *Vibrio cholerae* MTCC 3904, *Morganella morganii* ATCC 25829) and Gram positive bacteria (Methicillin resistant *Staphylococcus aureus* and *Listeria monocytogenes* ATCC 13932) indicating the host specificity of the isolated coliphages towards *E.coli*.

IV. Department of Science and Technology (DST) Projects

10. Development of clam cluster and clam processing facility at Perumbalam village, Thycattussery block, Cherthala taluk, Alappuzha

Setting up of the unit

The construction of the processing facility was completed and the equipment intended for the facility that was designed and fabricated for the purpose was set up at the facility. The depuration facility designed and set up for the unit has been fully established with a capacity of depurating 900 kg of whole calm per day. The

equipment transferred included meat shell separators and boiler-cum-cooking unit besides other equipment like flake ice machine, sealing machines, air curtain, processing and packaging tables etc.

Test run of the unit

Trial runs were initiated and quality of depurated clam meat were analysed. During trials 75 kg of whole clam can be cooked in 20 minutes and shucked using the meat-shell separator in 7 minutes. The Aerobic Plate Count (APC) in clam meat from depurated whole clam was found to be 1.2 x 10^5 cfu/ml.

Depurated clams were marketed in the local market and frozen samples are being test marketed abroad by the local project partner, Haritha Farmer's club.

Depuration facility

Loading of clams in cooking chamber

Generation of steam in cooking chamber

Boiler

Boiled clam meat, loading in meat shell separator, washed clam meat

Visit of Japanese buyer to the facility

11. Livelihood enhancement of Sidi tribal women and Kharwa fisherwomen of Veraval in Gujarat through the implementation of improved fish post harvest technologies

Various capacity building and skill development programmes were organized for Sidi tribal women and Kharwa fisherwomen are given below

Sl. No.	Title	Duration	Date	Beneficiary
1.	Training on hygienic fish handling and pre-processing protocols	1 day	13/12/2018	Sidi Tribal women
2.	Training on hygienic fish handling and pre-processing protocols	1 day	14/12/2018	Kharwa Fisherwomen
3.	Training on preparation of value added products from fish	3 days	22/02/2019-24/02/2019	Kharwa Fisherwomen

4.	Training/skill development programme on renewable energy based hygienic fish drying methods	2 days	26/02/2019-27/02/2019	Kharwa Fisherwomen
5.	Training/sapacity building programme onimproved packaging and labelling methods for producing better quality fish	1 day	18/03/2019	Sidi Tribal women
6.	Training/skill development programme on renewable energy based hygienic fish drying methods	2 days	19/03/2019-20/03/2019	Sidi Tribal women

Trainees with faculty during the capacity building programme on improved packaging and labelling methods for producing better quality fish organized for Sidi tribal women.

Demonstration of preparation of value added products from fish to Kharwa fisherwomen during the training programme on 'Preparation of value added products from fish'.

Certificate distribution by Dr. S. M. Zofair, HoD, Fish Processing, College of Fisheries, Veraval to the trainees of the programme on 'Preparation of value added products from fish' from.

V. Indian National Centre for Ocean Information (INCOIS) Projects

12. Validation and dissemination of ocean state forecast advisories along Gujarat coast

The Wave Rider Buoy was installed with the help of NIO at a depth of 15 m off Veraval coast. Survey was carried out during December 2018 to March 2019 to study the distribution, occurrence and biological factors of the jellyfishes along the Saurashtra coast. Jellyfishes occurs with both pelagic and demersal fish species like pomfrets, ribbonfish and sciaenids. More than 60% of the fishers observe an inverse correlation between jellyfishes and commercially important fishes.

With the available data on the occurrence of jellyfishes and commercially important fishes in the region, a co-occurrence analysis was carried out to find the assemblage structure of species along the coastal waters off

Gujarat. The analysis showed higher occurrence of jellyfishes along with catches *Trichiurus lepturus, Uroteuthis (P) duvauceli, Thryssa dussumieri* and *Alepes klenii,* with an average co-occurrence of more than 0.4.

Photograph showing wave rider buoy installation

Three awareness programmes were conducted at Veraval for the dissemination of the OSF information generated by INCOIS and improve the utilization rate of the ocean state forecasts.

VI. National Fisheries Development Board (NFDB) Project

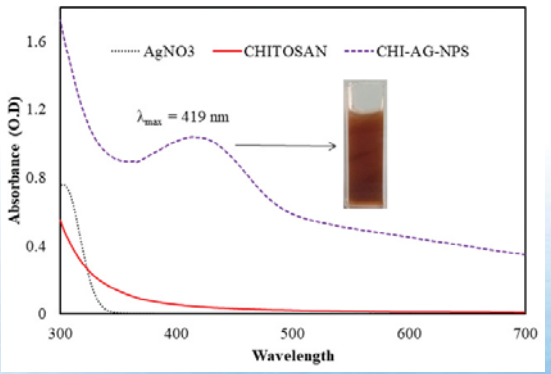
13. National surveillance programme for aquatic animal diseases

Collection of baseline data and active disease surveillance was carried out in total 21 fresh water fish farms and 29 brackish water shrimp farms. In finfish farms the major cause of disease outbreak was due to Infection with *Edwardsiella tarda* along with low dissolved oxygen. In six shellfish farms the cause of the disease outbreak was infection with WSSV and infection with WSSV and EHP was found in one farm.

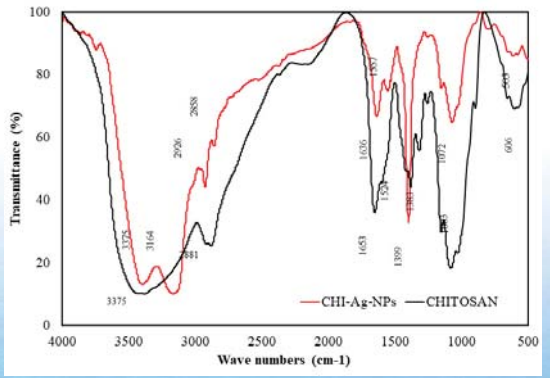
VII. ICAR-National Fellow Project

14. Biomodulation of marine biopolymers for the preparation of biomaterials of healthcare importance

Chitosan-mediated silver nanoparticles (Chi-Ag-NPs) were prepared and characterized. The Chi-Ag-NPs exhibited antioxidant and antibacterial properties which can be considered as potential properties for biomedical applications. A bilayer scaffold has been fabricated using chitosan, alginate and polyvinyl alcohol



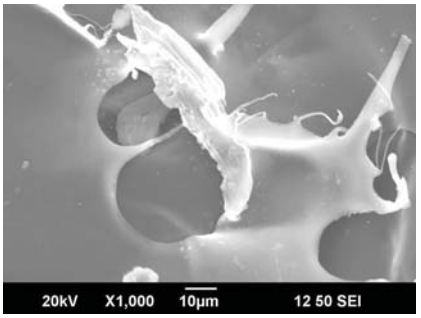
UV-VIS spectra of Chi-Ag-NPs



FTIR spectra of chitosan and Chi-Ag-NPs

(PVA) with remarkable swelling behaviour and porosity for tissue engineering applications. The histopathology observations on gastric mucosal membrane of rats confirmed the anti-ulcerogenic potential of anthocyanin loaded chitosan nanoparticles (AC-NPs) against alcohol-HCl induced experimental ulcer. Methodology was developed for the determination of amino acid profile of fish protein and its hydrolysates. Simple, cost effective and alkali/acid free green technology has been developed for the extraction of high pure collagen and gelatin from sea food processing waste.

Chi-Ag-NPs composites exhibit homogenous, dense, smooth, flake and porous surface structures indicating the Ag-NPs particles were aggregated and well distributed into the polymeric matrix.



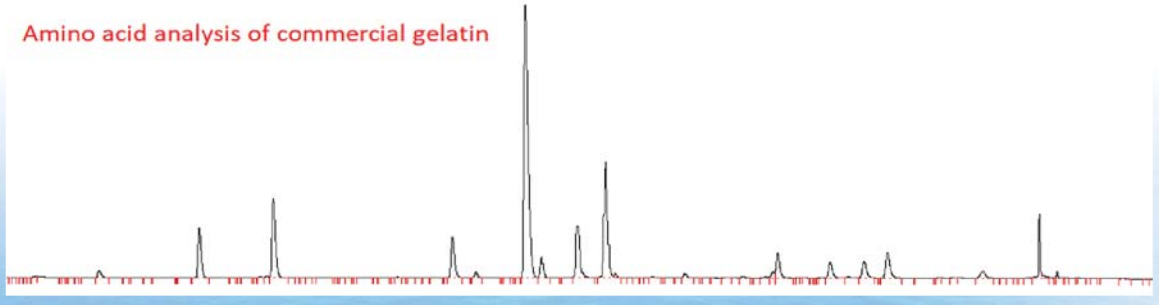
Scanning electron microscope (SEM) images of Chi-Ag-NPs

Rapid method of extraction and characterization of gelatin from tuna skin waste: Methodology for fast and effective extraction of gelatin from the skin of tuna was developed. The effectiveness of rapid method of gelatin extraction is comparable to that of conventional method. The protein and fat content of extracted gelatin were found to be 89.9% and 0.97%, respectively.The SDS-PAGE pattern showed three major bands corresponding to β, α1 and α2 in the molecular weight range of 200–120 kDa. UV-Vis spectra showed higher absorption in the wavelength region of 220-240 nm indicating the presence of rich amount of non-aromatic amino acids.



Rapid method of extraction

A method has been developed for analyzing amino acid content in the biopolymer and protein compounds. No significant difference was observed between the tuna skin and commercial available gelatin, which shows the effectiveness method of extraction. The extracted and characterized tuna skin gelatin was for the preparation of chitosan- gelatin membrane for wound healing applications.



HPLC chromatogram- Amino acid analysis of gelatin

Preparation and characterization of chitosan nanoparticles-loaded fish gelatin membrane as wound dressing material: Chitosan nanoparticles (CSNPs) were prepared by ultrasonication. The particle size of synthesized CSNPs had a *Z*-average diameter in the range of 80-100 nm.The synthesized CSNPs were added to gelatin solution to obtain chitosan nanoparticles-loaded fish gelatin membrane, and subjected to animal experiments for wound healing and biocompatibility.

Animal experiments – Biocompatibility evaluation of chitosan nanoparticles-loaded fish gelatin membrane

Five groups of male albino rats were taken with an approximate weight of 240-320 g. Incision (1 cm) was made on the skin and bionano composite membranes were grafted. No inflammation or allergy was observed, indicating the biocompatibility of naocomposite membrane for tissue engineering and biomedical applications.

Technology transferred: Collagen peptide preparation from fish scales and fish skin: MoU signed with M/s Eklavya Biotech Pvt. Ltd., Mumbai

VIII. Ministry of Food Processing Industries (MOFPI) Project

15. Design and development of hot air assisted continuous Infrared drying system for high value fish and fishery products.

Infrared (IR) offers faster drying of food materials with minimum energy consumption and nutrient losses than the conventional dryers. Thus, a hot air assisted continuous infrared dryer is aimed to be fabricated which finds multitude of application in food processing. Collection of literature related has been done with respect to design of hot air assisted IR dryer, combined effect of IR and hot air on drying, advantages and difficulties involving in hot air assisted IR drying of fish, important design considerations and through review of existing hot air assisted IR drying systems etc. Design of hot air assisted continuous infrared drying system was prepared based on through literature review. Preliminary experiment was carried out using ceramic infrared heater (1000 W) to know the temperature profile in drying chamber. Results obtained from this study were utilized for design of prototype hot air assisted continuous Infrared dryer for high value fish and fishery products.

IX. WorldFish Project

16. Establishing value chain for coastal and small indigenous freshwater fish species: Towards nutritional security for rural population

Memorandum of Understanding (MoU) has been signed between Indian Council of Agricultural Research and International Centre for Living Aquatic Resources Management (ICLARM) also known as WorldFish. Three ICAR institutes ICAR- CIFA, ICAR – CIFT and ICAR – CIFRI are partners of the new consortium. Theme areas for ICAR - CIFT are (i) establishing value chain for small indigenous fish species: towards nutritional security for rural population and (ii) value chain and nutritional research outputs: fish for nutrition and health of women and children

At Adava in Gajapathi District of Odisha - a Training-Cum-Demonstration was held for the benefit of women

fishers. Hadbanghi reservoir in a source of plenty of fish. Despite the abundant availability of fish, there is malnutrition among women and children of the area –fish cannot be stored due to absence of ice and other cold storage facilities. In order to improve the nutritional status of the people ICAR-CIFT has made several interventions in the form of introducing technologies related to value- addition of fish that included preparation of fish cutlets, fish wafers, iron-enriched fish powder that necessities no requirement of cold storage facilities.

During the period under report the demonstration of preparation of Fe- enriched fish powder was given to the women fishers and others to help development of entrepreneurial skills. Besides, the aim was to enhance food and nutritional security and improve socio-economic conditions by creating avocation that generates sustainable income.

Preparation of soup from Fe-enriched fish powder and children consuming soup

In Manipur, one of the eight north-eastern states where ICAR-CIFT has been active with interventions for the last 2 decades. The state is bestowed with number of natural resources that include Loktak Lake that harbours a number of islands namely Thanga, Ithing, Sentra. This lake also is a major source of different fish that cater to the food & nutrition security needs of the people in the area. As part of intervention, a series of meetings were conducted with self-help groups, namely Ester women, Priscilla women, Good Samaritan women, Luda women of Ngayok Marup, Saikot and other women fisher self-help groups of Moulvaiphei village of Churachandpur, Pherzawl districts of Manipur and fishers of Korag, were addressed in a congregation of more than 1000 participants. Meetings in this regard were held with VC of CAU, Imphal, Dr. Prem Chand Singh, all the fisheries Inspectors of Manipur, and also with the Fisheries Minister of Govt. of Manipur.

X. Food Safety and Standards Authority of India (FSSAI) Project

17. Monitoring of heavy metal in finfish and shellfish species along Indian coast and possible mitigation measures

The project was initiated in August 2018 with funding support from Food Safety and Standards Authority of India (FSSAI) and being operated from ICAR-CIFT, Kochi and Fisheries College and Research Institute, TNJFU, Thoothukudi. So far 800 number of samples have been collected from Ernakulam, Palakkad, Malappuram, Kanyakumari, Idukki, Kottayam and Thoothukudi (both freshwater and marine environments) and 610 samples have been analyzed.

Methods for determination of heavy metals (Lead, Cadmium, Mercury, Arsenic, Selenium, Chromium, Zinc and Nickel) in ICP-MS were standardized, optimized, validated and accredited as per ISO:17025 requirements. Also, method for determination of methyl mercury by a hyphenated system HPLC-ICP-MS was developed and accredited as per ISO:17025 provisions.

Highest bioaccumulation of Lead (Pb) was observed in finfish (0.12 ppm), followed by crustaceans (0.07 ppm) and mollusc (0.03 ppm). Cadmium was observed at moderate levels in molluscs (0.23 ppm) and crustaceans (0.2 ppm). In swordfish (*Xiphias gladius*) samples, the levels of mercury was detected as high as 1.8 ppm, much above the FSSR prescribed limit of 1.0 ppm.

General Information

(1 April, 2018 to 31 March, 2019)

PUBLICATIONS

Papers Published in Refereed Journals

Sl. No.	Title of the Publication	Identifier to Krishi Data Repository
1	Alfiya, P.V., Murali, S., Anisrani Delfiya, D.S. and Manoj P. Samuel (2018) Empirical modeling of drying characteristics of elongate glassy perchlet (*Chanda nama*) (Hamilton, 1822) in solar hybrid dryer. Fish. Technol. 55(2): 138-142	http://krishi.icar.gov.in/jspui/handle/123456789/20429
2	Alfiya, P. V., Murali, S., Aniesrani Delfiya, D. S. and Manoj P. Samuel (2019) Development of an energy efficient portable convective fish-dryer. Fish. Technol. 56(1): 74-79	http://krishi.icar.gov.in/jspui/handle/123456789/20425
3	Ahana Mohan and P. Muhamed Ashraf (2019) Biofouling control using nano silicon dioxide reinforced mixed charged zwitterionic hydrogel in aquaculture cage nets. Langmuir. DOI: 10.1021/acs.langmuir.8b04071	http://krishi.icar.gov.in/jspui/handle/123456789/20384
4	Ahmed Basha, K., Joseph, T. C., Lalitha, K. V.,Vineetha, D., Rathore, G., Gayatri Tripati and Pani Prasad, K. (2018) Nitrification potential of *Achromobacterxylos oxidans* isolated from fresh water finfish farms of Kerala, India. Int. J. Curr. Microbiol. Appl. Sci. 7(8):2645-2654	http://krishi.icar.gov.in/jspui/handle/123456789/20340
5	Ajeeshkumar, K. K., Vishnu, K. V., Navneethan, R., Kumar Raj, Remyakumari, K. R., Swaminathan, T. R., Suseela Mathew, Asha, K. K. and Sreekanth G. P. (2019) Proteoglycans isolated from the bramble shark cartilage show potential anti-osteoarthritic properties. Inflammopharmacology. 27(1): 175-187	http://krishi.icar.gov.in/jspui/handle/123456789/20355
6	Arathy Ashok and Raghu Prakash, R. (2019) Stakeholder preference towards conservation of marine mega fauna: olive ridley turtle (*Lepidochelys olivacea*) (Eschscholtz, 1829) Conservation Dilemma in Odisha. Fish. Technol. 56 (2): 158-163	http://krishi.icar.gov.in/jspui/handle/123456789/20359

7	Asha, K. K., Ajeesh kumar, K. K., Chatterjee, N. S., Anandan, R. and Mathew, S. (2018) Microencapsulation of β-Carotene with Vanillic Acid Grafted Chitosan Improves Stability and Glutathione Content in Rats. Clinical Journal of Nutrition and Dietetics. 1(1): 1-7	http://krishi.icar.gov.in/jspui/handle/123456789/20345
8	Benjamin, D., Harikrishnan, M., Rozario, J., Jose, D., Kurup, B., Sreedhar, U. and Cubelio, S. (2019) Reproductive traits of deep-sea armoured shrimp, *Glyphocrangon investigatoris* from Bay of Bengal, Indian Ocean. J. Mar. Biol. Assoc. UK. 99(1): 93-100. doi:10.1017/S0025315417001928	http://krishi.icar.gov.in/jspui/handle/123456789/20782
9	Bhaskaran, T. V., Nithin, C. T., Bindu, J., Gopal, T. K. S., Ashok Kumar, K. and Ravishankar, C. N. (2018) Drying fish preferences assessment and efficacy of semichemicals as repellents to blow fly *Chrysomyamega cephala* (F) (Diptera: Callipheridae) during sun drying of fish. Entomon. J. 43(3):157-164	http://krishi.icar.gov.in/jspui/handle/123456789/20339
10	Bhaskaran, T. V., Nithin, C. T., Bindu, J., Gopal, T. K. S., Ashok Kumar, K. and Ravishankar, C. N. (2018) Identifcation of volatile organic compounds with reference to water activity in salt cured and sun dried Indian mackerel (*Rastrelliger kanagurta*) by Headspace Gas Chromatography and Mass Spectrometry (HS-GCMS). Indian J. Fish. 65(3): 66-73	http://krishi.icar.gov.in/jspui/handle/123456789/20354
11	Binsi, P. K., Natasha Nayak, Sarkar, P. C., Upali Sahu, Lalitha, K. V., George Ninan and Ravishankar, C. N. (2019) Conversion of carp roe mass to caviar substitutes: Stabilization with oregano extract. LWT Food Sci. Technol. 108: 446-455	http://krishi.icar.gov.in/jspui/handle/123456789/20373
12	Chinnadurai, S., Paras Nth Jha, R. K. Renjith, M. P. Remesan and Saly N. Thomas (2018) Depredation in gillnets operated along the south west coast of India. Indian J. Fish. 65(4): 154-156	http://krishi.icar.gov.in/jspui/handle/123456789/20351
13	Chinnadurai, S., Jagadis, I., Meenakshi, V. K. and Mohamed, K. S. (2018) Effect of Acetic acid treatment on the control of non-indigenous ascidians in farmed Indian pearl oyster Pinctadafucata. J. Mar. Biol. Ass. India. 60 (2)	http://krishi.icar.gov.in/jspui/handle/123456789/20358
14	Danielle, F., Safeena, S. A., Manju Lekshmi, N., Chaki, S., Sreekanth, G.B. and Singh, N.P. (2018) Evaluation of Natural Carotenoid Sources from Rosa hybrida Varieties on Growth and Pigmentation of Gold fish (*Carassius auratus* L.) Natl. Acad. Sci. Lett. 1–6. https://doi.org/10.1007/s40009-018-0738-7	http://krishi.icar.gov.in/jspui/handle/123456789/14213
15	Daniel, N., Muralidhar, A. P., Srivastava, P. P., Jain, K. K., Pani Prasad, K., Anandan, R. and Manish, J. (2018) Influence of vitamin C on hematology of *Pangasianodon hypophthalmus* (Sauvage, 1878) juveniles during pre and post-challenge with *Aeromonas hydrophila* (Chester,1901), Fish. Technol. 55(2): 120-12	http://krishi.icar.gov.in/jspui/handle/123456789/20624
16	Deepjyoti Baruah, Apurba Bhuyan, Amalesh Dutta, M. Baiju, P. S. Nobi and P. Pravin (2018) Clap net Operation in Brahmaputra Valley for Capturing *Tenualosa ilisha* (Hamilton, 1822). Fish. Technol. 55 : 238-243	http://krishi.icar.gov.in/jspui/handle/123456789/20612

17	Devananda Uchoi, M. D. Hanjabam, Anuj Kumar, Pankaj Kishore, S. K. Panda and B. B. Nayak (2018) Assessment of Potential Hazards in Shidal, an Ethnic Fermented Fish Product of North-East India. Fish. Technol. 55: 262 - 269	http://krishi.icar.gov.in/jspui/handle/123456789/20611
18	Dhiju Das, P.H., Sruthi, P., Nikita Gopal and Leela Edwin (2018) Seasonal growth and instability of ring seine fishery in Kerala, Fish. Technol. 55(3): 168-172	http://krishi.icar.gov.in/jspui/handle/123456789/20619
19	Divya K. Vijayan, Sreerekha, P.R., Tejpal, C. S., Asha K. K., Mathew, S., Ravishankar, C. N. and Anandan, R. (2018). Extraction and characterization of acid soluble collagen (ASC) from airbladder of striped cat fish (*Pangasius hypophthalmus*). Int. J. Fish. Aquat. Stud. 6(4): 310-318	http://krishi.icar.gov.in/jspui/handle/123456789/19326
20	Fathima, P. E., Panda, S. K., Muhamed Ashraf, P.,Varghese, T. O. and Bindu, J. (2018) Polylactic acid/chitosan films for packaging of Indian white prawn (*Fenneropenaeus indicus*). Int. J. Biol. Macromolecules. 117:1002-1010	http://krishi.icar.gov.in/jspui/handle/123456789/20393
21	Femeena Hassan and Joshy, C.G. (2018) Comparison of flake ice and gel ice in the preservation of *Lethrinus lentjan* (Lacepede, 1802) fillets, Fish. Technol. 55(3): 197-204	http://krishi.icar.gov.in/jspui/handle/123456789/20873
22	Indra Singh, Rajib Deb, Sanjeev Kumar, Rani Singh, Jerome Andonissamy, Shuchi Smita, Sengar, G. S., Rajiv Kumar, Ojha, K.K., Sahoo, N.R., Murali, S., Rejani Chandran, Radhakrishnan Nair, V., Balal, S., Mishra, D.C. and Anil Rai (2019) Deciphering foot-and – mouth disease (FMD) virus-host tropism, J. Biomol. Struct. Dyn. DOI:10.1080/07391102.2019.1567	http://krishi.icar.gov.in/jspui/handle/123456789/20725
23	Jeyakumari, A., Murthy, L. N. and Visnuvinayagam, S. (2018) Biochemical and microbiological quality changes of Indian oil sardine (*Sardinella longiceps*) stored in flake ice and dry ice, Int. J. Curr. Microbiol. Appl. Sci. 7(8): 2758-2765	http://krishi.icar.gov.in/jspui/handle/123456789/20623
24	Jeyakumari, A., Zynudheen, A.A., Parvathy, U. and Binsi, P.K. (2018) Impact of chitosan and oregano extract on the physicochemical properties of micro-encapsulated fish oil stored at different temperature, Intl . Food Prop. 21(1): 942–955	http://krishi.icar.gov.in/jspui/handle/123456789/20404
25	Jeyakumari, A., Murthy, L. N., Visnuvinayagam, S. and Ravishankar, C. N. (2018) A comparative study on the quality changes of croaker (*Johnius dussumieri*) fish stored in slurry ice and flake ice. J. Aquat. Food Product Technol. 27(4): 508-517	http://krishi.icar.gov.in/jspui/handle/123456789/7521
26	Jha, G. K., Suresh, A., Punera, B. and Supriya, P. (2019) Growth of horticulture sector in India: Trends and prospects, Indian J. Agricult. Sci. 89 (2):314–21	http://krishi.icar.gov.in/jspui/handle/123456789/20603
27	Jose Fernandez, T., Anandan R. and Zynudheen, A. A. (2018) A comparative evaluation of nutritional composition of deep sea and coastal shrimp off south-west coast of India, Fish. Technol. 55(3): 188-196	http://krishi.icar.gov.in/jspui/handle/123456789/20396

28	Joshy, C. G., Balakrishna, N. and Madhu, V. R. (2018) Local polynomial regression estimation of trawl size selectivity parameters using genetic algorithm. Indian J. Fish. 65(3): 25-32	http://krishi.icar.gov.in/jspui/handle/123456789/20811
29	Joshy, C. G., Balakrishna, N., George Ninan and Ravishankar, C. N. (2018) Accelerated shelf life prediction models with correlated errors for bio-chemical and sensory responses of chill stored fish. J. Indian Soc. Agricult. Stat. 72(2):129–140	http://krishi.icar.gov.in/jspui/handle/123456789/20729
30	Kamalakanth, C. K. Srinivasa Gopal, T. K. and Joshy, C. G. (2018) Thermal processing characteristics and storage studies of ready-to-eat fish-incorporated noodles in semi-rigid container. J. Packag. Technol. Res.https://doi.org/10.1007/s41783-018-0042-5	http://krishi.icar.gov.in/jspui/handle/123456789/20614
31	Laly, S. J., Priya, E. R., Panda, S.K. and Zynudeen, A. A. (2018) Formaldehyde in seafood: A review. Fish. Technol. 55(2): 87-93	http://krishi.icar.gov.in/jspui/handle/123456789/20617
32	Laly, S. J., Jeyakumari, A., Ashok Kumar, K., Sankar, T.V., Lalitha, K.V. and George Ninan (2019) Formation of biogenic amines and associated biochemical and microbial attributes of whole sutchi catfish (*Pangasianodon hypophthalmus*) during Iced Storage, J. Aquat. Food Prod. Technol. DOI: 10.1080/10498850.2019.1572683	http://krishi.icar.gov.in/jspui/handle/123456789/20602
33	Madhusudana Rao, B. (2019) Microplastics in the aquatic environment-implications for post-harvest fish quality, Indian J. Fish. 66(1): 142-152	http://krishi.icar.gov.in/jspui/handle/123456789/20726
34	Manoj P. Samuel, Kalpana Sastry, R. and Sai Pavani (2018) A strategic framework for technology valuation in agriculture and allied sectors in India – case study of chitosan. J. Int. Prop. Rights. 23: 131-140	http://krishi.icar.gov.in/jspui/handle/123456789/20629
35	Manoj P. Samuel and Senthilvel, S. (2018) Hydrodynamic evaluation of irrigation efficiency through rain gun sprinkling, Indian J. Soil Conserv. 46(1): 77-84	http://krishi.icar.gov.in/jspui/handle/123456789/20780
36	Mathew, A.C., Thamban, C. and Manoj P. Samuel (2018) Efficacy of water conservation measures in coconut plantations to enhance ground water resource and coconut yield in West Coast region. J. Plant. Crops. 46(1): 12-20	http://krishi.icar.gov.in/jspui/handle/123456789/20779
37	Minimol, V.A., Balange, A.K., Nayak, B.B. and Sanath Kumar (2018) Distribution of potentially pathogenic *Vibrio parahaemolyticus* in seafood and the aquatic environment in Mumbai, India. Fish. Technol. 55(3): 205-211	http://krishi.icar.gov.in/jspui/handle/123456789/20437
38	Mohan, C.O., Ashitha, V.A., Pankaj Kishore, Panda, S.K. and Ravishankar, C.N. (2018) Influence of mono and multi-layered packaging material on the quality of seerfish (*Scomberomorus commerson*) during chilled storage, J. Packag. Technol. Res. 2 (1): 67-76	http://krishi.icar.gov.in/jspui/handle/123456789/15294
39	Mohan, C. O., Abin, J., Pankaj Kishore, Panda, S.K. and Ravishankar, C.N. (2019) Effect of vacuum and active packaging on the biochemical and microbial quality of Indian oil Sardine (*Sardinella longiceps*) during iced storage. J. Packag. Technol. Res. 3(1): 43-55	http://krishi.icar.gov.in/jspui/handle/123456789/20349

40	Mohan, C. O., Ravishankar., C. N., Ashok Kumar, K. and Gopal, T.K.S. (2019) Biogenic amines and nucleotide breakdown products of sodium acetate, sodium lactate, and sodium citrate treated seer fish (*Scomberomorus commerson*) during iced storage. J. Food Saf. 39(3): e12633	http://krishi.icar.gov.in/jspui/handle/123456789/20375
41	Mohan, C. O., Gunasekaran, S. and Ravishankar, C. N. (2019) Chitosan-capped gold nano particles for indicating temperature abuse in frozen stored products. npj science of food 3 (2): 1-6	http://krishi.icar.gov.in/jspui/handle/123456789/20348
42	Muhamed Ashraf, P. (2019) Nano CuO incorporated Polyethylene Glycol hydrogel coating over surface modified polyethylene aquaculture cage nets to combat biofouling. Fish. Technol. 56(1):115 - 124	http://krishi.icar.gov.in/jspui/handle/123456789/20356
43	Naik, R.N, Ghosh, S., Sreedhar, U.,Jaiswar, A.K and Shenoy, L. (2019) Length-weight relationship of selected commercially important marine fishes from east coast of India. J. Entomol. Zool. Stud. 7(1): 1650-1652	http://krishi.icar.gov.in/jspui/handle/123456789/20727
44	Nashad, M., Shirke Swapnil Shirke, Pradeep H.D. and Devi Monalisha S. (2018) First record of escolar, *Lepidocybium flavobrunneum*, (Smith, 1843) from the Indian EEZ of Andaman Sea. Indian J. Geo Mar. Sci. 47 (07): 1409-1412	http://krishi.icar.gov.in/jspui/handle/123456789/20610
45	Nithin, C. T., Joshy, C. G., Chatterjee, N. S., Panda, S. K.,Yathavamoorthi, R., Ananthanarayanan, T. R., Suseela Mathew., Bindu, J. and Srinivasa Gopal, T. K. (2018) Liquid smoking as a method for addressing polycyclic aromatic hydrocarbons (PAH) in traditional masmin. Indian J. Fish. 65(3): 84-94	http://krishi.icar.gov.in/jspui/handle/123456789/20472
46	Pandiselvam, R., Manikantan M. R., Sunoj S., Sreejith S. and Shameena Beegum (2018) Modeling of coconut milk residue incorporated rice-corn extrudates properties using multiple linear regression and artificial neural network. J. Food Process Eng. e12981. https://doi.org/10.1111/jfpe.12981	http://krishi.icar.gov.in/jspui/handle/123456789/20609
47	Parvathy, U., A. A. Zynudheen, L. N. Murthy, A. Jeyakumari and S. Visnuvinayagam (2018) Characterization and profiling of protein hydrolysates from white and red meat of tuna (*Euthynnus affinis*). Fish. Technol. 55 : 248 - 257	http://krishi.icar.gov.in/jspui/handle/123456789/20608
48	Parvathy, U., P. K. Binsi, A. A. Zynudheen, George Ninan and L. N. Murthy (2018). Peptides from white and red meat of yellowfin tuna (Thunnus albacares): A comparative evaluation. Indian J. Fish., 65(3): 74-83	http://krishi.icar.gov.in/jspui/handle/123456789/20630
49	Parvathy, U., P. K. Binsi, Joshy, C. G., Jeyakumari, A., Zynudheen, A. A., George Ninan and Ravishankar , C. N. (2018) Functional Hydrolysates from Yellow Fin Tuna Red Meat Using RSM Based Optimization. Int.J.Curr.Microbiol.App.Sci 7(11): 1462-1474	http://krishi.icar.gov.in/jspui/handle/123456789/20760
50	Parvathy U., Binsi P.K., Jeyakumari, A., George Ninan, Zynudheen, A. A. and Ravishankar , C. N (2019) Tuna red meat hydrolysate as core and wall polymer for fish oil encapsulation: a comparative analysis. J Food Sci Technol. 1–13 https://doi.org/10.1007/s13197-019-03694-w	http://krishi.icar.gov.in/jspui/handle/123456789/19328

51	Parvathy, U., P. K. Binsi, Jeyakumari, A., Joshy, C. G., Zynudheen, A. A., George Ninan and Ravishankar , C. N. (2019) Selective extraction of surface-active and antioxidant hydrolysates from yellowfin tuna red meat protein using papain by response surface methodology. The Indian Journal of Nutrition and Dietetics. DOI:10.21048/ijnd.2019.56.1.22125	http://krishi.icar.gov.in/jspui/handle/123456789/20448
52	Parvathy, U., Sathish Kumar,K., Binsi, P.K., Lijin Nambiar, George Ninan and Zynudheen, A. A.(2019) Effect of Anaesthetics, Temperature and Aeration in Live Transportation of Tilapia (*Oreochromis mossambicus*) (Peters, 1852). Fish. Technol. 56 : 38-43	http://krishi.icar.gov.in/jspui/handle/123456789/20613
53	Praveen, K.V., Suresh, A., Reddy, A.A. and Singh, D.R. (2018) Risks and adaptation strategies in rainfed agriculture in India: An analysis, Indian J. Agricult. Sci. 88(6): 958-63	http://krishi.icar.gov.in/jspui/handle/123456789/20615
54	Raghavendra, K.J. and A. Suresh (2018) Risk management in rainfed agriculture: An analysis of strategies and adaptations followed by farmers in Madhya Pradesh, Indian J. Agricult. Sci. 88 (6): 895-901	http://krishi.icar.gov.in/jspui/handle/123456789/20368
55	Rajisha, R., Pankaj Kishore, Panda, S.K. and Ashok Kumar, K. (2018) Ciguatoxin – An emerging biological hazard among reef fishes of India, Fish. Technol. 55(3): 153-167	http://krishi.icar.gov.in/jspui/handle/123456789/20456
56	Ranjith Kumar, N., Prasanna Kumar, P., Siddaiah, G.M., Murugadas, V., Basha, K.A., Sivaraman, G.K. and Prasad, M.M. (2018) – Effect of different organic acids on survival of larvae and control of water microflora in milkfish (*Chanos chanos*) hatchery system, Fish. Technol. 55(2): 128-137	http://krishi.icar.gov.in/jspui/handle/123456789/20616
57	Ranjit Kumar, N., Archana, K. K., Basha, K. A., Muthulakshmi, T., Joseph, T. C. and Prasad, M. M. (2018) Isolation and Identification of Sulphur Oxidizing Bacteriafrom Freshwater Fish Farm Soil. Fish. Technol. 55 : 270 – 275	http://krishi.icar.gov.in/jspui/handle/123456789/20618
58	Ranjit Kumar Nadella, Murugadas Vaiyapuri, Ahamed Basha Kusunur, Toms Cheraith Joseph, Lalitha Kuttanappilly Velayudhan and Mukteswar Prasad Mothadaka (2018) Biosurfactant production by *Pseudomonas aeruginosa* isolated from aquaculture farm soil and its optimisation. Indian J. Fish. 65(4): 127-134	http://krishi.icar.gov.in/jspui/handle/123456789/20338
59	Ratheesh Kumar, Dineshbabu, Jaiswar, A. K., Shukla, S. P., Manju Lekshmi, N., Sreekanth, G.B., Nakhwa, A.D. and Singh, V.V. (2018) Temporal variations in phytoplankton assemblages at dol net fishing grounds of Maharashtra, J. Curr. Microbiol. Appl. Sci. 7(6): 465-480	http://krishi.icar.gov.in/jspui/handle/123456789/20622
60	Rehana Raj, Raju, C. V. and Lakshmisha, I. P. and Jagpal (2018) Nutritional and Biochemical Properties of Fish Silage Prepared as an Ingredient in Poultry Feed. Int. J.Curr.Microbiol.App. Sci .7(5): 423-428	http://krishi.icar.gov.in/jspui/handle/123456789/20334
61	Remya, S., Mohan, C. O., Ravishankar, C. N., Sivaraman, G. K., Jha, A. K. and Venkateswaralu, G. (2018) Effect of active packaging atmosphere on the shelf life of chilled stored steaks of barracuda *Sphyraena jello*. Indian J. Fish. 65(4): 109-115	http://krishi.icar.gov.in/jspui/handle/123456789/20461

62	Renjith, R.K., Jaiswar, A.K., Chakraborty, S.K., Rajendran, K.,V., Landge, A.T. and Sreekanth, G.B. (2018) First record of anophthalmic large scale terapon, *Terapon theraps* (Cuvir, 1829) in trawl landings from Versova, Mumbai, India, Int. J. Curr. Microbiol. Appl Sci. 7(5): 429-432	http://krishi.icar.gov.in/jspui/handle/123456789/20621
63	Sajesh, V. K., Suresh, A., Mohanty, A. K., Sajeev, M. V., Ashaletha, S., Rejula, K. and Ravishankar, C. N. (2018) Trend and Pattern of Expenditure on Fisheries Extension in India: Implications for Policy. Indian J. Ext. Edu. 5(2):32-40	http://krishi.icar.gov.in/jspui/handle/123456789/20810
64	Sajesh, V.K. and Padaria, R. N. (2019) Farmers' extension priorities and service quality of extension agencies: Evidences from Maharashtra state of India. Indian J. Agricult. Sci.89 (3): 534–9	http://krishi.icar.gov.in/jspui/handle/123456789/20366
65	Sajesh, V. K., Padaria, R. N. and Sadamate, V.V. (2018) Pluralism in Agricultural Extension in India: Imperatives and Implications, Economic Affairs. 63 (4):1017-1025	http://krishi.icar.gov.in/jspui/handle/123456789/20604
66	Sajeev, M.V. and Saroj, P.L. (2018) - Socio-economic determinants and adoption of pest management practices in cashew farming: A study in Dakshina Kannada, Karnataka. J. Plant. Crops. 46(1): 66-73	http://krishi.icar.gov.in/jspui/handle/123456789/20606
67	Sarkar, Muhamed Ashraf, P., Sira Srinivas and Ashok Mulchandani (2018) Caixarene-functionalized single-walled carbon nanotubes for sensitive detection of volatile amines, Sensors & Actuators B, 268:115-122	http://krishi.icar.gov.in/jspui/handle/123456789/13010
68	Sathish Kumar, K., Chrisolite, B., Vijayarahavan Vetri, Aranand S.S. and Kaliyamurthi Venkatachalam (2019) Nutritional, textural and quality attributes of white and dark muscles of little tuna (*Euthynnus affinis*). Indian J. Geo Mar. Sci. 48 (02): 205-211	http://krishi.icar.gov.in/jspui/handle/123456789/20781
69	Sayana, K. A., M. P. Remesan and Leela Edwin (2018) Impact of operational parameters on drag of trawl nets. Fish. Technol. 55: 295-297	http://krishi.icar.gov.in/jspui/handle/123456789/20350
70	Sreedevi, K. H., James, J.P., Bindu, J, Sreejith, S. and Nikita Gopal (2018) – Chilled storage studies of depurated cooked clam meat in two different packaging materials, Fish. Technol. 55(2): 114-119	http://krishi.icar.gov.in/jspui/handle/123456789/20449
71	Sreelakshmi, K.R., Rehana Raj., Renjith, R. K., Sarika, K., Greeshma, S.S., Minimol, V.A., Ashok Kumar, K. and George Ninan (2019) Quality and Shelf Life Assessment of Puffer Fish (*Lagocephalus guentheri*) Fillets during Chilled Storage, J. Aquat. Food Prod. Technol. 28:1, 25-37, DOI: 10.1080/10498850.2018.1559905	http://krishi.icar.gov.in/jspui/handle/123456789/20386
72	Sreejith, S., James, J. P., Gokuan, C.R., Bindu, J and Nikita Gopal (2018) Design and fabrication of a modified model of indigenous meat-shell separator machine for small scale clam processing units. Fish. Technol.	http://krishi.icar.gov.in/jspui/handle/123456789/20432
73	Sumi, E. S., Anandan, R., Rajesh, R., Ravishankar, C. N. and Suseela Mathew (2018) Nutraceutical and therapeutic applications of squalene. Fish. Technol. 55: 229 – 237	http://krishi.icar.gov.in/jspui/handle/123456789/20607
74	Suresh, A. and Shinoj Parappurathu (2018) Capital formation in fisheries sector in India: trends, compositional changes and potential implications for sustainable development. Agricult. Econ. Res. Rev. 31 (2): 111-122	http://krishi.icar.gov.in/jspui/handle/123456789/20439

75	Suresh, A., V. K. Sajesh, A. K. Mohanty, C.N. Ravishankar, M. P. Mohanan and C. D. Joshy (2018) Safety of fisherfolk at seas: Points for Critical Intervention, Economic and Political Weekly 53 (3): 16-19	http://krishi.icar.gov.in/jspui/handle/123456789/20453
76	Suresh, A., V.K. Sajesh, A.A. Zynudheen, P.K. Binsi, S. Ashaletha and A.K. Mohanty (2018) Utilisation of biowaste from fish: Economic Potential and implications for policy, Indian J. Agricult. Econ. 72(3)	http://krishi.icar.gov.in/jspui/handle/123456789/20885
77	Vijayan, D. K., Raman, S. P., Krishnamoorthy, E., Mathew, S., C.N. Ravishankar and Anandan, R. (2018) Determination of Electrophoretic Subunit Pattern and Peptide Mapping of Collagen and Collagen Peptides Extracted from Skin of Hammer Head Shark (*Sphyrnae mokkaran*). SciFed J. Analyt. Biochem. 1(3)	http://krishi.icar.gov.in/jspui/handle/123456789/19327
78	Viji, P., Madhusudana Rao, B., Jesmi Debbarma and Prasad, M.M. (2018) Control of melanosis and spoilage during chilled storage of pacific white shrimp (*Penaeus vannamei*) using sulphite alternatives. Indian J. Fish. 65(3): 135-139	http://krishi.icar.gov.in/jspui/handle/123456789/20778
79	Viji P., Shamuka Sai, K.S., Jesmi Debbarma, Dhiju Das P.H., Madhusudana Rao, B. and Ravishankar, C.N. (2019) Evaluation of physicochemical characteristics of microwave vacuum dried mackerel and inhibition of oxidation by essential oils. J. Food Sci. Technol. DOI: 10.1007/s13197-019-03651-7	http://krishi.icar.gov.in/jspui/handle/123456789/20454
80	Vipin, P.M., Harikrishnan, M., Renju Ravi, Boopendranath, M.R. and Remesan, M.P. (2018) Population dynamics of Spinycheek lantern fish (*Benthosema fibulatum*) (Gilbert and Cramer, 1897) caught off the south-west coast of India, Asian Fish. Sci. 31: 161-171	http://krishi.icar.gov.in/jspui/handle/123456789/20620
81	Vishnu, K.V., Kumar, K.A., Chatterjee, N.S., Lekshmi, R.G.K., Sreerekha, P.R., Mathew S, Ravishankar, C.N. (2018) Sardine oil loaded vanillic acid grafted chitosan microparticles, a new functional food ingredient: Attenuates myocardial oxidative stress and apoptosis in cardiomyoblast cell lines (H9c2). Cell Stress and Chaperones, 23(2):213-22	http://krishi.icar.gov.in/jspui/handle/123456789/20605
82	Zynudheen, A. A., Lijin Nambiar, M. M., Rahul Ravindran, Anandan, R. and George Ninan (2019) Nutritional Quality Evaluation of Feeds Developed from Secondary Raw Material from Fish Processing Industry. Fish. Technol. 56 (1) : 125 – 129	http://krishi.icar.gov.in/jspui/handle/123456789/20364

BOOKS

Sl. No.	Title of the Publication	Identifier to Krishi Data Repository
1	Murthy, L.N., Girija Phadke and Rajanna Karani (2019) An approach to utilization of Bull'seye fish (*Priacanthus hamrur*) -A concept of effective utilization of fish mince and value addition, Lap Lambert Academic Publishers, Germany, 108 p	http://krishi.icar.gov.in/jspui/handle/123456789/20893
2	Nikita Gopal, Neelima, M.V., Harsha, K., Sajesh, V.K., Arathy Ashok, Bindu, J., Sreejith, S., Sumisha Velloth, Pillai, N.G.K. and Jeyakumar, A. (2018) Traditional knowledge in marine fisheries of Kerala, ICAR-CIFT, Kochi, 100 p	http://krishi.icar.gov.in/jspui/handle/123456789/20792
3	Ramesha, T.J., Prasad, M.M., Murthy, L.N. and Jimmy Mize (Eds.) (2018) Community smoking of fish – A sustainable livelihood approach for tribal fisherfolk, KrishiVigyan Kendra, Lower Dibang Valley, Arunachal Pradesh, 28 p	http://krishi.icar.gov.in/jspui/handle/123456789/20746
4	Viji, P. and Prerna Pandey (2019) Natural additives in fish processing. Delve Publishing, Canada, 309 p	http://krishi.icar.gov.in/jspui/handle/123456789/20954

BOOK CHAPTERS

Sl. No	Title of the Publication	Identifier to Krishi Data Repository
1	Abhay Kumar, Murthy, L. N. and Jeyakumari, A. (2018) Microbial quality of seafood and its safety. In: Training Manual on Microbiological Examination of Seafood Pathogens with special reference *V. mimicus* & *V. valnificus*. Murthy, L.N., Abhay Kumar, Jeyakumari, A. and Ezhil Nilavan, S. (Eds.) ,Mumbai Research Centre of ICAR-Central Institute of Fisheries Technology, Vashi, India. pp 5-10	http://krishi.icar.gov.in/jspui/handle/123456789/20722
2	Abhay Kumar, Murthy, L. N. and Jeyakumari, A. (2018) Sterilization technique used in microbiology. In: Training Manual on Microbiological examination of seafood pathogens with special reference *V. mimicus* & *V. valnificus*. Murthy, L.N., Abhay Kumar, Jeyakumari, A. and EzhilNilavan, S. (Eds.), Mumbai Research Centre of ICAR- Central Institute of Fisheries Technology, Vashi, India. pp 11-13	http://krishi.icar.gov.in/jspui/handle/123456789/20721

3	Abhay Kumar, Murthy, L. N. and Jeyakumari, A. (2018) Do's and do not's in the microbiology laboratory. In: Training Manual on Microbiological examination of seafood pathogens with special reference *V. mimicus* & *V. valnificus*. Murthy, L.N., Abhay Kumar, Jeyakumari, A. and Ezhil Nilavan, S. (Eds.) ,Mumbai Research Centre of ICAR- Central Institute of Fisheries Technology, Vashi, India. pp 14-15	http://krishi.icar.gov.in/jspui/handle/123456789/20720
4	Abhay Kumar, Murthy, L. N. and Jeyakumari, A. (2018) Plating techniques in isolation of micro-organisms. In: Training Manual on Microbiological examination of seafood pathogens with special reference *V. mimicus* & *V. valnificus*. Murthy, L. N., Abhay Kumar, Jeyakumari, A. and Ezhil Nilavan, S. (Eds.), Mumbai Research Centre of ICAR- Central Institute of Fisheries Technology, Vashi, India. pp 16-20	http://krishi.icar.gov.in/jspui/handle/123456789/20719
5	Abhay Kumar, Murthy, L. N. and Jeyakumari, A. (2018) Sampling of fish and fishery products. In: Training Manual on Microbiological examination of seafood pathogens with special reference V.mimicus & V.valnificus. Murthy, L. N., Abhay Kumar, Jeyakumari, A. and Ezhil Nilavan, S. (Eds.), Mumbai Research Centre of ICAR-Central Institute of Fisheries Technology, Vashi, India. pp 21-23	http://krishi.icar.gov.in/jspui/handle/123456789/20718
6	Anuj Kumar (2018) Seafood Biscuits. In: Training Manual on Seafood Value Addition. Sreelekshmi, K.R., Elavarasan, K., Mohan, C. O. and Ashok Kumar, K. (Eds.), ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 50-52	http://krishi.icar.gov.in/jspui/handle/123456789/20319
7	Anuj Kumar (2018) Seafood Biscuits. In: Training manual on 'Value addition of Seafood. Jesmi Debbarma, Viji, P., and Madhusudana Rao, B. (Eds.), ICAR-Central Institute of Fisheries Technology, pp 34-36	http://krishi.icar.gov.in/jspui/handle/123456789/20799
8	Asha, K. K., Suseela Mathew and Prasad, M. M. (2018) Iron-calcium fortified fish soup powder: a deterrent for malnutrition In: Suresh, A., Sajeev, M. V., Rejula, K. (Eds.) Extension Management Techniques for Up-Scaling Technology Dissemination in Fisheries, ICAR-Central institute of Fisheries Technology, Kochi, India. pp129-134	http://krishi.icar.gov.in/jspui/handle/123456789/20397
9	Ashaletha, S. (2018) Prospects of micro-financing in fisheries sector. In: Extension Management Techniques for Up-scaling Technology Dissemination in Fisheries (e-manual), Suresh, A., Sajeev, M.V., Rejula, K. and Mohanty, A.K. (Eds.) ICAR-Central Institute of Fisheries Technology, Cochin, India, pp 176-181	http://krishi.icar.gov.in/jspui/handle/123456789/20382
10	Ashaletha, S. (2018) Impact assessment of technologies. In: Advanced Statistical Methods and Computational Software for Fisheries Research and Management, Geethalakshmi, V. and Chandrasekar, V. (Eds.) (2018), Kochi, India, ICAR-Central Institute of Fisheries Technology. pp112-115	http://krishi.icar.gov.in/jspui/handle/123456789/20576

11	Anuj Kumar (2018) Biscuits with aquatic bioactive ingredients. In: Protocols for the production of high value secondary products from industrial fish and shellfish processing. Bindu, J., Sreejith, S., and Sarika, K. (Eds.), ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 159-162	http://krishi.icar.gov.in/jspui/handle/123456789/20507
12	Bindu J. (2018) Packaging of fishery byproducts. In: Protocols for the production of high value secondary products from industrial fish and shellfish processing. Bindu, J., Sreejith, S., and Sarika, K. (Eds.) , ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 175-182	http://krishi.icar.gov.in/jspui/handle/123456789/20488
13	Bindu, J. and Sreejith, S.(2018) Packaging of Seafood products. In: Training Manual on Seafood Value Addition. Sreelakshmi, K.R., Elavarasan, K., Mohan, C.O. and Ashok Kumar, K. (Eds.), ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 53-60	http://krishi.icar.gov.in/jspui/handle/123456789/20318
14	Bindu, J. (2018) Packaging of Seafood Products. In: Training manual on Value addition of Seafood. Jesmi Debbarma, Viji, P. and Madhusudana Rao, B. (Eds.), ICAR-Central Institute of Fisheries Technology, pp 37-45	http://krishi.icar.gov.in/jspui/handle/123456789/20798
15	Binsi, P. K. (2018) Overview of waste generation in fish and shellfish processing industry. In: Protocols for the production of high value secondary products from industrial fish and shellfish processing. Bindu, J., Sreejith, S., and Sarika, K. (Eds.), ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 18-27	http://krishi.icar.gov.in/jspui/handle/123456789/20489
16	Binsi, P. K. (2018) Chitins: Chitin and its derivatives. In: Protocols for the production of high value secondary products from industrial fish and shellfish processing. Bindu, J., Sreejith, S. and Sarika, K. (Eds.), Central Institute of Fisheries Technology, Cochin, India. pp 34-40	http://krishi.icar.gov.in/jspui/handle/123456789/20506
17	Binsi, P. K., Sreelakshmi, K.R. and K. Ashok Kumar (2018) Value added fish products In: Protocols for the production of high value secondary products from industrial fish and shellfish processing. Suresh, A., Sajeev, M.V., Rejula, K. (Eds.). Central institute of Fisheries Technology, Kochi, India. pp 47-57	http://krishi.icar.gov.in/jspui/handle/123456789/20557
18	Binsi, P.K., Viji, P. and Zynudheen, A. A. (2019) Chitins and its applications in seafood processing. In: Natural additives in fish processing, Viji Pankyamma and Prerna Pandey (Eds.)., Delve, publishing, 85-104	http://krishi.icar.gov.in/jspui/handle/123456789/20733
19	Binsi, P.K. (2018) Fish meal. In: Production and Quality evaluation of feed from fish waste. Binsi, P.K. and Zynudheen, A. A. (Eds.) ICAR-Central Institute of Fisheries Technology, pp 8-13	http://krishi.icar.gov.in/jspui/handle/123456789/20789

20	Chandrasekhar, V., Sajeev, M. V. and Nikita Gopal (2018) Matsyavashishtathilninnu matsytheetta pellet undakkunnathinulla cherukida samrambathinte sampathikarooparekha, In: Production and Quality evaluation of feed from fish waste. Binsi, P.K. and Zynudheen, A.A. (Eds.), ICAR- Central Institute of Fisheries Technology, India. pp 37-42	http://krishi.icar.gov.in/jspui/handle/123456789/20889
21	Chandrasekar, V., Geethalakshmi, V. and Nikita Gopal (2018) Linear Programming techniques for fisheries management. In: Advanced statistical methods and computational techniques for fisheries research and management. V. Geethalakshmi and V. Chandrasekar (Eds.), ICAR- Central Institute of Fisheries Technology, Kochi, India. pp 69-78	http://krishi.icar.gov.in/jspui/handle/123456789/20517
22	Chandrasekar, V., Geethalakshmi, V. and Nikita Gopal (2018) Methods for value chain analysis in fisheries. In : Advanced statistical methods and computational techniques for fisheries research and management, V. Geethalakshmi and V. Chandrasekar (Eds.), ICAR- Central Institute of Fisheries Technology, Kochi, India. pp 208-217	http://krishi.icar.gov.in/jspui/handle/123456789/20515
23	Chandrasekar, V., Geethalakshmi, V. and Nikita Gopal (2018) Data envelopment analysis. In : Advanced statistical methods and computational techniques for fisheries research and management, V. Geethalakshmi and V. Chandrasekar (Eds.), ICAR- Central Institute of Fisheries Technology, Kochi, India. pp 157-163	http://krishi.icar.gov.in/jspui/handle/123456789/20378
24	Chandrasekar, V., Geethalakshmi, V. and Nikita Gopal (2018) Economic valuation in fisheries – tools and techniques. In : Advanced statistical methods and computational techniques for fisheries research and management, V. Geethalakshmi and V. Chandrasekar (Eds.), ICAR- Central Institute of Fisheries Technology, Kochi, India. pp 143-147	http://krishi.icar.gov.in/jspui/handle/123456789/20523
25	Chandrasekar, V., Geethalakshmi, V. and Nikita Gopal (2018) Costing of fishery technologies developed through research for commercialization. In : Advanced statistical methods and computational techniques for fisheries research and management, V. Geethalakshmi and V. Chandrasekar (Eds.) (2018), ICAR- Central Institute of Fisheries Technology, Kochi, India. pp 57-68	http://krishi.icar.gov.in/jspui/handle/123456789/20377
26	Ejaz Parmar, Rahim, A., Remya, S., Rais M. Khadri and Arti Joshi (2018) Responsible and improved post harvest practices in the field of fisheries for food security and nutrition, In: Hemlata Pant, Srivastava, D. K., Preeti Singh, Swaroop, D. and Kamlesh Sing (Eds.), New approaches in agricultural, environmental and nutritional technology, SBSRD, Allahabad, 102p	http://krishi.icar.gov.in/jspui/handle/123456789/20886

27	Elavarasan, K. (2018) Protein hydrolysates from fish processing waste: Health benefits and their potential application. In: Bindu, J., Sreejith, S. and Sarika, K. (Eds.) Protocols for the production of high value secondary products from industrial fish and shellfish processing, ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 44-52	http://krishi.icar.gov.in/jspui/handle/123456789/20487
28	Elavarasan, K. (2018) The Structure and Quality of Fish Waste. In: Production and Quality evaluation of feed from fish waste. Binsi, P.K. and Zynudheen, A.A. (Eds.), ICAR-Central Institute of Fisheries Technology, pp 1-3	http://krishi.icar.gov.in/jspui/handle/123456789/20791
29	Elavarasan, K. (2018) Fish meal and oil from fish waste: An industrial perspective. In: Protocols for the production of high value secondary products from industrial fish and shellfish processing. Bindu, J., Sreejith, S., and Sarika, K. (Eds.) , Central Institute of Fisheries Technology, Cochin, India. pp 53-61	http://krishi.icar.gov.in/jspui/handle/123456789/20499
30	Elavarasan, K., Satish Kumar, K. and Mandakini, D.H. (2018) Surimi and surimi products. In: Protocols for the production of high value secondary products from industrial fish and shellfish processing. Bindu, J., Sreejith, S., and Sarika, K. (Eds.), Central Institute of Fisheries Technology, Cochin, India. pp 70-71	http://krishi.icar.gov.in/jspui/handle/123456789/20483
31	Elavarasan, K. (2018) Fish Sausage- A Ready to Eat Product. In: Training Manual on Seafood Value Addition. Sreelekshmi, K.R., Elavarasan, K., Mohan, C.O. and Ashok Kumar, K. (Eds.),Central Institute of Fisheries Technology, Cochin, India. pp 49	http://krishi.icar.gov.in/jspui/handle/123456789/20320
32	Elavarasan, K. (2018) Fish sausage- a ready to eat product. In: Training manual on 'Value addition of Seafood .Jesmi Debbarma, Viji, P. and Madhusudana Rao, B. (Eds.), ICAR-Central Institute of Fisheries Technology, pp 29-30	http://krishi.icar.gov.in/jspui/handle/123456789/20801
33	Ezhil Nilavan, S. (2018) Staining methods. In: Training Manual on Microbiological examination of seafood pathogens with special reference *V. mimicus* & *V. valnificus*. Murthy, L.N., Abhay Kumar, Jeyakumari, A. and Ezhil Nilavan, S. (Eds.), Mumbai Research Centre of ICAR-Central Institute of Fisheries Technology, Vashi, India. pp 37-44	http://krishi.icar.gov.in/jspui/handle/123456789/20714
34	Ezhil Nilavan, S. (2018) Isolation and identification of pathogenic vibrios from seafood. In: Training Manual on Microbiological examination of seafood pathogens with special reference *V. mimicus* & *V. valnificus*. Murthy, L. N., Abhay Kumar, Jeyakumari, A. and Ezhil Nilavan, S. (Eds.), Mumbai Research Centre of ICAR- Central Institute of Fisheries Technology, Vashi, India. pp 45-50	http://krishi.icar.gov.in/jspui/handle/123456789/20713

35	Ezhil Nilavan, S. (2018) Staining methods. In training manual on microbial examination of seafood with special reference to *Vibrio mimicus* and *Vibrio vulnificus*, In: ICAR- CIFT, MRC, pp 37-44	http://krishi.icar.gov.in/jspui/handle/123456789/20714
36	Geethalakshmi, V. (2018) Data needs in fisheries and computational software for fisheries research and management. In : Advanced statistical methods and computational techniques for fisheries research and management, V. Geethalakshmi and V. Chandrasekar (Eds.), (2018), Kochi, India, ICAR- Central Institute of Fisheries Technology, pp 17-22	http://krishi.icar.gov.in/jspui/handle/123456789/20455
37	Geethalakshmi, V. (2018) Data and computational needs in fisheries research and management. In: Extension management techniques for upscaling technology dissemination in fisheries, Suresh, A., Sajeev, M.V. and Rejula, K. (Eds.),ICAR- Central Institute of Fisheries Technology, Cochin, pp 182-87	http://krishi.icar.gov.in/jspui/handle/123456789/20480
38	Geethalakshmi, V. (2018) Introduction to R software and basic statistical data analysis. In: Advanced statistical methods and computational techniques for fisheries research and management, V. Geethalakshmi and V. Chandrasekar (Eds.), (2018), Kochi, India, ICAR- Central Institute of Fisheries Technology, pp 50-56	http://krishi.icar.gov.in/jspui/handle/123456789/20518
39	Geethalakshmi, V. (2018) Sampling Techniques for fisheries data collection. In: Advanced statistical methods and computational techniques for fisheries research and management, V. Geethalakshmi and V. Chandrasekar (eds.), (2018), Kochi, India, ICAR- Central Institute of Fisheries Technology, pp 132-142	http://krishi.icar.gov.in/jspui/handle/123456789/20568
40	Geethalakshmi, V. (2018) Multivariatedata analysis and data reduction techniques. In: Advanced statistical methods and computational techniques for fisheries research and management, V. Geethalakshmi and V. Chandrasekar (eds.), (2018), Kochi, India, ICAR- Central Institute of Fisheries Technology, pp 218-225	http://krishi.icar.gov.in/jspui/handle/123456789/20514
41	George Ninan (2018) Specialty Products from Shrimp. In: Training Manual on Seafood Value Addition. Sreelekshmi, K.R., Elavarasan, K., Mohan, C.O. and Ashok Kumar, K. (Eds.), Central Institute of Fisheries Technology, Cochin, India. pp 45-48	http://krishi.icar.gov.in/jspui/handle/123456789/20321
42	George Ninan (2018) Specialty Products from Shrimp. In: Training Manual on Value addition of Seafood. Jesmi Debbarma, Viji, P. and Madhusudana Rao, B. (Eds), ICAR-Central Institute of Fisheries Technology, pp 25-28	http://krishi.icar.gov.in/jspui/handle/123456789/20802

43	George Ninan (2018) Freezing and Frozen Storage of Fish and Shellfish Products. In: Training Manual on Seafood Value Addition. Sreelekshmi, K.R., Elavarasan, K., Mohan, C.O. and Ashok Kumar, K. (Eds.), ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 27-36	http://krishi.icar.gov.in/jspui/handle/123456789/20323
44	George Ninan and Shyni, K. (2019) Gelatin: Extraction, properties and applications. In: Natural additives in fish processing, Viji, P. and Prerna Pandey (Eds.), Delve Publishing, Canada, pp 135-170	http://krishi.icar.gov.in/jspui/handle/123456789/20731
45	Jesmi, Debbarma., Viji, P. and Madhusudana Rao, B. (2018) Seaweeds: a promising functional food ingredient. In: Training manual on 'Value addition of Seafood' (JesmiDebbarma, Viji, P., Madhusudana Rao, B. and Eds), ICAR-Central Institute of Fisheries Technology, pp 31-36	http://krishi.icar.gov.in/jspui/handle/123456789/20800
46	Jesmi Debbarma. (2019) Bioactive colorants for seafood applications. In: Natural additives in Fish Processing, Viji, P. and Prerna Pandey (Eds.), pp.105-134. Delve Publishing, Canada	http://krishi.icar.gov.in/jspui/handle/123456789/20732
47	Jeyakumari, A., Murthy, L.N. and Abhay Kumar (2018) Biochemical quality assessment of fish and fishery products. In: Training Manual on Microbiological examination of seafood pathogens with special reference *V. mimicus* & *V. valnificus*. Murthy, L.N., AbhayKumar,Jeyakumari, A. and Ezhil Nilavan, S. (Eds.), Mumbai Research Centre of ICAR- Central Institute of Fisheries Technology, Vashi, India. pp 51-62	http://krishi.icar.gov.in/jspui/handle/123456789/20712
48	Jeyakumari, A., Zynudheen, A. A., Binsi, P.K., Parvathy, U. and Ravishankar, C.N. (2018) Effect of oregano essential oil on the stability of microencapsulated fish oil. In: Innovative Food Science and Emerging Technologies- The Science behind the Health. Rajakumari R, Anne George, Nandakumar K and Sabu Thomas (Eds.), Apple Academic Press Inc., USA.233-242	http://krishi.icar.gov.in/jspui/handle/123456789/20474
49	Jeyakumari, A., Parvathy, U., Zynudheen, A. A., Narasimha Murthy, L., Visnuvinayagam, S. and Ravishankar, C. N. (2018) Microencapsulation of bioactive food ingredients: Methods, Applications, and Controlled Release Mechanism – A Review. In: Innovative Food Science and Emerging Technologies- The Science behind the Health. Rajakumari R, Anne George, Nandakumar K and Sabu Thomas (Eds.), Apple Academic Press Inc., USA. 417-442	http://krishi.icar.gov.in/jspui/handle/123456789/20473
50	Jeyakumari, A and Parvathy, U. (2019) Natural Preservatives: Effect on sensory attributes. In: Natural Additives in Fish Processing. Viji, P. and Prerna Panda (Eds.), Delve Publisher, 171-181	http://krishi.icar.gov.in/jspui/handle/123456789/20730

51	Jeyanthi, P (2018) Estimation of marketing efficiency and analysis of price data. In: Advanced Statistical Methods and Computational Software for Fisheries Research and Management, Geethalakshmi, V. and Chandrasekar, V. (Eds.), Kochi, India, ICAR-Central Institute of Fisheries Technology, pp 148-151	http://krishi.icar.gov.in/jspui/handle/123456789/20447
52	Jeyanthi, P. (2018) Marketing research methods. In: Advanced Statistical Methods and Computational Software for Fisheries Research and Management, Geethalakshmi, V. and Chandrasekar, V. (Eds.), Kochi, India, ICAR-Central Institute of Fisheries Technology, pp 152-156	http://krishi.icar.gov.in/jspui/handle/123456789/20516
53	Jeyanthi, P. (2018) Supply chain management in Fisheries. In: Extension Management Techniques for Up-scaling Technology Dissemination in Fisheries, Suresh. A., Sajeev, M.V., Rejula, K. (Eds.), ICAR-Central Institute of Fisheries Technology, Cochin, India. p 221-228	http://krishi.icar.gov.in/jspui/handle/123456789/20343
54	Jimmy Mize, T. J. Ramesha and L. N. Murthy (2018). Community Fish Smoking. In: Community smoking of fish – a sustainable livelihood approach for tribal fisherfolk. T. J. Ramesha, M. M. Prasad, L. N. Murthy, Jimmy Mize (Eds.), Mumbai Research Centre of ICAR-Central Institute of Fisheries Technology, KrishiVigyan Kendra, Lower Dibang Valley, Arunachal Pradesh, pp 13-17	http://krishi.icar.gov.in/jspui/handle/123456789/20666
55	Jimmy Mize, T. J. Ramesha and L. N. Murthy (2018) Fish Balls. In: Community smoking of fish – a sustainable livelihood approach for tribal fisherfolk. T. J. Ramesha, M. M. Prasad, L. N. Murthy, Jimmy Mize (Eds.), Mumbai Research Centre of ICAR-Central Institute of Fisheries Technology, KrishiVigyan Kendra, Lower Dibang Valley, Arunachal Pradesh, pp 17-20	http://krishi.icar.gov.in/jspui/handle/123456789/20667
56	Jimmy Mize, T. J. Ramesha and L. N. Murthy (2018) Fish Cutlet. In: Community smoking of fish – a sustainable livelihood approach for tribal fisherfolk. T. J. Ramesha, M. M. Prasad, L. N. Murthy, Jimmy Mize (Eds.), Mumbai Research Centre of ICAR-Central Institute of Fisheries Technology, KrishiVigyan Kendra, Lower Dibang Valley, Arunachal Pradesh, pp: 21-23.	http://krishi.icar.gov.in/jspui/handle/123456789/20669
57	Jimmy Mize, T. J. Ramesha and L. N. Murthy (2018) Fish Finger. In: Community smoking of fish – a sustainable livelihood approach for tribal fisherfolk. T. J. Ramesha, M. M. Prasad, L. N. Murthy, Jimmy Mize (Eds.), Mumbai Research Centre of ICAR-Central Institute of Fisheries Technology, KrishiVigyan Kendra, Lower Dibang Valley, Arunachal Pradesh, pp 23-25	http://krishi.icar.gov.in/jspui/handle/123456789/20673
58	Jimmy Mize, T. J. Ramesha and L. N. Murthy (2018) Fish Pickle. In: Community smoking of fish – a sustainable livelihood approach for tribal fisherfolk. T. J. Ramesha, M. M. Prasad, L. N. Murthy, Jimmy Mize (Eds.), Mumbai Research Centre of ICAR-Central Institute of Fisheries Technology, KrishiVigyan Kendra, Lower Dibang Valley, Arunachal Pradesh, pp 25-28	http://krishi.icar.gov.in/jspui/handle/123456789/20678

59	Joshy, C. G. (2018) Statistical methods for research and product/process development. In: Protocols for the production of high value secondary products from industrial fish and shellfish processing. Bindu, J., Sreejith, S., and Sarika, K. (eds.), ICAR-Central Institute of Fisheries Technology, Cochin, India, pp 223-235	http://krishi.icar.gov.in/jspui/handle/123456789/20403
60	Joshy, C. G. (2018) Introduction to Statistical Methods and Experimental Designs. In: Advanced Statistical Methods and Computational Software for Fisheries Research and Management, Geethalakshmi, V. and Chandrasekar, V. (eds.), ICAR-Central Institute of Fisheries Technology, Kochi, India, pp 32-43	http://krishi.icar.gov.in/jspui/handle/123456789/20519
61	Joshy, C.G. (2018) Nonlinear and Non-parametric Regression Models and their Applications In: Advanced Statistical Methods and Computational Software for Fisheries Research and Management, Geethalakshmi, V. and Chandrasekar, V. (Eds.), ICAR-Central Institute of Fisheries Technology, Kochi, India, pp 96-103	http://krishi.icar.gov.in/jspui/handle/123456789/20513
62	Joshy, C. G. (2018) Response surface methodology for process/product optimization. In: Advanced Statistical Methods and Computational Software for Fisheries Research and Management, Geethalakshmi, V. and Chandrasekar, V. (Eds.), ICAR-Central Institute of Fisheries Technology, Kochi, India, pp 44-49	http://krishi.icar.gov.in/jspui/handle/123456789/20511
63	Joshy, C. G. (2018) ICT application in fisheries In: In: Extension Management Techniques for Up-scaling Technology Dissemination in Fisheries (e-manual) Suresh, A., Sajeev, M.V. and Rejula, K. (Eds.), Central institute of Fisheries Technology, Kochi, India. pp. 238-241.	http://krishi.icar.gov.in/jspui/handle/123456789/20401
64	Leela Edwin (2018) Responsible fishing and its strategic implementation for sustainability In: Extension Management Techniques for Up-Scaling Technology Dissemination in Fisheries. Suresh, A., Sajeev, M.V. and Rejula, K. (Eds.) Extension Management Techniques for Up-Scaling Technology Dissemination in Fisheries, Central institute of Fisheries Technology, Kochi, India. pp 35-46	http://krishi.icar.gov.in/jspui/handle/123456789/20344
65	Madhusudana Rao, B., Murthy, L. N., Prasad, M. M. and Meenakumari, B. (2019) Varying lipid composition of Godavari hilsa (*Tenualosa ilisha,* Hamilton, 1822) with special reference to its anadromous spawning migration. In: Advances in Fish Research, Mohanty, B.P. (Ed.), Vol.VII, Narendra Publishing House, Delhi, India, pp 121-131	http://krishi.icar.gov.in/jspui/handle/123456789/20877

66	Madhusudana Rao, B., Jesmi, Debbarma, Viji, P. and K. Ahamed Basha (2018) Quality of fishery products with special emphasis on battered and breaded products. In: Training manual on 'Value addition of Seafood'. Jesmi Debbarma, Viji, P. and Madhusudana Rao, B. (Eds.), ICAR-Central Institute of Fisheries Technology, pp 46-55	http://krishi.icar.gov.in/jspui/handle/123456789/20797
67	Madhusudana Rao, B., Murthy, L. N., Jesmi Debbarma., Viji, P. and M.M. Prasad (2018) CIFT-Shrimp stretching mould for value addition of shrimp as stretched shrimp. In: Training manual on 'Value addition of Seafood' (Jesmi Debbarma, Viji, P. and Madhusudana Rao, B. (Eds.), ICAR-Central Institute of Fisheries Technology, pp 56-60	http://krishi.icar.gov.in/jspui/handle/123456789/20879
68	Madhusudana Rao, B. (2018) Palm impression technique for popularizing hygiene literacy among fish handlers. In: Training manual on 'Value addition of Seafood'. Jesmi Debbarma, Viji, P., Madhusudana Rao, B. (Eds), ICAR-Central Institute of Fisheries Technology, 61p	http://krishi.icar.gov.in/jspui/handle/123456789/20880
69	Madhusudana Rao. B. (2019) Natural Antimicrobials for Biopreservation of Fish. In: Natural additives in Fish Processing. Viji, P. and Prerna Pandey (Eds.), Delve Publishing, Canada, pp1-32	http://krishi.icar.gov.in/jspui/handle/123456789/20736
70	Madhu, V. R. (2018) Overview of fishing gear selectivity studies and analysis. In: Advanced Statistical Methods and Computational Software for Fisheries Research and Management, Geethalakshmi, V. and Chandrasekar, V. (Eds.) (2018), ICAR-Central Institute of Fisheries Technology, Kochi, India, pp 79-88	http://krishi.icar.gov.in/jspui/handle/123456789/20459
71	Mandakini Devi, H. and Rehana Raj (2018) Fish Feed. In: Production and Quality evaluation of feed from fish waste. Binsi, P.K. and Zynudheen, A. A. (Eds.) ICAR-Central Institute of Fisheries Technology, pp 26-32	http://krishi.icar.gov.in/jspui/handle/123456789/20788
72	Mandakini Devi, H. (2018) Collagen, gelatin and its derivatives from fish wastes. In: Protocols for the production of high value secondary products from industrial fish and shellfish processing. Bindu, J., Sreejith, S., and Sarika, K. (Eds.) ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 41-43	http://krishi.icar.gov.in/jspui/handle/123456789/20504
73	Manoj P. Samuel, Murali, S. Aniesrani Delfiya, D.S. and Alfiya, P.V. (2018) Engineering tools and technologies for fish processing: a profitable venture in agri-business In: Extension Management Techniques for Up-Scaling Technology Dissemination in Fisheries. Suresh, A., Sajeev, M.V., Rejula, K. (Eds.) ICAR-Central institute of Fisheries Technology, Kochi, India. pp 64-73	http://krishi.icar.gov.in/jspui/handle/123456789/20478

74	Minimol, V.A., Pankaj Kishore and Prasad, M.M. (2019) 'Jaliye Krishi me Antibiotic: Vishwa Patal Par Ek Ubharat Khatra', In: 'Samajik Uthaan Me Antrasthalie MatsyakiKi Mahatta'. Das, B.K., Pravin Maurya, Sahu, S.K. and Suman Kumari (Eds.), ICAR-CIFRI, Barrackpore, pp 156-158	http://krishi.icar.gov.in/jspui/handle/123456789/20953
75	Mohan, C. O. (2018) Thermal processing of fishery products. In: Protocols for the production of high value secondary products from industrial fish and shellfish processing. Bindu, J., Sreejith, S. and Sarika, K. (Eds.), Central Institute of Fisheries Technology, Cochin, India. pp 87-98	http://krishi.icar.gov.in/jspui/handle/123456789/20482
76	Mohan, C. O. (2018) Modern practices in seafood packaging. In: Protocols for the production of high value secondary products from industrial fish and shellfish processing. Bindu, J., Sreejith, S., and Sarika, K. (Eds.), Central Institute of Fisheries Technology, Cochin, India. pp 163-174	http://krishi.icar.gov.in/jspui/handle/123456789/20490
77	Mohan, C. O., Ashok Kumar, K. and Ravishankar, C. N. (2018) Fish Processing and Preservation Technologies: An overview. In: Seafood Value Addition. Sreelakshmi, K.R, Elavarasan, K., Mohan, C. O. and Ashok Kumar, K. (Eds.), ICAR- Central Institute of Fisheries Technology, Cochin. pp 7-14	http://krishi.icar.gov.in/jspui/handle/123456789/20326
78	Mohan, C. O., Elavarasan, K. and Sreelakshmi, K.R. (2018) Sensory Evaluation of Fish Products. In: Seafood Value Addition. Sreelakshmi, K. R., Elavarasan, K., Mohan, C. O. and Ashok Kumar, K. (Eds.) ICAR- Central Institute of Fisheries Technology, Cochin. pp15-19	http://krishi.icar.gov.in/jspui/handle/123456789/20325
79	Mohan, C.O., Elavarasan, K and Sreelakshmi K. R (2018) Sensory Evaluation of Fish Products. In: Training manual on 'Value addition of Seafood. Jesmi Debbarma, Viji, P. and Madhusudana Rao, B. (Eds.), ICAR-Central Institute of Fisheries Technology, pp 62-67	http://krishi.icar.gov.in/jspui/handle/123456789/20882
80	Mohan, C. O., Ashok Kumar, K. and Ravishankar, C. N. (2018) Fish Processing and Preservation Technologies: An Overview. In: Training manual on 'Value addition of Seafood. Jesmi Debbarma, Viji, P. and Madhusudana Rao, B. (Eds.), ICAR-Central Institute of Fisheries Technology, pp 6-15	http://krishi.icar.gov.in/jspui/handle/123456789/20805
81	Mohanty, A. K. (2018) SWOT-AHP: A multi attribute decision making model in fisheries management. In : Advanced statistical methods and computational techniques for fisheries research and management, V. Geethalakshmi and V. Chandrasekar (Eds.), Kochi, India, ICAR- Central Institute of Fisheries Technology, pp 193-197	http://krishi.icar.gov.in/jspui/handle/123456789/20509

82	Mohanty, A. K., Sajeev, M. V.,Sajesh, V. K. and Rejula, K. (2018) Innovative Extension Approaches for Sustainable Fisheries. In: Extension Management Techniques for Up-scaling Technology Dissemination in Fisheries (e-manual). Suresh, A., Sajeev, M. V., Rejula, K. and Mohanty, A. K. (Eds.), ICAR-Central Institute of Fisheries Technology, Cochin, India, pp 19-34	http://krishi.icar.gov.in/jspui/handle/123456789/20398
83	Mohanty, A. K. (2018) Strategic decision making through multi-criteria based SWOT-AHP Technique, In: Innovative approaches and ICT applications in extension, research, teaching and work, Kumar, G.A.K. (Ed.), ICAR-NRRI, Cuttack, pp 287-295	http://krishi.icar.gov.in/jspui/handle/123456789/20887
84	Mohanty, A. K. (2018) Disruptive Extension – An Innovative Extension approach for sustainable Development. In: Innovative approaches and ICT applications in extension, research, teaching and work, Kumar, G. A. K. (Ed.), ICAR-NRRI, Cuttack, pp 296-302	http://krishi.icar.gov.in/jspui/handle/123456789/20888
85	Mohanty, A. K., Kumar G. A. K., Tripathi, A. K. and Roy, A. (2018) Smart Agricultural Marketing for Livelihood Security-Prospects and Opportunities, In : A Book on “Agribusiness Management - A Training Manual”. Ram Singh & S M Feroze (Eds.) Publ. Bio-Tech Books & Publishers,New Delhi-110002, (ISBN 978-81-7622-350-8). 2018, pp 76-87	http://krishi.icar.gov.in/jspui/handle/123456789/20896
86	Mohanty, A. K. (2018) Disruptive Extension – An Innovative Extension approach for sustainable Development,In: Innovative approaches and ICT applications in extension, research, teaching and work, Kumar, G.A.K. (Ed.), ICAR-NRRI, Cuttack, pp 296-302	http://krishi.icar.gov.in/jspui/handle/123456789/20711
87	Murugadas, V., Abhay Kumar, Murthy, L. N. and Jeyakumari, A. (2018) Biochemical tests. In: Training Manual on Microbiological examination of seafood pathogens with special reference *V. mimicus* & *V. valnificus*. Murthy, L.N., AbhayKumar, Jeyakumari, A. and Ezhil Nilavan, S. (Eds.), Mumbai Research Centre of ICAR- Central Institute of Fisheries Technology, Vashi, India. pp 34-36	http://krishi.icar.gov.in/jspui/handle/123456789/20715
88	Murugadas, V. and Prasad, M.M. (2018) AMR in Fisheries Sector, Detection & Control. In: Protocols for the production of high value secondary products from industrial fish and shellfish processing. Bindu, J., Sreejith, S., and Sarika, K. (Eds.), Central Institute of Fisheries Technology, Cochin, India. pp 207-216	http://krishi.icar.gov.in/jspui/handle/123456789/20508
89	Murugadas, V., Madhusudana Rao, B., Prasad, M. M. and Ravishankar, C.N. (2019) Antibiotic resistance: Genes and Associated Mechanism. In: Antimicrobial resistance: Concepts, methodologies and strategies to overcome. Sandeep Kumar Sharma, Vikas Galav, Manish Agarwal and Farah Naz Faridi (Eds.), Narendra Publishing House, New Delhi, pp 148-167	http://krishi.icar.gov.in/jspui/handle/123456789/20809

90	Murugadas, V. and Prasad, M. M. (2018) Bioinformatics in Microbial systematic In: Advanced Statistical Methods and Computational Software for Fisheries Research and Management, Geethalakshmi, V. and Chandrasekar, V. (Eds.), ICAR-Central Institute of Fisheries Technology, Kochi, India, pp116-127	http://krishi.icar.gov.in/jspui/handle/123456789/20376
91	Nikita Gopal, Chandrasekar.V., Bindu, J. and Sreejith S. (2018) Livelihood opportunities for fisherwomen through activity clusters – a case study of clam" in the ITEC programme on "Extension management techniques for Up-Scaling Technology Dissemination in Fisheries" during 09th to 22nd Nov, 2018. At ICAR-CIFT, Kochi, pp 229-232, Chapter 26	http://krishi.icar.gov.in/jspui/handle/123456789/20385
92	Nikita Gopal (2018) Labour in fisheries: Issues & Challenges. In: Extension Management Techniques for Up-scaling Technology Dissemination in Fisheries (e-manual). Suresh, A., Sajeev, M.V., Rejula, K. and Mohanty, A.K. (Eds.), ICAR-Central Institute of Fisheries Technology, Cochin, India, pp 146-153	http://krishi.icar.gov.in/jspui/handle/123456789/20381
93	Panda, S.K. (2018) Development of standards for ensuring seafood safety In: Extension Management Techniques for Up-Scaling Technology Dissemination in Fisheries. Suresh, A., Sajeev, M.V. and Rejula, K. (Eds.), Central institute of Fisheries Technology, Kochi, India. pp135-145	http://krishi.icar.gov.in/jspui/handle/123456789/20440
94	Pankaj Kishore, Devnanda Uchoi and Minimol, V.A. (2019) 'Bhratiya Shetra ke Liye Mulya Wardhit Matsya Utpadan'. In: 'Samajik Uthaan Me Antrasthalie MatsyakiKi Mahatta'. Das, B.K., Pravin Maurya, Sahu, S.K. and Suman Kumari (Eds.), ICAR-CIFRI, Barrackpore, pp 184-198	http://krishi.icar.gov.in/jspui/handle/123456789/20945
95	Parvathy, U., A. Jeyakumari, George Ninan, L. N. Murthy and S. Visnuvinayagam (2018) Aquatic enzymes and their applications in seafood industry. In: Innovative Food Science and Emerging Technologies. Sabu Thomas, Rajakumari Rajendran, Anne George and Nandakumar Kalarikkal (Eds.), pp 43-68, Apple Academic Press, USA, ISBN 9781771886611	http://krishi.icar.gov.in/jspui/handle/123456789/20476
96	Parvathy, U. (2018) Drying and salting of fish. In: Protocols for the production of high value secondary products from industrial fish and shellfish processing. Bindu, J., Sreejith, S., and Sarika, K. (Eds.), Central Institute of Fisheries Technology, Cochin, India. pp 132-139	http://krishi.icar.gov.in/jspui/handle/123456789/20503
97	Parvathy, U. and Jeyakumari, A. (2018) Microencapsulation and spray drying technology. In: Protocols for the production of high value secondary products from industrial fish and shellfish processing. Bindu, J., Sreejith, S., and Sarika, K. (Eds.), Central Institute of Fisheries Technology, Cochin, India. pp 140-147	http://krishi.icar.gov.in/jspui/handle/123456789/20491

98	Prasad, M. M. (2018) Introduction to techniques in microbiology. In: Training Manual on Microbiological examination of seafood pathogens with special reference *V. mimicus* & *V. valnificus*. Murthy, L.N., Abhay Kumar, Jeyakumari, A. and Ezhil Nilavan, S. (Eds.), Mumbai Research Centre of ICAR- Central Institute of Fisheries Technology, Vashi, India. pp 1-4	http://krishi.icar.gov.in/jspui/handle/123456789/20710
99	Prasad, M. M., Ranjith Kumar, N., Ezhil Nilavan, S., Muthulakshmi, T, Abhay Kumar, Greeshma, S. S., Minimol, V.A., Sivaraman, G. K., Murugadas, V., Visnuvinayagam, S. and Ravishankar, C.N. (2018) Emerging bacterial pathogens in seafood, In: Compendium of 8th Conference of Indian Meat Science Association, Subhash Biswas, Joardar, S.N., Das, A.K., and Gopal patra (Eds.), WB Univ. of Animal and Fishery Sciences, pp 125-127	http://krishi.icar.gov.in/jspui/handle/123456789/20883
100	Prasad, M. M. (2018) Microbiological safety and quality of fish and fishery products In: Suresh, A., Sajeev, M.V. and Rejula, K. (Eds.), Extension Management Techniques for Up-Scaling Technology Dissemination in Fisheries, ICAR-Central institute of Fisheries Technology, Kochi, India. pp 74-89	http://krishi.icar.gov.in/jspui/handle/123456789/20394
101	Radhakraishnan Nair, V. (2018) Genomic study of Fish pathogens using softwares In: Advanced Statistical Methods and Computational Software for Fisheries Research and Management, Geethalakshmi, V. and Chandrasekar, V. (Eds.), (2018), ICAR-Central Institute of Fisheries Technology, Kochi, India, pp.180-192.	http://krishi.icar.gov.in/jspui/handle/123456789/20577
102	Ramasundaram, P., Suresh, A., Josily Samuel and Shwetal Wankhade (2018) Welfare gains from application of first generation biotechnology in Indian agriculture: The case of Bt cotton. In: Biotechnology for a Second Green Revolution in India Socio-economic, Political, and Public Policy Issues, Rao, N.C., Carl Pray, C. and Herring, R.J. (Eds.), Academic Foundation, New Delhi	http://krishi.icar.gov.in/jspui/handle/123456789/20892
103	Ravishankar, C. N. (2018) Indian fisheries: Harvest and Post-Harvest Scenario. In: Advanced Statistical Methods and Computational Software for Fisheries Research and Management. Geethalakshmi, V. and Chandrasekar, V. (eds.) ICAR-Central Institute of Fisheries Technology, Kochi, India, pp1-16	http://krishi.icar.gov.in/jspui/handle/123456789/20570
104	Ravishankar, C. N. (2018) Indian fisheries: harvest and post-harvest scenario In: Extension Management Techniques for Up-Scaling Technology Dissemination in Fisheries. Suresh, A., Sajeev, M.V., Rejula, K. (Eds.) Central institute of Fisheries Technology, Kochi, India. pp1-18	http://krishi.icar.gov.in/jspui/handle/123456789/20400

105	Ravishankar, C. N., Mohan, C. O., Panda, S. K. and Meenakumari, B. (2018) Prospects of Antarctic Krill utilization by India. In: Food Process Engineering & Quality Assurance Mohan, C. O., Elizabeth Carvajal-Millan., Ravishankar, C.N. and Haghi, A. K. (Eds.), CRC & Apple Academic Press, USA. pp. 295-310	http://krishi.icar.gov.in/jspui/handle/123456789/20884
106	Rejula, K. (2018) Gender issues in fish entrepreneurship development. In: Extension Management Techniques for Up-Scaling Technology Dissemination in Fisheries. A. K. Mohanty, M.V. Sajeev, Sajesh V.K. and Rejula K. (Eds.), ICAR-Central institute of Fisheries Technology, Kochi, India, pp 233-237	http://krishi.icar.gov.in/jspui/handle/123456789/20402
107	Rejula, K. (2018) Data preparation, basic statistical tools for analysis of experimental data. In: Advanced statistical methods and computational techniques for fisheries research, Geethalakshmi, V. and Chandrasekar, V. (Eds), Central institute of Fisheries Technology, Kochi, India, pp 23-31	http://krishi.icar.gov.in/jspui/handle/123456789/20525
108	Remya, S., Mohan, C.O., Bindu, J. and Ravishankar, C. N. (2019) Natural additives in antimicrobial packaging for fish preservation. In: Natural additives in fish processing. Viji, P. and Prerna Pandey (Eds.), Delve Publishing, Canada, pp 55-84	http://krishi.icar.gov.in/jspui/handle/123456789/20734
109	Sajesh, V. K. (2018) Forecasting using Delphi method: an Overview. In: Extension Management Techniques for Up-scaling Technology Dissemination in Fisheries (e-manual), Suresh, A., Sajeev, M.V., Rejula, K. and Mohanty, A.K. (Eds.), ICAR-Central Institute of Fisheries Technology, Cochin, India, pp 188-193	http://krishi.icar.gov.in/jspui/handle/123456789/20477
110	Sajesh, V. K. (2018) Delphi method: An Overview. In : Advanced statistical methods and computational techniques for fisheries research and management. Geethalakshmi, V. and V. Chandrasekar (Eds.), ICAR- Central Institute of Fisheries Technology, Kochi, India, pp 175-179	http://krishi.icar.gov.in/jspui/handle/123456789/20524
111	Sajesh, V. K., Mohanty, A. K. and Ravishankar, C.N. (2019) Up liftment of tribal fisher folks through harvest and post-harvest technologies: ICAR-CIFT interventions. A chapter in Souvenir - Cum - Extended Abstracts : National Workshop on & quot; Aquaculture as a Livelihood Option for Tribal Farmers of India & quot; (Eds.) Barat, A., Kumar, R., Siddaiah, G. M., Sivaraman, I., Mahapatra, B. C., & Pillai, B. R., 2019. ICAR-Central Institute of Freshwater aquaculture, Bhubaneswar, Odisha, India, pp 30-36	http://krishi.icar.gov.in/jspui/handle/123456789/20898
112	Sajeev, M. V. (2018) E-marketing of fish: Scope and Dynamics. In: Extension management techniques for up-scaling technology dissemination in fisheries. Suresh, A., Sajeev, M.V., Rejula, K. (Eds.), ICAR-Central Institute of Fisheries Technology, Kochi, India, pp. 211-220	http://krishi.icar.gov.in/jspui/handle/123456789/20479

113	Sajeev, M. V. and Mohanty, A. K. (2018) Participatory and integrative techniques in fisheries vulnerability measurement. Advanced statistical methods and computational software for fisheries research and management. ICAR-Central Institute of Fisheries Technology, Kochi, India, pp 164-174	http://krishi.icar.gov.in/jspui/handle/123456789/20512
114	Sarika, K. and Bindu J. (2018) An overview of non-thermal preservation techniques in food. In: Protocols for the production of high value secondary products from industrial fish and shellfish processing. Bindu, J., Sreejith, S., and Sarika, K. (Eds.) Central Institute of Fisheries Technology, Cochin, India. pp 99-108	http://krishi.icar.gov.in/jspui/handle/123456789/20380
115	Sathish Kumar, K. (2018) Smoke-drying technology in fish preservation. In: Protocols for the production of high value secondary products from industrial fish and shellfish processing. Bindu, J., Sreejith, S., and Sarika, K. (Eds.), ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 113-122	http://krishi.icar.gov.in/jspui/handle/123456789/20484
116	Sivaraman, G. K. (2018) Mpn method of enumeration of indicator organism. In: Training Manual on Microbiological examination of seafood pathogens with special reference *V. mimicus* & *V. valnificus*. Murthy, L.N., Abhay Kumar, Jeyakumari, A. and Ezhil Nilavan, S. (Eds.), Mumbai Research Centre of ICAR-Central Institute of Fisheries Technology, Vashi, India. pp 30-33	http://krishi.icar.gov.in/jspui/handle/123456789/20716
117	Sivaraman, G.K. (2018) Plating techniques for the isolation and purification of bacterial colonies, In: Training manual for faculty of CIFNET for refresher course on Microbiological aspects of sea foods. pp 48-53	http://krishi.icar.gov.in/jspui/handle/123456789/20891
118	Sivaraman, G. K. (2018) Molecular methods for the identification of pathogenic bacteria, In: Training manual for faculty of CIFNET for refresher course on Microbiological aspects of sea foods. pp 60-65	http://krishi.icar.gov.in/jspui/handle/123456789/20890
119	Sreelakshmi, K. R. and George Ninan (2018) Coated products from fish meat. In: Protocols for the production of high value secondary products from industrial fish and shellfish processing. Bindu, J., Sreejith, S. and Sarika, K. (Eds.), ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 148-158	http://krishi.icar.gov.in/jspui/handle/123456789/20505
120	Sreelekshmi, K. R. and George Ninan (2018) Battered and Breaded Fish Products. In: Training Manual on Seafood Value Addition. Sreelekshmi, K. R., Elavarasan, K., Mohan, C. O. and Ashok Kumar, K. (Eds.), ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 37-44	http://krishi.icar.gov.in/jspui/handle/123456789/20322

121	Suresh, A. (2018) Application of economic surplus model for impact assessment: case of Bt Cotton in India. In: Extension Management Techniques for Up-scaling Technology Dissemination in Fisheries. Suresh, A., Sajeev, M.V., Rejula, K. (Eds.), ICAR-Central Institute of Fisheries Technology, Cochin, India. pp198-210	http://krishi.icar.gov.in/jspui/handle/123456789/20481
122	Suresh, A. (2018) Estimation of Total Factor Productivity by using Malmquist Total Factor Productivity Approach: The case of rice in India. In: Advanced Statistical Methods and Computational Software for Fisheries Research and Management. Geethaleskhsmi, V. and Chandrasekar, V. (Eds.), ICAR- Central Institute of Fisheries Technology, Kochi, India, pp 198-207	http://krishi.icar.gov.in/jspui/handle/123456789/20522
123	Suseela Mathew and Tejpal, C. S. (2018) Nutraceuticals from fish and fish wastes: scopes and innovations In: Extension Management Techniques for Up-Scaling Technology Dissemination in Fisheries. Suresh, A., Sajeev, M.V., Rejula, K. (Eds.), ICAR-Central institute of Fisheries Technology, Kochi, India. pp 58-63	http://krishi.icar.gov.in/jspui/handle/123456789/20558
124	Toms C. Joseph (2018) Probiotics use in fish farms. In: Production and Quality evaluation of feed from fish waste. Binsi, P. K. and Zynudheen, A. A. (Eds.), ICAR-Central Institute of Fisheries Technology, pp 33-36	http://krishi.icar.gov.in/jspui/handle/123456789/20787
125	Viji, P., Jesmi, D. and Madhusudana Rao, B. (2018) Nutritional significance of Seafood. In: Training manual on 'Value addition of Seafood' Jesmi Debbarma, Viji, P. and Madhusudana Rao, B. (Eds), ICAR-Central Institute of Fisheries Technology, pp 1-5	http://krishi.icar.gov.in/jspui/handle/123456789/20806
126	Viji, P., George Ninan and Jesmi, D. (2018) Value Added Chilled or Frozen Fish. In: Training manual on 'Value addition of Seafood. Jesmi Debbarma, Viji, P. and Madhusudana Rao, B. (Eds.), ICAR-Central Institute of Fisheries Technology, pp 16-18	http://krishi.icar.gov.in/jspui/handle/123456789/20804
127	Viji, P., George Ninan and Jesmi, D. (2018) Battered and breaded fish products. In: Training manual on 'Value addition of Seafood .Jesmi Debbarma, Viji, P. and Madhusudana Rao, B. (Eds.), ICAR-Central Institute of Fisheries Technology, pp 19-24	http://krishi.icar.gov.in/jspui/handle/123456789/20803
128	Viji, P. and Ravishankar, C. N. (2019) Natural antioxidants and its application in fish and fish products. In: Natural additives in Fish Processing (Viji Pankyamma and Prerna Pandey, (Eds.),Delve Publishing, Canada, pp. 33-54	http://krishi.icar.gov.in/jspui/handle/123456789/20735

129	Visnuvinayagam, S., Abhay Kumar, Murthy, L. N. and Jeyakumari, A. (2018) Isolation and enumeration of microbes from seafood. In: Training Manual on Microbiological examination of seafood pathogens with special reference *V. mimicus* & *V. valnificus*. Murthy, L. N., Abhay Kumar, Jeyakumari, A. and Ezhil Nilavan, S. (Eds.) Mumbai Research Centre of ICAR-Central Institute of Fisheries Technology, Vashi, India. pp 24-29	http://krishi.icar.gov.in/jspui/handle/123456789/20717
130	Zynudheen, A. A. and Binsi, P. K. (2018) High value products from fish processing wastes. In: Protocols for the production of high value secondary products from industrial fish and shellfish processing, Bindu, J., Sreejith, S., and Sarika, K. (Eds.), ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 28-33	http://krishi.icar.gov.in/jspui/handle/123456789/20495
131	Zynudheen A. A (2018) Fish Silage. In: Production and Quality evaluation of feed from fish waste. Binsi, P. K. and Zynudheen, A. A. (Eds.), ICAR-Central Institute of Fisheries Technology, pp 4-7	http://krishi.icar.gov.in/jspui/handle/123456789/20790
132	Zynudheen, A. A. and Binsi, P. K. (2018) Fish processing waste: Valuable raw material source for silage, foliar spray and animal feed preparation. In: Bindu, J., Sreejith, S., and Sarika, K. (Eds.), Protocols for the production of high value secondary products from industrial fish and shellfish processing, ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 53-69	http://krishi.icar.gov.in/jspui/handle/123456789/20423
133	Zynudheen, A. A. (2018) Wealth from fish waste: CIFT interventions In: Extension Management Techniques for Up-Scaling Technology Dissemination in Fisheries, Suresh, A., Sajeev, M. V. and Rejula, K. (Eds.), Central institute of Fisheries Technology, Kochi, India. pp 90-96	http://krishi.icar.gov.in/jspui/handle/123456789/20341

POPULAR ARTICLES

Sl. No.	Title of the Publication	Identifier to Krishi Data Repository
1	Amulya, P. R., Murali, S., Alfiya, P. V., Aniesrani, D. S. and Manoj P. Samuel (2018) Energy optimization in seafood processing industries, Indian Food Industry Magazine. 37(6): 49-52	http://krishi.icar.gov.in/jspui/handle/123456789/20628
2	Aniesrani Delfiya, D. S., Murali, S., Alfiya, P. V. and Manoj P. Samuel (2018) – Infrared fish dryer, Fish Tech Reporter. 4(1): 33-34	http://krishi.icar.gov.in/jspui/handle/123456789/20541
3	Ashaletha, S. (2019) "Ciftil ninnum fertifish". Malayala Manorama Karshakasree March issue	http://krishi.icar.gov.in/jspui/handle/123456789/20875
4	Biju, A. George and Manoj P. Samuel (2018) Flood management – Myths and realities, Decan Chronicle,3 September, 2018	http://krishi.icar.gov.in/jspui/handle/123456789/20728
5	Binsi, P. K., Anupama, T. K., Parvathy, U. and Zynudheen, A. A. (2018) Astaxanthin: A promisive antioxidant and UV protective agent, Fish Tech Reporter. 4(1):13-14	http://krishi.icar.gov.in/jspui/handle/123456789/20530
6	Chinnadurai, S., Sreekanth, G. B., Renjith, R. K. and Madhu, V. R. (2018) Demonstration and operational efficiency of Off-Bottom Trawl Systems (OBTS): A new initiative in Goa by ICAR-CIFT, Fishtech Reporter. 4(1):3-6	http://krishi.icar.gov.in/jspui/handle/123456789/20436
7	Femeena Hassan and Bably J. Vijayan (2018) Quality evaluation studies in ready-to-use soup tablets, Fish Tech Reporter. 4(1):17	http://krishi.icar.gov.in/jspui/handle/123456789/20408
8	George Ninan, Aswathy, K. S. and Joshy, C. G. (2018) Development of dietary fiber incorporated fish sausage, Fish Tech Reporter. 4(1):16-17.	http://krishi.icar.gov.in/jspui/handle/123456789/20452
9	Joshy, C. G., Shyla, N. C., George Ninan and Ravishankar, C. N. (2018) CIFTFISHPRO – An information system on ICAR-CIFT value added fish products, Fish Tech Reporter. 4(1):27	http://krishi.icar.gov.in/jspui/handle/123456789/20426
10	Laly, S. J., Anupama, T. K., Sankar, T. V. and Ashok Kumar, K. (2018) Significance of biogenic amines in food safety, Fishing Chimes. 38(3): 41-44	http://krishi.icar.gov.in/jspui/handle/123456789/20371
11	Madhusudana Rao, B. (2019) Antibiotic free fishery products from aquaculture (IN Telugu), Chepala Sandhadi. 10(1): 8-20	http://krishi.icar.gov.in/jspui/handle/123456789/20874
12	Madhu, V. R., Vasudevan, N. and Leela Edwin (2018) Adoption of square mesh codends for the trawl fishery: A success story along Sindhudurg coast, Maharasthra, Fish Tech Reporter. 4(1):8-11	http://krishi.icar.gov.in/jspui/handle/123456789/20445
13	Manoj P. Samuel (2018) To combat drought (In Malayalam), Krishi Jagaran. 2(6): 44-45	http://krishi.icar.gov.in/jspui/handle/123456789/20739
14	Manoj P. Samuel (2018) Quantity and quality management of water resources in hilly agro-ecosystems of India, Voice of Kerala Engineers.14(8)	http://krishi.icar.gov.in/jspui/handle/123456789/20876

15	Manoj P. Samuel (2018) Flood after: A rethinking (In Malayalam), Vegetable and Fruit Promotion Council Magazine, 1(5), October-November issue	http://krishi.icar.gov.in/jspui/handle/123456789/20740
16	Manoj P. Samuel (2018) Flood after: A rethinking (In Malayalam), ISACUF Souhrudam, 2(4), November-December issue	http://krishi.icar.gov.in/jspui/handle/123456789/20775
17	Manoj P. Samuel, Siddique, V. K., Babu, K. S. and Gopakumar, G. (2019) Kiosk to sell hygienic fish (In Malayalam), Karshakashree, March 2019	http://krishi.icar.gov.in/jspui/handle/123456789/20777
18	Meryl Williams, Nikita Gopal, Kyoko Kusakabe, Arlene Nietes Satapornvanit, and Hillary Egna (2018) Expanding the horizons: from nurturing fish to nurturing society, INFOFISH International 5/2018; pp. 42-46. www.infofish.org	http://krishi.icar.gov.in/jspui/handle/123456789/20785
19	Meryl Williams, Veena N., Kyoko Kusakabe, Cherdsak Virapat, Nikita Gopal, Salin Krishna and Danika Kleiber (2018) Report on GAF7 (7th Global Conference on Gender in Aquaculture and Fisheries), Asian Fisheries Society e-Newsletter 27: 3-6	http://krishi.icar.gov.in/jspui/handle/123456789/20895
20	Mohan, C. O., Remya, S., Bindu, J. and Ravishankar, C. N. (2018) Development of antioxidant packaging film using Rosemary Essential Oil (REO) and chitosan, Fish Tech Reporter. 4(1):11-13	http://krishi.icar.gov.in/jspui/handle/123456789/20428
21	Muhamed Ashraf, P., Manju Lekshmi, N., Sasikala, K.G. and Raghu Prakash, R. (2018) Biofouling resistant polyethylene cage aquaculture nettings using polyaniline and nano copper oxide, Fishtech Reporter. 4(1):6-8	http://krishi.icar.gov.in/jspui/handle/123456789/20443
22	Murugadas, V., Veena Lal, Zynudheen, A. A. and Prasad, M. M. (2018) Marine origin *Bacillus* sp.: A potential collagenase source for fishery waste utilization, Fish Tech Reporter. 4(1):24-25	http://krishi.icar.gov.in/jspui/handle/123456789/20418
23	Nadella, R.K., Basha, K.A., Muthulakshmi, T. and Prasad, M. M. (2018) Immobilization and sulphur oxidation capability of sulphur oxidizing bacteria, Fishtech Reporter. 4(1):25-27	http://krishi.icar.gov.in/jspui/handle/123456789/20419
24	Nikita Gopal, J. P. James, K. H. Sreedevi, J. Bindu and Sreejith, S. (2018) Black Clam is all set to go places, MPEDA Newsletter, Vol. VI; No. 3; June 2018	http://krishi.icar.gov.in/jspui/handle/123456789/20894
25	Parvathy, U., Binsi, P. K., Zynudheen, A. A. and George Ninan (2018) Utilization of yellowfin tuna protein hydrolysate in health beverage formulation, Fishtech Reporter. 4(1):19-20	http://krishi.icar.gov.in/jspui/handle/123456789/20463
26	Parvathy, U., Binsi, P. K., Jeyakumari, A., George Ninan, Zynudheen, A.A.and Ravishankar, C.N. (2018) Fish protein hydrolysates: a potential additive in foods, Aquastar, August:31-35	http://krishi.icar.gov.in/jspui/handle/123456789/20748
27	Parvathy, U., Binsi, P. K., Sathish Kumar, K., Murali, S. and Ravishankar, C. N. (2019) Live Fish Transportation: Technology assuring quality. Aquastar. pp 36-38	http://krishi.icar.gov.in/jspui/handle/123456789/20749

28	Prajith, K. K. and Ejaz A. Rahim (2018) Recycle and reuse of abandoned fishing net: Reports from Saurashtra, Gujarat, Fishtech Reporter. 4(1):28-30	http://krishi.icar.gov.in/jspui/handle/123456789/20446
29	Priya, E. R., Laly, S. J., Panda, S. K. and Ashok Kumar, K. (2018) Rapid detection kits (CIFtest Kits) to check adulteration of formaldehyde and ammonia in fresh fish, Fishtech Reporter. 4(1):31-32	http://krishi.icar.gov.in/jspui/handle/123456789/20407
30	Sayana, K. A., Remesan, M. P. and Leela Edwin (2018) Low drag trawls for fuel saving, Fishtech Reporter. 4(1):1-3	http://krishi.icar.gov.in/jspui/handle/123456789/20534
31	Sivaraman, G. K., Visnuvinayagam, S., Murugadas, V. and Prasad, M.M. (2018) Molecular phylogenetic study of femA gene sequences of Methicillin Resistant *Staphylococcus aures* in seafood, Fish Tech Reporter. 4(1):22-23	http://krishi.icar.gov.in/jspui/handle/123456789/20417
32	Sreelakshmi, K. R., Mohan, C. O. and Elavarasan, K. (2018) Green synthesis of gold nanoparticles using different reducing agents of aquatic origin, Fishtech Reporter. 4(1):34-35	http://krishi.icar.gov.in/jspui/handle/123456789/20383
33	Viji, P., Madhusudana Rao, B. and Jesmi, D. (2018) Microwave vacuum drying: An innovative technology for rapid drying of fish, Fishtech Reporter. 4(1):21-22	http://krishi.icar.gov.in/jspui/handle/123456789/20438
34	Viji, P., Madhusudana Rao, B. and Jesmi Debbarma (2019) Squalene in the perspective of human health, Fishing Chimes. 38(3): 28-31	http://krishi.icar.gov.in/jspui/handle/123456789/20648
35	Zynudheen, A. A., Joshy, C. G., Rinu Agnes, M. V. and George Ninan (2018) Optimization of prawn pulp incorporated fish sausage using mixture response surface methodology, Fish Tech Reporter, 4(1):14-15.	http://krishi.icar.gov.in/jspui/handle/123456789/20442

TRAINING MANUALS

Sl. No.	Title of the Publication	Identifier to Krishi Data Repository
1	Bindu, J., Sreejith, S. and Sarika, K. (Eds.), (2018) Protocols for the production of high value secondary products from industrial fish and shellfish processing, Training manual of International training programme sponsored by ITEC, MEA, Govt. of India held at ICAR-CIFT, Kochi during 26 November – 22 December, 2018	http://krishi.icar.gov.in/jspui/handle/123456789/20742
2	Binsi, P.K. and Zynudheen, A. A. (2018) Production and Quality evaluation of feed from fish waste. ICAR-Central Institute of Fisheries Technology. 42 p	http://krishi.icar.gov.in/jspui/handle/123456789/20786
3	Geethalakshmi, V. and Chandrasekar, V. (2018) Advanced statistical methods and computational techniques for fisheries research and management. ICAR-Central Institute of Fisheries Technology, Cochin, India	http://krishi.icar.gov.in/jspui/handle/123456789/20744
4	Jesmi Debbarma, Viji, P., Kamei, G., Sreedhar, U., Madhusudana Rao, B. and Raghu Prakash, R. (Eds.), (2019) Fishing gear engineering for increasing inland fishing efficiency and improved smoking process for quality smoked product, 34 p	http://krishi.icar.gov.in/jspui/handle/123456789/20750
5	Jesmi Debbarma, Viji P., Kamei, G., Sreedhar, U., Madhusudana Rao, B. and Raghu Prakash, R. (Eds.), (2018) Value addition of seafood, 67 p	http://krishi.icar.gov.in/jspui/handle/123456789/20750
6	Kamei, G., Sreedhar, U. and Raghu Prakash, R. (Eds.) (2018) Fishing techniques-Responsible fishing, trap fishing (In Telugu)	http://krishi.icar.gov.in/jspui/handle/123456789/20751
7	Madhusudana Rao, B., Basha, K.A., Viji, P. and Jesmi Debbarma (Eds.), (2018) Microbiological methods and HACCP concepts for seafood industry	http://krishi.icar.gov.in/jspui/handle/123456789/20745
8	Manoj P. Samuel, Murali, S., Alfiya, P.V., Aniesrani Delfiya, D.S., Rakesh Raghavan and Menon, A. R. S. (Eds.), (2018) Pre-processing and drying of fish	http://krishi.icar.gov.in/jspui/handle/123456789/20759
9	Murthy, L. N., Abhay Kumar, Jeyakumari, A. and Ezhil Nilavan, S. (Eds.), (2018) Microbiological examination of seafood with special reference to *Vibrio mimicus* and *V. vulnificus*, 82 p	http://krishi.icar.gov.in/jspui/handle/123456789/20752
10	Murthy, L. N., Jeyakumari, A., Abhay Kumar and Laly, S.J. (Eds.), (2019) Value added fish products (In Marathi)	http://krishi.icar.gov.in/jspui/handle/123456789/20723

11	Murthy, L. N., Jeyakumari, A., Abhay Kumar and Laly, S.J. (Eds.), (2019) Value added fish products (In Hindi)	http://krishi.icar.gov.in/jspui/handle/123456789/20768
12	Remya, S., Mohan, C. O., Jha, A. K. and Toms C. Joseph (2018) Hygiene and safety of fish and fishery products. Published during the NFDB, Hyderabad funded Skill development programme on 'Hygiene and safety of fish and fishery products' during 23- 25 October, 2018	http://krishi.icar.gov.in/jspui/handle/123456789/20772
13	Remya, S., Renuka, V., Sreelakshmi, K. R. and Toms C. Joseph (2018) Hygienic drying and packing of fish. Published during NFDB, Hyderabad funded Skill development programme on 'Pre-processing and drying of fish' duringt 29-31 October, 2018	http://krishi.icar.gov.in/jspui/handle/123456789/20770
14	Sreelekshmi, K. R., Elavarasan, K., Mohan, C. O. and Ashok Kumar, K. (2018) Training Manual on Seafood Value Addition. ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 60.	http://krishi.icar.gov.in/jspui/handle/123456789/20743
15	Suresh, A., Sajeev, M.V. and Rejula, K. (Eds.), (2018) Extension management techniques for up-scaling technology dissemination in fisheries, Training manual of International training programme sponsored by ITEC, MEA, Govt. of India held at ICAR-CIFT, Kochi during 9-22 November, 2018	http://krishi.icar.gov.in/jspui/handle/123456789/20807
16	Viji, P. Jesmi Debbarma and Madhusudana Rao, B. (Eds.) ,(2018) Speciality Fish Products (In Telugu),14 p	http://krishi.icar.gov.in/jspui/handle/123456789/20897
17	Viji, P. Jesmi Debbarma and Madhusudana Rao, B. (Eds.), (2019) Value addition of fish and fishery products(In Telugu), 13 p	http://krishi.icar.gov.in/jspui/handle/123456789/20796

LEAFLETS

Sl. No.	Title of the Publication	Identifier to Krishi Data Repository
1	Binsi, P. K. and Zynudheen, A. A. (2019) Astacift: Astaxanthine in virgin coconut oil capsules	http://krishi.icar.gov.in/jspui/handle/123456789/20738
2	Kamei, G., Sreedhar, U. and Raghu Prakash, R. (2019) Foldable traps – A suitable fishing practice for freshwater resources (In Telugu)	http://krishi.icar.gov.in/jspui/handle/123456789/20724
3	Madhusudana Rao, B., Viji, P. and Jesmi, D. (2019) Value added fish products	http://krishi.icar.gov.in/jspui/handle/123456789/20723
4	Murthy, L. N., Jeyakumari, A. and Abhay Kumar (2018) Fish soup powder (In Hindi)	http://krishi.icar.gov.in/jspui/handle/123456789/20767
5	Murthy, L. N., Jeyakumari, A. and Abhay Kumar (2018) Butterfly zinga (In Hindi)	http://krishi.icar.gov.in/jspui/handle/123456789/20764
6	Murthy, L. N., Jeyakumari, A., Laly, S. J. and Abhay Kumar (2018) Kolambi chutney (In Marathi)	http://krishi.icar.gov.in/jspui/handle/123456789/20765
7	Murthy, L. N., Jeyakumari, A., Laly, S. J. and Abhay Kumar (2018) Fish pasta (In Marathi)	http://krishi.icar.gov.in/jspui/handle/123456789/20766
8	Rehana Raj and Binsi, P. K. (2018) Fish Cutlet Instant Mix Powder	http://krishi.icar.gov.in/jspui/handle/123456789/20331
9	Rehana Raj and Binsi, P. K. (2018) Instamix	http://krishi.icar.gov.in/jspui/handle/123456789/20794
10	Remya, S., Jha, A. K., Renuka, V. and Mohan, C. O. (2018) Women fish-preneur promotion programme	http://krishi.icar.gov.in/jspui/handle/123456789/20774
11	Remya, S., Renuka, V., Jha, A. K., Arti. M. Joshi, Ejaz Parmar, A. R., Toms C. Joseph, and Ravishankar, C. N. (2018) Fish burger (In English and Gujarati)	http://krishi.icar.gov.in/jspui/handle/123456789/20773
12	Remya, S., Renuka, V., Jha, A. K., Arti. M. Joshi, Ejaz Parmar, A. R., Toms C. Joseph and Ravishankar, C. N. (2018) Fish Pickle (In English and Gujarati)	http://krishi.icar.gov.in/jspui/handle/123456789/20771
13	Saly N. Thomas, Chandrasekhar, V. and Rejula, K. (2019) Gilnet matsyabandhanathinulla pariseelana paripadi	http://krishi.icar.gov.in/jspui/handle/123456789/20705

14	Sarika, K., Sreelakshmni, K. R., Rehana Raj and Bindu, J. (2018) – Fish samosa (In English and Malayalam)	http://krishi.icar.gov.in/jspui/handle/123456789/20747
15	Viji, P. and Binsi, P. K. (2018) Microwave vacuum Dried fish fingers	http://krishi.icar.gov.in/jspui/handle/123456789/20793
16	Viji, P., Madhusudana Rao B., Jesmi Debbarma and Bindu, J. (2019) - Value addition of green mussel (*Perna viridis*) (In English and Telugu).	http://krishi.icar.gov.in/jspui/handle/123456789/20333
17	Zynudheen, A. A., Gokulan, C. R., Manoj P. Samuel, Murali, S., Anieseani Delfiya, D. S. and Alfiya, P. V. (2018) Fish descaling machine (In Hindi)	http://krishi.icar.gov.in/jspui/handle/123456789/20795

COMMUNICATING RESEARCH OUTCOMES

Participation in Symposia/Seminars/Workshops etc.

Scientists from the Headquarters and Research Centres participated in several national and international symposia, seminars and workshops. Some of the notable events were National conference on 'Marine debris', ICAR-CMFRI, Kochi (11-12 April, 2018), International conference on 'Nanomaterials: Synthesis, characterization and applications', MG University, Kottayam (11-13 May, 2018), Third International symposium on'Aquaculture and fisheries education', ICAR-CIFE, Mumbai (16-18 May, 2018), National conference on 'Innovative mechanization for small and marginal farmers under rainfed agriculture', Thiruvananthapuram (25-26 May, 2018), Workshop on 'Coastal zone regulation', CUSAT, Kochi (16 June, 2018), Workshop on 'Rating of ICAR Institutes', ICAR-NAARM, Hyderabad (20 June, 2018), Workshop on 'Scientific management of marine fishereies of Kerala', ICAR-CMFRI, Kochi (18-19 September, 2018), International conference on 'Recent advances in food processing technology', IIFPT, Thanjavur (17-19 August, 2018), World Congress of Food and Technology on '15 Billion meals a day by 2025 with healthy, nutritious, safe and diverse foods', Mumbai (23-27 October, 2018), International symposium on 'Technological innovations in muscle food processing for nutritional security, quality and safety', WBUAFS, Kolkatta (22-24 November, 2018), International conference on 'Natural polymers', MG University, Kottayam (7-9 December, 2018), International conference on 'Proteomics for cell biology and molecular medicine', NCCS, Pune (12-14 December, 2018), International conference on 'Statistics for 21st century', University of Kerala, Thiruvananthapuram (13-15 December, 2018), International Conference on Brackishwater Aquaculture, ICAR-CIBA, Chennai (23-25 January, 2019), International symposium on 'Engineering technologies for precession and climate smart agriculture', Institute of Agricultural Science, BHU, Varanasi (28-30 January, 2019), XIV Agricultural Science Congress, New Delhi (20-23 February, 2019) and World Ocean Science Congress – 2019, Andhra University, Visakhapatnam (25-27 February, 2019). 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.	Biochemical composition, in vitro digestability and gastro-protective role of brown seaweed	1	Kochi (1 April – 30 June, 2018)
2.	Utilization of Indian oil sardine for the simultaneous preparation of n-3 poly unsaturated fatty acids and biodiesal	1	Kochi (1 April – 30 June, 2018)
3.	Chloramphenical and AOZ residue analysis in shrimps by ELISA	8	Mumbai (2-4 April, 2018)
4.	In vitro antioxidant activity of protein hydrolysate prepared from Tilapia (*Oerochromis mossambicus*) using proteolytic process.	1	Kochi (5 March – 5 April, 2018
5.	Comparative studies on electrophoretic pattern of soluble protein extracted from Etroplus (*Etroplus suratensis*), Reef code (*Epinephelus diacanthus*) and Pipe Fish	1	Kochi (5 March – 5 April, 2018
6.	Comparative studies on n-3/ n-6 fatty acid profile of natch Karimeen (*Scatophagus argus*), Sardine (*Sardinella ongiceps*) and Squid (*Uroteuthis duvauceli*)	1	Kochi (5 March – 5 April, 2018
7.	Nutrient profiling and biochemical composition analysis of *Channa striatus*, *Metapeaneus dobsoni* and *Mytilus edulis*	1	Kochi (5 March – 5 April, 2018
8.	Incidence of Plesiomonas shigelloides in seafood	1	Kochi (5 April – 4 July, 2018)
9.	A study on understanding the diversity of MRSA clone in seafood	1	Kochi (1 January -7 April, 2018)
10.	Studies on occurrence of *Vibrio mimicus* in fish and fishery products	1	Kochi (1 January -7 April, 2018)
11.	Monitoring the incidence of ESBL producing *E. coli* and it's antimicrobial resistance patterns in seafood, Kochi	1	Kochi (1 January -7 April, 2018)
12.	Effect of temperature on growth of *Vibrio parahaemolyticus* when subjected to chemical treatment in fish and fishery products	1	Kochi (1 January -7 April, 2018)
13.	Antibacterial effect of green tea extract encapsulated nano chitosan for control of *Vibrio harveyi*	1	Kochi (5 January -7 April, 2018)

14.	Prevalence of methicillin resistant *Staphylococcus aureus* in aquaculture farms of Thrissur district	1	Kochi (13 April – 30 June, 2018)
15.	Isolation and identification of extended spectrum beta lactamases producing *E. coli* from aquaculture farms	1	Kochi (13 April – 30 June, 2018)
16.	Screening for bacteriophage against pathogen of aquaculture and seafood importance	1	Kochi (13 April – 30 June, 2018)
17.	Isolation identification and antibiotic resistance of Arcobacter isolated from seafood	1	Kochi (13 April – 30 June, 2018)
18.	Identification and molecular characterization of Aeromonassp. from aquatic sources	1	Kochi (16 April – 7 July, 2018)
19.	Microbiology analysis and water quality analysis	11	Kochi (17-21 April, 2018)
20.	Gillnet fabrication and optimization	20	Aliyar Reservoir, Tamil Nadu(18-19 April, 2018)
21.	Modern analytical techniques in biochemical analysis of food and advanced analytical instruments	1	Kochi (19 April – 5 May, 2018)
22.	Gillnet fabrication and optimization	25	Kanjirappuzha Reservoir (20 April, 2018)
23.	Analysis of poly aromatic hydrocarbons (PAHs) in fish and water by HPLC with fluorescence detector	1	Kochi (20 April – 20 May, 2018)
24.	Method of analaysis of free formaldehyde in fish and fishery products	10	Kochi (22-25 April, 2018
25.	Fishing technology and fish processing	26	Kochi (27-28 April, 2018)
26.	Development and quality evaluation of shrimp flavouring extracted from carotenoprotein	1	Kochi (1 February – 30 April, 2018)
27.	Development of fish ham from tilapia and prawn, and its shelf life in flexible packaging under chilled storage	1	Kochi (1 February – 30 April, 2018)
28.	Development of dietary fiber incorporated tuna sausage and its shelf life studies in chilled condition	1	Kochi (1 February – 30 April, 2018)
29.	Extraction and characterization of Astaxanthin and assessment of formulation for cosmetic and nutraceutical application	1	Kochi (1 February – 30 April, 2018)
30.	Studies on sequential reduction of coliforms during accelerated free drying of shrimp	1	Kochi (1 May – 31 July, 2018)
31.	Microbiological; and molecular quality evaluation of fishes from different markets of Alappuzha and Ernakulam districts of Kerala	1	Kochi (1 May – 31 July, 2018)

32.	Evaluation of bacteriological growth media developed from cattle fish skin hydrolysale and tilapia head hydrolysale	1	Kochi (1 May – 31 July, 2018)
33.	Preparation and quality evaluation of chitin and chitosan	2	Kochi (2-3 May, 2018)
34.	Pathotyping of ESBL producing *E. coli* from seafood	1	Kochi (1 Februaray – 5 May, 2018)
35.	*Antibacterial activity* of *Garcinia cambogia* and *Allium sativum* on Vibrio parahaemolyticus	1	Kochi (3 March - 5 May, 2018)
36.	PCR techniques for detection of bacteria	1	Kochi (2-7 May, 2018)
37.	Microbiological examination of fish and fishery products	10	Kochi (7-9 May, 2018)
38.	Laboratory techniques for microbiological examination of seafood	11	Kochi (7-19 May, 2018)
39.	Preparation of fishery products	29	Kochi (7-21 May, 2018)
40.	Instrumentation techniques in the biocompositional analyses of seafood	1	Kochi (14 May – 14 June, 2018)
41.	Processing and value addition of fish and shellfish	14	Kochi (15-17 May, 2018)
42.	Eco-friendly harvest methods and fortified fish soup preparation	70	Jia, Rukmo and Kerra-Aati villages, Arunachal Pradesh (17-19 May, 2018)
43.	Isolation and characterization of *Cronobacter sakazakii* from seafoods	1	Kochi (1 February – 19 May, 2018)
44.	Isolation and identification of *Photobacterium damselae* from seafoods	1	Kochi (1 February – 19 May, 2018)
45.	Studies on collagen degrading bacteria	1	Kochi (1 February – 19 May, 2018)
46.	Eco-friendly harvest methods and fortified fish soup preparation	50	Imphal, Manipur (21-23 May, 2018)
47.	Conversion of diamond mesh to square mesh codend	25	Veraval (22 May, 2018)
48.	Popularization of sea cage farming	25	ICAR-CMFRI, Veraval (22 May, 2018)
49.	Analysis of chloramphenicol and AOZ residue in shrimps by ELISA	8	Mumbai (23-25 May, 2018)
50.	Conversion of diamond mesh to square mesh codend	25	Porbandar, Gujarat (24 May, 2018)
51.	Bioactivity of expolysaccharide produced by *Paenibacillus elgii*	1	Kochi (1 March – 31 May, 2018)

52.	Fingerprinting of mrsa from seafood by PFGE (Pulsed Field Gel Electrophoresis)	1	Kochi (1 March – 31 May, 2018)
53.	Harmonizing isolation protocols of emerging pathogens in seafood	1	Kochi (1 March – 31 May, 2018)
54.	Good laboratory practices	1	Kochi (29-31 May, 2018)
55.	Assessment of microbial quality of seafood	1	Kochi (1-21 June, 2018)
56.	Biochemical analysis of food and advanced analytical techniques	2	Kochi (4-23 June, 2018)
57.	Production and quality evaluation of feed from fish waste	25	Kochi (5-7 June, 2018)
58.	Preparation of chitin and chitosan from shrimp shall waste	2	Mumbai (6-7 June, 2018)
59.	Conversion of diamond mesh to square mesh codend	25	Veraval (11 & 13 June, 2018)
60.	ISO 17025-2017 (Clause 5 and 6)	15	Kochi (14 June, 2018)
61.	Validation of ICP-MS for determination of heavy metals in fish	1	Kochi (15 June – 30 July, 2018)
62.	HACCP concepts	35	Kochi (18-22 June, 2018)
63.	Square mesh codend fabrication and demonstration	25	Munambam (19 June, 2018)
64.	Assessjment of antimicrobial resistance for *E. coli* and *V. parahaemolyticus* associated with fisheries and aquaculture	3	Kochi (25-30 June, 2018)
65.	Hygienic handling for ensuring fish quality	3	Kochi (27-28 June, 2018)
66.	Microbiological aspects of seafood	10	Kochi (27-29 June, 2018)
67.	Fish Microbiology, Biochemistry, Processing and Quality Control	8	Kochi (28-29 June, 2018)
68.	Incidence of extended spectrum beta lactamases producing *Escherichia coli* and its antimicrobial resistance in aquaculture	1	Kochi (2 March- 30 June, 2018)
69.	Value addition of fish and fishery products	2	Mumbai (2-4 July, 2018)
70.	Value added fish products preparation	75	Veraval (9-11 July, 2018)
71.	Estimation of added formaldehyde in fish	6	Kochi (16-17 July, 2018)
72.	Advanced statistical methods and computational software for fisheries research and management	27	Kochi (17-26 July, 2018)
73.	Fabrication of 40 mm square mesh codend for trawl/dol net fishing gear	100	Maharashtra (21-22 July, 2018)

74.	Microbiological examination of seafood with special reference to *V. mimicus* and *V. vulnificus*	11	Mumbai (23-27 July, 2018)
75.	Determination of antimicrobial resistance in pathogens of fish	1	Kochi (23-28 July, 2018)
76.	Value addition of fish and fishery products	25	Veraval (24-26 July, 2018)
77.	Value addition of fish and shrimp	25	Chempu, Kottayam (July, 2018)
78.	Value addition of fish and fishery products	25	Visakhapatnam (30 July - 1 August, 2018)
79.	Molecular detection and characterization of seafood pathogens	1	Kochi (3-14 August, 2018)
80.	Biochemical quality analysis of fish meal	2	Mumbai (13-16 August, 2018)
81.	Value addition of fish and fishery products	25	Mumbai (16-18 August, 2018)
82.	Hygiene and safety of fish and fishery products	25	Veraval (25-28 August, 2018)
83.	Fishing techniques (Responsible fishing and trap fishing)	20	Visakhapatnam (27-29 August, 2018)
84.	Microbiological examination of seafood pathogens	3	Mumbai (27 August – 1 September, 2018)
85.	Value addition of fish and fishery products	25	Veraval (30 August – 1 September, 2018)
86.	Advanced analytical instrumentation techniques in biochemical composition and chemical contaminant profiling of seafood	1	Kochi (3 September – 3 November, 2018)
87.	Pre-processing and drying of fish	25	Kochi (4-6 September, 2018)
88.	Value added products	3	Kochi (5-6 September, 2018)
89.	Optimization of micro encapsulation protocol for grape seed bioactive supercritical CO_2 extract	1	Kochi (7 March -7 September, 2018)
90.	Effect of age and stress on acetyl choline esterase activity in Wistar strain albino rats	1	Kochi (7 March - 7 September, 2018)
91.	Structural and functional characterization of Ulvan - a sulphated polysaccharaide from *Ulva lactua* – a green seaweed	1	Kochi (7 March - 7 September, 2018)
92.	Development of wound healing collagen-chitosan composite hydrogel scaffolds incorporated with nano-encapsulated curcumin	1	Kochi (7 March - 7 September, 2018)
93.	Advances in analytical biochemistry	8	Kochi (11-26 September, 2018)
94.	Seafoods value addition	35	Kochi (12-14 September, 2018)
95.	Identification of *Vibrio parahaemolyticus* with PCR method	2	Kochi (14-15 September, 2018)

96.	Pre-processing and drying of fish	25	Kochi (17-19 September, 2018)
97.	Preparation of dried fish products and battered and breaded products from Bombay duck	25	Taloja, Mumbai (21 September, 2018)
98.	Value addition of fish and fishery products	25	Dhadgaon, Nandurbar, Maharashtra (24-26 September, 2018)
99.	Pre-processing and drying of fish	25	Kochi (25-27 September, 2018)
100.	Microbiological examination of fish and fishery products	25	Kochi (25-27 September, 2018)
101.	NABL Lead Assessor Training	20	Kochi (26-30 September, 2018)
102.	Value added fishery products	2	Kochi (27-28 September, 2018)
103.	Fabrication/conversion of square mesh codend from diamond mesh netting	50	Fort Kochi (4 October, 2018)
104.	Sodium and sodium chloride estimation (AOAC)	14	Visakhapatnam (9-10 October, 2018)
105.	Microbiological examination of fish and fishery products	25	Kochi (9-11 October, 2018)
106.	Pre-processing and drying of fish	22	Kochi (10-12 October, 2018)
107.	Value added fishery products	1	Kochi (15-19 October, 2018)
	Pragmatization of SOP's of INFAAR project	12	Kochi (22-31 October, 2018)
108.	Hygiene and safety of fish and fishery products	24	Veraval (23-25 October, 2018)
109.	Laboratory methods for microbiological examination of seafood	14	Visakhapatnam (23 October – 3 November, 2018)
110.	Pre-processing and drying of fish		Veraval (29-31 October, 2018)
111.	Square mesh codend fabrication and demonstration	50	Sakthikulanagar, Kollam (30 October, 2018)
112.	Fabrication/conversion of square mesh codend from diamond mesh netting	50	Thottappally, Kollam (31 October, 2018)
113.	Fisheries technology	21	Kochi (1-3 November, 2018)
114.	Hygienic handling and quality assurance in seafood outlets	1	Kochi (8 November, 2018)
115.	Preparation of fish pickle	2	Kochi (8 November, 2018)
116.	Extension management techniques for up-scaling technology dissemination in fisheries	20	Kochi (9-22 November, 2018)
117.	Microbiological examination of fish and fishery products	25	Kochi (12-14 November, 2018)
118.	Value addition of fish and fishery products	25	Mumbai (12-14 November, 2018)

119.	Fabrication/conversion of square mesh codend from diamond mesh netting	35	Cherai, Ernakulam (4 October, 2018)
120.	Mending of fishing nets and value addition ofd fish and fishery products	40	Cherai, Ernakulam (14-16 November, 2018)
121.	Extension management techniques for up-scaling technology dissemination in fisheries	20	Kochi (9-22 November, 2018)
122.	Pre-processing and drying of fish	25	Kochi (15-18 November, 2018)
123.	Screening for AMR genes and PFGE typing of ESBL producing *E. coli* strains from aquaculture	1	Kochi (15 November – 12 February, 2019)
124.	WHONET software for data management of Antimicrobial Resistance (AMR)	28	Kochi (19 November, 2018)
125.	Marinated dry fish production	3	Kochi (22 November – 22 December, 2018)
126.	Fishing technology and KMFA Rules	18	Kochi (26-29 November, 2018)
127.	Protocols for the production of high value secondary products from industrial fish and shellfish processing	10	Kochi (26 November – 22 December, 2018)
128.	Pre-processing and drying of fish	25	Veraval (27-29 November, 2018)
129.	Value addition of fish and fishery products	25	Visakhapatrnam (28-30 November, 2018)
130.	Microbiological analysis of seafood and screening of aquatic bacteria for antimicrobial resistance by PCR	2	Kochi (1-29 December, 2018)
131.	Isolation and molecular identification of Staphylococci from different points of waste discharging into Vembanad Lake	1	Kochi (1-29 December, 2018)
132.	Molecular confirmation of *E. coli* from Vembanad region	1	Kochi (1-29 December, 2018)
133.	Laboratory techniques for microbiological examination of seafood	1	Kochi (3-15 December, 2018)
134.	Pre-processing and drying of fish	25	Kochi (4-6 December, 2018)
135.	Smoke curing of fish by scientific and hygienic methods employing COFISKI	55	Umladhkur village of Amlarem Block of West Jaintia Hills District of Meghalaya (6-9 December, 2018).
136.	Solar drying of fish and fishery products	20	Kochi (7 December, 2018)
137.	Fish diseases diagnosis and treatmnent	25	Kochi (10-11 December, 2018)

138	Value added product development	50	ICAR-RC for NEH, Barapani (10-12 December, 2018)
139.	Survival of Salmonella and Listeria in acidified fishery products	1	Kochi (10 December, 2018 – 8 March, 2019)
140.	Prevalence and characterization of *listeria monocytogenes* from fish retail markets	1	Kochi (10 December, 2018 – 8 March, 2019)
141.	Survival of Coliforms in modified atmosphere packaged freeze dried shrimps	1	Kochi (10 December, 2018 – 31 March, 2019)
142.	Basics of Fourier transform infra-red spectroscopy (FTIR)	1	Kochi (11-15 December, 2018)
143.	Disease in aquaculture, diagnosis and its management	69	Kodungallur (12-13 December, 2018)
144.	Value addition of fish and fishery products	50	Chandil, Jharkhand (12-14 December, 2018)
145.	Hygeinic fish handling and pre-processing protocols	25	Veraval (13 December, 2018)
146.	Hygeinic fish handling and pre-processing protocols	25	Veraval (14 December, 2018)
147.	Microbiological examination of seafood pathogens	2	Mumbai (17-21 December, 2018)
148.	Screening for Cephems antibiotic resistant *Escherichia coli* from seafood	20	Kochi (17 December, 2018 – 3 January, 2019)
149.	Value addition of fish and fishery products	25	Mumbai (18-20 December, 2018)
150.	Analysis of biochemical parameters of fish and fishery products	2	Kochi (18 December, 2018 – 5 January, 2019)
151..	Improved fishing techniques (Responsible fishing, trap fishery etc.)	24	SIFT, Kakinada (21-23 December, 2018)
152.	Genotyping of *E. coli* isolated from Vembanad Lake	1	Kochi (1-31 January, 2019)
153.	Antibiotic resistance of bacteria isolated from cultured shrimp	1	Kochi (11-25 January, 2019)
154.	Value added fishery products	15	Thekkady (14-15 January, 2019)
155.	Microbiological examination of seafood pathogens	1	Mumbai (14-18 January, 2019)
156.	Biochemical and microbiological quality evaluation of fish meal and fish oil	2	Kochi (15-18 January, 2019)
157.	Hygienic handling and seafood value addition	25	Sakthikulangara, Kollam (6-17 January, 2019)

158.	FAO assessment tool for laboratories and antimicrobial resistance surveillance systems	25	Kochi (21-25 January, 2019
159.	Distribution of Community Fish Smoking Kilns and demonstration of smoke curing of fish in hygienic conditions	30	SIFT, Kakinada (27 January, 2019)
160.	Fish processing and post harvest engineering technology	19	Kochi (1-2 February, 2019)
161.	Seafood quality assurance	1	Kochi (1-15 Februaray, 2019)
162.	Fish processing and post harvest engineering technology	19	Kochi (1-21 Februaray, 2019)
163.	Advanced analytical techniques for nutrient and contaminant analysis of seafood	12	Kochi (5-7 Februaray, 2019)
167.	Studies on antibiotic resistance pattern of Staphylococcus aureus isolated from aquatic environment	2	Kochi (5 February – 4 March, 2019)
168.	Production and quality evaluation of chitin and chitosan from prawn shell	3	Kochi (7-8 February, 2019)
169.	HACCP concepts	24	Kochi (11-15 February, 2019)
170.	Harvest and post harvest fishery technologies	60	B. Kottur village, Koyyur Mandal, Visakhapatnam (12 February, 2019)
171.	Post harvest fisheries engineering	19	Kochi (13-22 February, 2019)
172.	Quality inspection of fish, concept of cold chain and value addition	16	Kochi (20-23 February, 2019)
173.	Preparation of value added products from fish	10	Veraval (22-24 February, 2019)
174.	Renewable energy based hygienic fish drying methods	12	Veraval (26-27 February, 2019)
175.	Preprocessing and drying of fish	11	Kochi (26-28 February, 2019
176.	Modern analytical techniques in Biochemistry	1	Kochi (1-30 March, 2019)
177.	Prevalence and characterization of *Listeria monocytogenes* from fish retail markets	1	Kochi (10 December, 2018 – 8 March, 2019)
178.	Preparation of value added products from fishon	25	Veraval (8 March, 2019)
179.	Fish waste utilization	25	Kavaratti, Lakshadeep Islands (8-13 March, 2019)
180.	Seafood quality assurance	1	Kochi (12-21 March, 2019)
181.	Value addition of fish and fishery products	25	Veraval (14 March, 2019)

182.	Improved packaging and labeling methods for producing better quality fish	15	Veraval (18 March, 2019)
183.	Renewable energy based hygienic fish drying methods	8	Veraval (19-20 March, 2019)
184.	Harvest technologies and value addition of fish and fish products	50	Munchingpattu, Visakhapatnam (21-23 March, 201)
185.	Isolation and identification of bacteria of public health significance	13	Kochi (26-30 March, 2019)
186.	Fishing gear engineering for increasing inland fishing efficiency and improved smoking process for quality smoked fish products	50	Imphal, Manipur (27-29 March, 2019)
187.	Survival of Coliforms in modified atmosphere packaged freeze dried shrimps	1	Kochi (10 December, 2018 – 31 March, 2019)

ICAR-CIFT stall at Motihari

Shri Radha Mohan Singh, Hon'ble Union Minister visiting ICAR-CIFT stall

Receiving the Best Stall Award

Exhibition during 'Aquaculture and Fisheries Education' symposiumat ICAR-CIFE, Mumbai

Shri Radha Mohan Singh, Hon'ble Union Minister visiting ICAR-CIFT stall at Agri- startup and Entrepreneurship Conclave in New Delhi

'AquaEx India 2019' (Hyderabad)

'Agri-Summit 2019' (Motihari)

2nd World Ocean Science Congress (Visakhapatnam)

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

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

- Dr. Manoj P. Samuel, Principal Scientist and HOD, Engg. - Talk on 'Flood management' (In Malayalam) through 'Kisanvani' Programme of AIR Kochi FM 102.3 on 2 September, 2018.
- Dr. Manoj P. Samuel, Principal Scientist and HOD, Engg. – Panel discussion on 'Water conservation and drought management' (In Malayalam) through AIR Kochi on 28 February, 2019.
- Dr. B. Madhusudana Rao, Principal Scientist - Interview (In Telugu) on 'Livelihood opportunities through value added fish products' through AIR, Visakhapatnam on 10 March, 2019.

Representation in committees

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

Dr. Ravishankar C.N., Director

As Chairman

- KAU-technical Committee for the selection of award winning scientists

As Director

- Lakshadweep Development corporation Limited, Kochi

As Member

- Governing Council, Kerala Agricultural University, Thrissur
- Academic Council, ICAR-CIFE, Mumbai
- Technical committee, Food Safety Standards Authority of India, New Delhi
- Advisory Board, National Network of Veterinary Laboratories Establishment, FAO, New Delhi
- Scientific Advisory Committee, RGCA, MPEDA, Ministry of Commerce
- Core Committee, Selection of Reference Laboratories under FSSAI, Govt. of India
- Selection Committee, ASRB, New Delhi
- Selection Board for Professors, Sri Venkateswara Veterinary University, Tirupathi
- Selection Board, Kerala University of Fisheries and Ocean Studies, Kochi
- Technical Committee on Fish and fishery products, BIS, New Delhi
- Subject Expert – Review of ICAR area of excellance projects, ICAR, New Delhi
- Internal Review Committee of ICAR Niche Area of Excellance programme on Fish Safety and quality Assurance, TNFU, Tuticorin
- Committee for preparing guidelines for hiring technical manpower, ICAR, New Delhi

- Core group for review and finalization of Vision and Perspective Plan of Himachal fisheries
- Committee to review food safety and hygiene requirements for meat, poultry and fish under FSS regulations, FSSAI, New Delhi
- Expert Committee, Sacred Hearts College, Kochi
- Board of Studies in Food Technology, Kerala University of Fisheries and Ocean Studies, Kochi
- Advisory Board, Indian fisheries Society of India

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

As Member

- Academic Council, Kerala University of Fisheries and Ocean Studies, Kochi
- External examiner, CUSAT, Kochi, KUFOS, Kochi, Sri Venkateswara Veterinary University, Tirupathi, College of Fisheries, Thoothukkudi and Mar Athanasius College, Kothamangalam

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

As Member

- FSSAI Scientific panel on antibiotics
- Board of studies, Cochin University of Science and Technology (CUSAT), Kochi
- Board of studies, Sacred Heart College, Kochi

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

As Member

- Expert member in scrutinizing application for the post of Assistant Professor in Kerala University of Fisheries & Ocean Studies (KUFOS), Panangad, Kerala.
- Expert member in Life Science Cluster-Kochi, Kerala State Industrial Development Corporation (KSIDC).

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

As Member

- Technical committee, Dept. of Fisheries, Govt. of Kerala to evaluate the technical bids for LSA and electronic equipments
- TED 18 Sectional committee, BIS, New Delhi
- Board of Studies, M.F.Sc. Fisheries Engineering and Technology, KUFOS, Kochi
- Steering committee for the Fishery improvement project for the Indian oil sardine in the state of Mahsarashtra and Goa
- Expert member (Chancellor's nominee) in the Statutory Selection Committee of Orissa Agricultural University and Technology, Bhuvaneswar.
- Member, Expert Committee on Fisheries policy Constituted by the Govt. of Kerala
- Member, National Research Advisory Committee of National Innovation Foundation Gandhinagar, Gujarat.
- Member, National Steering Committee (NSC) for the Agriculture Sector, Technology Need Assessment Project, TIFAC, DST, Govt. of India.
- Member, Expert committee constituted by Govt. of Kerala for formulation of the conceptual framework for drawing as a comprehensive special package for the overall development of the Ockhi affected fisherfolk in Kerala.

Dr. A.K. Mohanty, Principal Scientist and Head, Extension, Information and Statistics Division

As Member

- Extension Education Council, KUFOS, Kochi
- External Examiner for Post Graduate students of Agricultural Extension of Department of Agricultural Extension, College of Agriculture (KAU), Vellayani

Dr. Manoj P. Samuel, Principal Scientist and Head, Engineering Division

As Member

- Selection Committee for Asst. Professors at KUFOS, Kochi
- Promotion Council, IIFPT, Thanjavur

Dr. A.A. Zynudheen, Principal Scientist, Head In-charge, Quality Assurance and Management Division

As Member

- Technical expert, technical committee for risk assessment for import of fish and fishery products to India organized by DARE, Krishi Bhavan, New Delhi
- Internal quality auditor and academic councilor for distance learning programme Diploma in Fish Products Technology (DFPT) by IGNOU
- Technical committee constituted by Matsyafed for setting up of fish meal plant and glucosamine plant.
- Passing Board of MSc. Industrial Fisheries, School of Industrial Fisheries, CUSAT
- Board of Examiners, M.Sc Aquaculture Course, Calicut University.
- Board of Examiners, M.Sc Aquaculture and Fish Processing Course, SH College, Thevara.
- APE visit for approval fish processing plant.
- Board of examiners of Mahatma Gandhi University and KUFOS.

Dr. R. Raghu Prakash, Principal Scientist and Scientist Incharge, Visakhapatnam Research Centre

As Member

- Board of Studies, Dept. of Marine Living Resource, Andhra University.

Dr. Toms C. Joseph, Principal Scientist Scientist Incharge, Veraval Research Centre

As Chairman

- Town Official Language Implementation Committees, Veraval
- Institution ethics committee, Malabar Dental College and Research Centre, Edappal, Kerala

As Member

- Assessment Panel of experts for approval of seafood processing plants for EU
- Board of Studies of Faculty of Veterinary & Animal Sciences, Kerala, Veterinary and Animal Sciences University.
- Institutional Biosafety committee (IBSC) of Cochin University of Science and Technology (CUSAT)
- Institutional Biosafety Committee (IBSC), College of Veterinary and Animal Sciences, Pookode

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

As Member

- Assessment panel of experts for approval of seafood processing plants for EU
- Experts Panel of Agribusiness Incubation Centre for Association with Vasantrao Naik State Agriculture Extension Management Training Institute (VANAMATI)
- Advisory Committee for Ph.D. students of ICAR-CIFE, Mumbai
- Ph.D. thesis examiner of CUSAT, Kochi

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

As Member

- Member Secretary: Research Advisory Committee, ICAR-CIFT
- Member Secretary: Institutional Animal Ethics Committee (IAEC)
- Recognized NABL Assessor
- Internal Auditor NABL

Dr. Saly N. Thomas, Principal Scientist

As Chairperson

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

As Member

- Expert member (Chancellor's nominee) in the Statutory Selection Committee of Orissa Agricultural University and Technology, Bhuvaneswar.
- Expert committee constituted by Matsyafed, Kerala for implementation for fish net factory.

Dr. M.P. Remesan, Principal Scientist

As Member

- Member, Board of Studies in the Dept. of M.F.Sc Fisheries Engineering & Technology, KUFOS
- Advisory Committee Member for M.FSc Students (Fisheries Engineering and Technology) from KUFOS
- Functioned as Member in DPC held at Coir Board and MPEDA

Dr. Nikita Gopal, Principal Scientist

As Vice Chairperson

- Gender in Aquaculture & Fisheries Section (GAFS) of the Asian Fisheries Society, Malaysia

As Member

- Research Guide KUFOS, Tamil Nadu Agricultural University
- Question Paper Setting and Evaluvation, KUFOS
- Academic counsellor: MA (Rural Development), IGNOU

Dr. V. Geethalakshmi, Principal Scientist

As Member

- Reviewer for 'Lakes & Reservoir' Journal & 'Fishery Technology' Journal
- External Examiner/Question paper setter for UG and PG Statistics courses at KUFOS, Kochi, CIFNET, Kochi and CUSAT, Kochi

Dr. Femeena Hassan, Principal Scientist

As Member

- Assessment panel of experts for approval of seafood processing plants for EU

Dr. J. Bindu, Principal Scientist

As Member

- Advisory Board member, PhD student of KCAET, Tavannur; CVAS, Wyanad; CIFE Mumbai, KUFOS
- External expert for setting up of question papers for the MSc students of KUFOS
- Question paper setter and evaluator for BFSc. and PhD students of KUFOS
- Examiner and evaluator CIFE, Mumbai & Bharathiar University, Coimbatore

Dr. S. Ashaleta, Principal Scientist

As Member

- Member, Academic Advisory Board, KUFOS, Kochi
- Authority Member, MPEDA, Kochi

Dr. U. Sreedhar, Principal Scientist

As Member

- Examiner for CIFNET, Visakhapatnam

Dr. George Ninan, Principal Scientist

As Member

- Assessment panel of experts for approval of seafood processing plants for EU
- Committee of the State Level Agency for Export Development of Aquaculture and Fisheris (SAEDAF)
- MPEDA Subsidy Committees on assistance for large cold storages/conveyance, TUSMP and TIUSMP Schemes, setting up of new ice plant/renovation of existing ice plants and chilled fish handling centers
- Agrinnovate India Ltd. empaneled commercial expert for techno economic assessment committee in commercializing technologies of NARS
- Board of examiners, Calicut University, Calicut/CUSAT, Kochi/MG University, Kottayam

Dr. P. Muhamed Ashraf, Principal Scientist

As Member

- Expert member (Chancellor's nominee) in the Statutory Selection Committee of Orissa Agricultural University and Technology, Bhuvaneswar.
- Member in ISO17025, ISO9000

Dr. B. Madhusudana Rao, Principal Scientist

As Member

- Assessment panel of experts of Export Inspection Council and Marine Product Development Authority
- External Ph.D. Examiner in Marine Sciences, CUSAT, Kochi
- External Post Graduate Students Examiner for GITAM Deemed to be University, Visakhapatnam
- Board of Studies of Microbiology and Biochemistry, Dr. V.S. Krishna Govt. Degree College, Visakhapatnam

Dr. G.K. Sivaraman, Principal Scientist

As Member

- Assessment Panel of Experts for approval of seafood processing plants for EU
- Member of Kerala Antimicrobial Resistance State Action Plan

Dr. S.K. Panda, Principal Scientist

As Member

- FSSAI Scientific Panel on Fish and Fisheries Products
- Method Review Group, FSSAI
- Assessment Panel of Experts, Export Inspection Council
- FAD 12 (Fish and Fisheries Products), Bureau of Indian Standards
- FAD 15 (Food Hygiene, Safety Management and Other Systems), Bureau of Indian Standards
- Technical Working Group, Department of Animal Husbandry Dairy and Fisheries, Ministry of Agriculture and Farmers Welfare, Government of India
- Codex EWG, General Principles on Food hygiene
- Codex EWG, Methyl Mercury in Fish

Dr. A. Suresh, Principal Scientist

As Member

- Departmental Promotion Committee, ICAR-NRC - Meat, Hyderabad
- Executive Committee, Agricultural Economics Research Association (India)
- External Examiner for vivavoce examination of Post Graduate student of Agricultural Economics, College of Agriculture, Vellayani
- Reviewer for the journal, "World Development"

Dr. K.K. Asha, Principal Scientist

As Member

- Member of inter-institutional Working Group 3 on Blue Economy : (Fisheries, Aqua Culture and Fish Processing)

Dr. V.R. Madhu, Principal Scientist

As Member

- Member of the committee constituted for the implementation of Marine Stewardship Council (MSC) certification for 5 species in Kerala.

Dr. C.O. Mohan, Senior Scientist

As Member

- Assessment panel of experts for approval of seafood processing plants for EU
- MPEDA subsidy committee on Assistance to seafood industry
- Faculty of Marine Science, CUSAT
- Academic councellor, IGNOU

Shri M.V. Baiju, Senior Scientist

As Chairperson

- Assessment Committee to two Technical Officers of CMFRI.
- As member
- Technical Committee of Department of Fish., Kerala to evaluate the technical bid receive for AIS, LSA, GPA, Echosounder/Fish finder
- Member of the committee to amend the KMFRA of Dept. of Fisheries attended the meeting to suggest rules for the (1) colour coding of traditional fishing vessels (2) Life span of fishing vessels etc.
- Tender committee for the purchase of marine equipments to the department of fisheries, Govt of Kerala.
- Expert committee of MPEDA, Cochin to provide subsidy for installation of insulated fish hold and refrigeration onboard fishing vessels.

Dr. M.V. Sajeev, Senior Scientist

As Member

- Scientific Advisory Committee, KVK, Kumarakom
- Internal Quality Assurance Committee for IGNOU DFPT Programmet

Dr. Jesmi Debbarma, Scientist

As Member

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

Dr. S. Remya, Scientist

As Member

- Assessment panel of experts for approval of seafood processing plants for EU.
- Physical Verification Committee of MPEDA.
- Technologist assessment committee of EIA, Veraval.
- External examiner in the panel for viva-voce/synopsis presentation of M.F.Sc and Ph.D. students of College of Fisheries, Veraval, Junagadh Agricultural University.
- External expert in the Advisory Committee for M.F.Sc. and Ph.D. students of Kamdhenu University, Gandhinagar.
- External expert in the advisory committee for M.F.Sc. and Ph.D. students of College of Fisheries, Veraval, Junagadh Agricultural University.
- Member in the inspection committee of EIA, Veraval pertaining to Rapid Alert System for Food and Feed.

Smt. V. Renuka, Scientist

As Member

- Assessment panel of experts for approval of seafood processing plants for EU.
- Physical Verification Committee of MPEDA.
- Evaluation panel member for the training conducted by MPEDA
- External expert member for the programme organized by Reliance foundation

Dr. C.G. Joshy, Scientist

As Member

- External Evaluator of Msc. Mark Sheets, Sacred Heart College, Kochi

Dr. P. Viji, Scientist

As Member

- Assessment panel of experts for approval of seafood processing plants for EU

Dr. P. K. Binsi, Scientist

As Member

- Assessment panel of experts for approval of seafood processing plants for EU
- Academic counsellor of IGNOU Study Centre

Dr. A. Jeyakumari, Scientist

As Member

- Assessment panel of experts for approval of seafood processing plants for EU
- Advisory Committee for Ph.D. students of ICAR-CIFE, Mumbai
- External member for setting question paper for M.F.Sc. and Ph.D. programme, TNJFU, Thoothukkudi

Smt. U. Parvathy, Scientist

As Member

- Assessment panel of experts for approval of seafood processing plants for EU
- Woking group on Fisheries, Aquaculture and Fish processing, NITI Aayog

Shri S. Sreejith, Scientist

As Member

- Expert panel on Use of liquefied natural gas (LNG) to replacefuels used in the fisheries sector

Smt. S.J. Laly, Scientist
As Member

- Assessment panel of experts for approval of seafood processing plants for EU
- Committee constituted by Ministry of Commerce for investigating the root cause and possible recommendation to mitigate the issue of formaldehyde in fishes of Goa along with Export Inspection Agency (EIA)

Dr. Anuj Kumar, Scientist
As Member

- Assessment panel of experts for approval of seafood processing plants for EU

Dr. Pankaj Kishore, Scientist
As Member

- Assessment panel of experts for approval of seafood processing plants for EU

Dr. T.K. Anupama, Scientist
As Member

- Assessment panel of experts for approval of seafood processing plants for EU
- External member for setting question paper for M.F.Sc. and Ph.D. programme, TNJFU, Thoothukkudi

Smt. E.R. Priya, Scientist
As Member

- Assessment panel of experts for approval of seafood processing plants for EU

Smt. K.R. Sreelakshmi, Scientist
As Member

- External examiner of M.F.Sc. student thesis of KUFOS, Kochi
- Assessment panel of experts for approval of seafood processing plants for EU

Smt.S.S. Greeshma, Scientist
As Member

- Assessment panel of experts for approval of seafood processing plants for EU

Shri. P. N. Jha, Scientist
As member

- ISO Core Committee to update Quality Manual and risk assessment for upgradation to ISO 9001: 2015 from ISO 9001:2008

Smt.T. Muthulakshmi, Scientist
As Member

- Assessment panel of experts for approval of seafood processing plants for EU

Dr. Abhay Kumar, Scientist
As Member

- Major Advosor for a P.G. student from K.J. Somaiya College, Mumbai

Dr. R.K. Renjith, Scientist
As Member

- Expert committee of MPEDA scheme, Certification of fishjery and chain of custody

Dr. D.S. Aniesrani Delfiya, Scientist

As Member

- Physical verification committee of seafood processing units, MPEDA, Kochi

Smt. P.V. Alfiya, Scientist

As Member

- Physical verification committee of seafood processing units, MPEDA, Kochi

Dr. J. Renuka, Deputy Director (OL)

As Member

- Evaluation Committee, TOLIC, Kochi

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

Dr. B. Ganesan, Chief Technical Officer

As Member : Animal Ethics Committee in

- MET'S School of Engineering, Kuruvilassery Thrissur
- Jubilee Mission Medical College & Research Institute, Thrissur
- Nirmala College of Pharmacy, Muvattupuzha
- Nehru College Pharmacy, Thiruvilwamala, Thrissur
- Pushpagiri College of Pharmacy, Tiruvalla
- Arjuna Natural Extracts LTD, Edayar; Govt. Medical Collage, Kottayam
- CARe KERALAM, Thrissur
- Amrita Institute of Mediacl Sciences and Research Centre, Kochi
- M.G. University, Kottayam
- St: Joseph's College of Pharmacy, Allappuzha

Dr. Santosh Alex, Asst. Chief Technical Officer

As Editor

- Triveni, Kochi TOLIC Journal

As Member

- Evaluation Committee, TOLIC, Kochi

Dr. P. Shankar, Sr. Technical Officer

As Member

- Evaluation Committee, TOLIC, Kochi

Shri P.S. Nobi, Technical Officer

As Member

- ICAR- Central Joint Staff Council
- ICAR- Technical Anomaly Committee
- ICAR- Fishing Vessel Crew Recrutment Rule Amendment Committee

TRAINING AND CAPACITY BUILDING

Human resource development activities

During the period under report, the Human Resources Deveopment Cell of the Institute met many times and as recommended by the HRD Cell, 113 staff of the Institute participated in training programmes during the period (Scientific – 49, Technical – 26 and Administrative & Finance – 38). Further two scientists were sent abroad to attend workshops and conferences.

Participation in trainings (Category-wise)

Sl. No.	Name(s) of participant(s)	Training attended	Venue and date
	Category - Scientific		
1.	Dr. Manoj P. Samuel	Leadership development	ICAR-NAARM, Hyderabad (4-15 June, 2018)
2.	Shri S. Chinnadurai	Remote sensing: An overview for decision makers	IIRS, Dehra Dun (12-15 July, 2018)
3.	Shri K. Ahmaed Basha Dr. V.A. Minimol Smt. S.S. Greeshma Smt. Rehana Raj	HACCP concepts	ICAR-CIFT, Kochi (18-22 June, 2018)
4.	Dr. M.V. Sajeev Dr. Pe. Jeyya Jeyanthi Dr. V.K. Sajesh Dr. K. Rejula Smt. T. Muthulakshmi Smt. P.V. Alfiya	Advanced statistical methods and computational software for fisheries research management	ICAR-CIFT, Kochi (17-26 July, 2018)
5.	Dr. A.A. Zynudheen Dr. G.K. Sivaraman	Laboratory quality system management and internal audit as ISO/IEC 17025: 2017	NIPHM, Hyderabad (23-27 July, 2018)
6.	Dr. A. Jeyakumari	Seafood sampling	EIA, Mumbai (10 August, 2018)
7.	Dr. B. Madhusudana Rao	WHO-NET software	ICAR-NBFGR, Lucknow (17-18 August, 2018)
8.	Shri S. Chinnadurai Shri K.R. Renjith	Good fishing vessel practices and seafood HACCP	MPEDA, Kochi (4-7 September, 2018)
9.	Dr. U. Sreedhar Dr. Jesmi Debbarma Shri G. Kamei	Trainers training programme	MPEDA, Visakhapatnam (10-13 September, 2019)
10.	Dr. V.K. Sajesh Dr. K. Elavarasan Dr. R.K. Renjith	Training of Trainers (TOT) programme	UAS, Bengaluru (24-26 September, 2018

11.	Dr. V.R. Madhu	Time series forecasting of fisheries catch using R	INCOIS, Hyderabad (24-28 September, 2018)
12.	Dr. Ravishankar C.N. Dr. Suseela Mathew Dr. K. Ashok Kumar Dr. M.M. Prasad Dr. Leela Edwin Dr. Manoj P. Samuel Dr. A.A. Zynudheen Dr. Saly N. Thomas Dr. R. Anandan Dr. S.K. Panda	NABL Lead Assessor Training	ICAR-CIFT, Kochi (26-30 September, 2018)
13.	Dr. M.V. Sajeev	Orientation programme for Academic Counselors of DFPT Programme	IGNOU, Kochi (28 September, 2018)
14.	Dr. Saly N. Thomas	Training workshop for Vigilance Officers of ICAR Institutes	ICAR-NAARM, Hyderabad (31 October – 1 November, 2018)
15.	Shri P.N. Jha	Climate change impacts and resilience options for Indian marine fisheries	ICAR-CMFRI, Kochi (8-29 November, 2018)
16.	Dr. P. Viji Dr. S. Remya	Spectroscopic techniques (GC-MS, LC-MS, FT-IR and NMR) in food analysis	CSIR-CFTRI, Mysore (12-16 November, 2018)
17.	Shri R.K. Nadella Dr. V.A. Minimol Smt. S.S. Greeshma Smt. T. Muthulakshmi Shri S. Ezhil Nilavan	WHOINET software for data management of antimicroibial resistance	ICAR-CIFT, Kochi (19 November, 2018)
18.	Smt. U. Parvathy	Spectroscopic and chromatographic techniques for material characterization	ICAR-CIRCOT, Mumbai (27-29 November, 2018)
19.	Dr. S. Visnuvinayagam	Applications of reverse geneticsand transcription profiling in molecular pathogenesis of viral diseases with special reference to avian viruses	Madras Veterinary College, Chennai (28 November – 18 December, 2018)
20.	Dr. N.S. Chatterjee	Basic and advanced proteomics approach	IIT, Bombay (3-14 December, 2018)
21.	Dr. Saly N. Thomas	ICAR Research Data Repository for Knowledge Management	New Delhi (4-5 December, 2018)
22.	Dr. A. Suresh	Impact assessment of agricultural research and technologies	ICAR-NAARM, Hyderabad (4-7 December, 2018)
23.	Dr. A. Zynudheen Dr. M.M. Prasad	Leadership development	ICAR-NAARM, Hyderabad (18-29 December, 2018)

24.	Dr. V. Murugadas	Detection of mycotoxins	Agri-Food Veterinary Authority of Singapore (8-10 January, 2019)
25.	Dr. B. Madhusudana Rao	Assessment Tool for Laboratory AMR Surveillance Systems (ATLASS)	ICAR-CIFT, Kochi (21-25 January, 2019)
26.	Dr. P.K. Binsi Dr. H. Mandakini Devi Smt. U. Parvathy Smt. K. Sarika Shri K.K.Anas Smt. Lekshmi R.G. Kumar Smt. Rehana Raj Dr. Anuj Kumar Shri R.K. Nadella Shri S. Ezhil Nilavan Smt. T. Muthulakshmi Dr. V.A. Minimol	Advanced analytical techniques for nutrient and contaminant analysis of seafood	ICAR-CIFT, Kochi (5-7 February, 2019)
27.	Dr. N. Manju Lekshmi	Rubber wood processing, mechanical property testing and quality control	RRII, Kottayam (26 February – 1 March, 2019)
28.	Dr. K.K. Asha	Effective implementation of training functions by HRD Nodal Officers of ICAR	ICAR-NAARM, Hyderabad (14-16 March, 2019)
		Category - Technical	
29.	Shri N. Sunil	Energy efficiency	KSPC, Kochi (21-24 May, 2018)
30.	Dr. P. Shankar	Motivation and positive thinking	ICAR-NAARM, Hyderabad (21-27 June, 2018)
31.	Dr. P.H. Dhiju Das Smt. P. Sruthi	Advanced statistical methods and computational software for fisheries research management	ICAR-CIFT, Kochi (17-26 July, 2018)
32.	Smt. P.A. Jaya Shri K.A. Noby Varghese Shri P.A. Aneesh	Chromatographic techniques (GC, HPLC, UHPLC) and their analytical approaches in food analysis	CSIR-CFTRI, Mysuru (3-7 September, 2018)
33.	Shri H.V. Pungera	Motivation, positive thinking and communication skills for technical staff of ICAR	ICAR-NAARM, Hyderabad (4-10 October, 2018)
34.	Shri P. Prabhakar	Microbiological analysis of seafood	Visakhapatnam Research Centre of ICAR-CIFT (23 October – 9 November, 2018)

35.	Smt. M. Rekha	Application of advanced molecular methods in marine fishery resources management, conservation and sustainable mariculture	ICAR-CMFRI, Kochi (24 October – 3 November, 2018)
36.	Dr. A.R.S. Menon	Orientation Programme for Retiring Government Officials	ISTM, New Delhi (29-30 October, 2018)
37.	Smt. Sangeetha D. Gaikwad	Spectroscopic and chromatographic techniques for material characterization	ICAR-CIRCOT, Mumbai (27-29 November, 2018)
38.	Shri P. Bhaskaran	KOHA for library staff of ICAR	ICAR-NAARM, Hyderabad (21-26 February, 2019)
39.	Smt. K.G. Sasikala Shri K.C. Anishkumar	Rubber wood processing, mechanical property testing and quality control	RRII, Kottayam (26 February – 1 March, 2019)
40.	Dr. Ancy Sebastian	Motivation, positive thinking and communication skills for Technical Officer (T-5 and above) of ICAR Institutes	ICAR-IISWC, Dehradun (13-19 March, 2019.
Category - Adminsitrative			
41.	Smt. G. Surya Smt. K.S. Sobha	Goods and service tax (GST)	KSPC, Kochi (24 April, 2018)
42.	Shri T.R. Syam Prasad	Organization specific programme for newly recruited Assusstants	ISTM, New Delhi (14 May – 8 June, 2018)
43.	Shri M. Arockya Shaji	Establishment and financial matters for Assistants	ICAR-CPRI, Shimla (15-20 November, 2018)
44.	Shri K.S. Sreekumaran	Goods and Service Tax	ISTM, New Delhi (3-4 December, 2018)
45	Smt. N. Leena Smt. V.S. Aleyamma Smt. G.N. Sarada Shri C.K. Sukumaran Smt. K. Renuka Smt. V.K. Raji Shri K. Das Shri P.K. Somasekharan Nair Smt. G. Surya Smt. Nilina Elais Smt. N.R. Akhila Smt. A.R. Raji Shri P. Mani Smt. Jaya Das Smt. E. Jyothilaksmy	Enhancing the Capabilities of Administrative Personnel (2-4 January, 2019)	ICAR-CIFT, Kochi (2-4 January, 2019)

	Smt. P.R. Mini Shri T.N. Shaji Shri Santhosh Mohan Smt. Shiji John Shri T.R. Syam Prasad Shri P.G. David Smt. K.V. Suseela Shri T.D. Bijoy Smt. K.S. Sobha Kum. T. Deepa Shri P.P. George Smt. Subin George Smt. Suni Surendran Shri G.S. Sahoo Shri deu Umesh Aroskar Kum. N. Archana Shri S.S. Subeesh Shri P.M. Rizwan Smt. C.G. Bhavyamol Smt. S. Joshna Shri T.V. Anish		

During the period under report, the HRD Cell also organized the following inhouse training prorammes:

i Enhancing the capabilities of administrative personnel during 2-4 January, 2019.

ii Advanced analytical techniques for nutrient and contaminant analysis of seafood for Scientists during 5-7 Februaray, 2019.

Visits Abroad

Dr. Ravishankar (Second from left) with other members of the Indian delegation

Dr. Ravishankar C.N., Director, ICAR-CIFT, Kochi visited WorldFish, Penang, Malaysia during 26-27 November, 2018 to finalize the strategy document for submission to ICAR, as a part of the Work plan agreement between ICAR and World Fish. The workshop was attended by both ICAR and WorldFish officials. WorldFish team comprised of Dr. Michael Phillips, Programme Director and Management Committee Chair; Dr. Mohan Chadag, Senior Scientist, Aquaculture and Research Lead, India; Dr. Philippa Cohen, Prof. John Benzie, Dr. David Shearer, Dr. Shakuntala Thilsted, Dr. Sharon and Ms. Claire. The Indian delegation included Dr. J.K Jena, Deputy Director General (Fisheries Science), ICAR, New Delhi; Dr. Bindu Pillay, Director, ICAR-CIFA, Bhubaneswar, Odisha; Dr. Basanta Kumar Das, Director, ICAR-CIFRI, Barrackpore, West Bengal; Dr Ravishankar C.N, Director, ICAR-CIFT), Kochi, Kerala and Dr. Sudhir Raizada, Emeritus Scientist, ICAR-NBFGR, Lucknow.

Dr. Suseela Mathew, Principal Scientist and Head, Biochemistry & Nutrition Division; Dr. A.K. Mohanty, Principal Scientist and Head, Extension, Information and Statistics Division and Dr. George Ninan, Principal

ICAR-CIFT team with WorldFish Team at Combodia (In Circles: Dr. Suseela mathew, Dr. A.K. Mohanty and Dr. George Ninan

Scientist, Fish Processing Division, ICAR-CIFT, Kochi visited World Fish Centre, Siem Reap, Cambodia on deputation during 22-28 October, 2018 to review and learn work being done by WorldFish and partners. The purpose of the visit was mainly interaction of ICAR-CIFT scientists with WorldFish team in Cambodia to get a first-hand experience about the success of "Feed the future Cambodia-Rice field fisheries II project", which aims to improve the food and nutritional security of poor and vulnerable rural households in Cambodia by enhancing the productivity and increasing the availability of rice field fisheries.

Dr. Manoj P. Samuel, Principal Scientist & Head, Engineering Division, ICAR-CIFT, Kochi attended the Conference on "Seafood and fisheries emerging technologies" (SAFET 2019) held at Bangkok, Thailand during 13-16 February, 2019. He also presented a paper on "Development of portable fish freshness assessment sensor based on digital image processing" in the Session on 'Artificial Intelligence and Machine Learning'. He was also a Panel Member in the Session on 'Electronic Monitoring'.

Dr. Manoj P. Samuel making the presentation

Dr. Nikita Gopal, Principal Scientist, Extension, Information and Statistics Division attended the AquaFish Innovation Lab Meetings and AQUA 2018 Conference held at Montepellier, France during 25-29 August, 2018. AFIL organized a panel session on "A conversation with the AquaFish Innovation Lab on the future of sustainable aquaculture" which gave an in-depth view of the status of the AquaFish Innovation Lab project that has been ongoing for more than three decades in several countries in Africa and Asia. Dr. Nikita Gopal moderated the panel 'What is needed now in 2018 to make aquaculture a vital enterprise for smallholders in Africa?'.The forum also discussed whether serious entrepreneurs would be attracted to the same, who actually capture the benefits and the strategies for the advocacy.

Participants of the AFIL Meetings (Dr. Nikita Gopal in circle)

Dr. Nikita Gopal, Principal Scientist also attended the 1st International Conference on 'Women in fisheries' held at Santiago de Compostela, Galicia, Spain during 5-7 November 2018. The event organized by the General Secretariat of Fisheries of the Ministry of Agriculture, Fisheries and Food (Spain), in collaboration with the Xunta de Galicia and the Organization of the United Nations for Food and Agriculture (FAO). Dr. Nikita spoke at the Inaugural Plenary of the Conference as a Social Block Speaker on

Dr. Nikita Gopal at the Inaugural plenary

5 November, 2018. She was an invited panelist at the Workshop on 'Role of women in fisheries and aquaculture' held on 6 November, 2018.

Dr. Nikita Gopal, Principal Scientist, Dr. Pe. Jeyya Jeyanthi and Dr. K. Rejula, Scientists, Extension, Information and Statistics Division, ICAR-CIFT, Kochi attended the 7th Global Conference on 'Gender in Aquaculture and Fisheries' held at Asian Institute of Technology, Bangkok, Thailand, during 18-21 October, 2018. The Scientists from ICAR-CIFT also presented research papers in the Conference.

Dr. L.N. Murthy, Principal Scientist and SIC, Mumbai Research Centre of ICAR-CIFT and Dr. A.K. Jha, Scientist, Veraval Research Centre of ICAR-CIFT attended the International Conference "Asian Aquaculture – 2018' held at Asian Institute of Technology (AIT), Bangkok, Thailand during 3-6 December, 2018. They also presented research papers in the Conference.

Dr. L.N. Murthy and Dr. A.K. Jha with other delegates

Dr. P. Muhamed Ashraf, Principal Scientist attended the Global project workshop on "In situ observation of the coastal productivity deoxygenation and acidification" held at Lisbon, Portugal during 18-20 April, 2018. He also presented a research proposal entitled, "In situ studies on oxygen and carbon dynamics in selected coastal waters of India and its impacts on fisheries". The project partners are ICAR-CMFRI and NERCI, Kochi.


Dr. P. Muhamed Ashraf with other delegates of the workshop


Dr. Madhusudana Rao Chairing the Woorking Group II Session

Dr. B. Madhusudana Rao, Principal Scientist participated in the FAO-NACA Regional consultation and related study on 'Antimicrobial resistance (AMR) risk to aquaculture in Asia' and preliminary consultation on 'Monitoring of AMR in bacterial pathogens in aquaculture' held at Bangkok, Thailand during 4-7 September, 2018.

Dr. V. Murugadas, Scientist, Microbiology, Fermentation and Biotechnology Division, ICAR-CIFT, Kochi was deputed to Singapore to attend the FSSAI sponsored Training workshop on "Detection of mycotoxins' held at Agri-Food Veterinary Authority of Singapore during 8-10 January, 2019. The training was held at the laboratory which tests all the products imported to Singapore for domestic consumption from neighbouring countries including India for the various parameters.

Dr. Murugadas and other participants of the Workshop

LINKAGES/PARTNERSHIPS

Collaboration with other institutes
Local Institutions in the area other than ICAR Institutes

- Goa Shipyard Ltd., Goa
- Marine Products Export Development Authority, Kochi
- Export Inspection Agency, Kochi, Visakhapatnam, Veraval
- Naval, Physical and Oceanographic Laboratory, Kochi
- Fishery Survey of India
- National Institute of Oceanography, Goa, Kochi
- Central Institute of Fisheries Nautical Engineering and Training, Kochi
- Kerala Fishermen's Co-operative Federation (MATSYAFED), Thiuvananthapuram
- National Institute of Fisheries Post Harvest Technology and Training, Kochi
- Kerala State Pollution Control Board, Kochi
- Cochin University of Science and Technology, Kochi
- 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, Biohar, 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 Devekllopment Authority
- Andhra University, Visakhapatnam
- Amity University, Noida
- JNTU, Hyderabad
- Sri Venkateswara Veterinary University, Tirupati
- State Institite of Fisheries Technlogy, 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, Cocimbatore
- College of Fisheries, Veraval, Gujarat
- Junagadh Agricultural University, Junagadh, Gujarat
- Kamadhenu University, Gandhi Nagar, Gujarat
- Chrish College, Rajkot, Gujarat
- Shri M.N. Virani Science College, Rajkot, Gujarat

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

Extension and Development Agencies

- 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)
- Chellanam Panchayat SC/ST Co-operative Society Ltd., Kochi
- Development Action through Self Help Network (DARSHN)
- Agency for Development of Aquaculture in Kerala (ADAK)
- 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
- District Youth Fisheries Welfare Association, Visakhapatnam

Consultancies

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

Sl No.	Name of the firm	Consultancy
1.	M/s. WEBAP Ventures, Kakkanad, Ernakulam	Production of cleaned fish and packaging
2.	M/s Capitano Ventures, Sasthamangalam P.O., Thiruvananthapuram	Technical know-how and training in the value addition of fish (Drying, marination, battered and breaded products)
3.	M/s. Coal India Ltd., Kolkata	Contract research project on 'Establishment of community fish smoking kilns (COFISKI)'
4.	M/s. ICAR-Indian Institute of Spices Research, Kozhikode	Contract service work for NABL accreditation of their laboratories
5.	M/s. Janatha Fish Meal and Oil Products, Kota, Karnataka	Preparation of detailed project report on Commercial purse seining
6.	M/s. Aabbaa Food Products, Champakkara, Ernakulam	Setting up a Solar fish dryer (50-60 kg capacity) with electrical backup
7.	M/s. J. Arc Communications and Power Solutions, Thiruvananthapuram	Certification of marine engines
8.	M/s. Swaminathan Research Foundation, Tharamani, Chennai	Undertaking a task on regulation, required institutional mechanism, current schemes, financial facilities, credit availability, approach, value addition and recommendations for fisheries as model for agricultural commodities in view of doubling farmers
9.	College of Horticulture, KAU, Thrissur	Availing HPP facility at the Institute for the research project on 'Effect of HPP on textural and nutritional behavior of minimally processed fruits and vegetables'
10.	Kerala Livestock Development Board (KLDB), Thiruvananthapuram	HACCP certification of three stations
11.	Town Harbour, Edappally, Kochi	Technical guidance and design of ICAR-CIFT descaling machine'
12.	J. Arc Communications & Power Solutions, Thiruvananthpuram	certification of marine engines
13.	M/s. Hi-Media Laboratories Pvt. Ltd., Mumbai	Licensing Rapid Detection Kits (CIFTest) for checking adulteration of fresh fish with formaldehyde and ammonia
14.	M/s. Baby Marine Seafoods Retail Pvt. Ltd., Kochi	Technology transfer on product optimization, nutrient profiling, process training and shelf life study of value added frozen fishery products
15.	M/s. Hi-Q Agro Foods, Nadapuram, Kannur	Optimization of process conditions for the production of jackfruit based products

16.	M/s. Coral Exports, Kochi	Transferring the technology of fish cutlet and its nutritional profiling
17.	M/s. Sanj Feed Technologies Pvt. Ltd., Nandyal, Andhra Pradesh	Transfer of technical know-how for the production of protein hydrolysate from fishery waste
18.	M/s. Ponnoos Fish Feed, Kodungallur, Thrissur	technology transfer of production of feed from fish waste
19.	Nallakarshakan Agro Pvt. Ltd., Manjummel, Kochi	technology transfer of production of chilled fish and dry fish
20.	M/s Chellanam Sea Fish, Chellanam, Kochi	technology transfer of production of fish pickle and fish silage
21.	M/s. Sagar Manthan Machhimar Utthan Mandal, Veraval	technology transfer of production of value added fish products
22.	M/s. Fab Dye Kem Pvt. Ltd., Aroor, Alappuzha	technology transfer of production of protein hydrolysate from fish/shrimp waste
23.	Shri K. Johnson, Vallukkattil Villa, Chennithala, Mavelikkara, Alappuzha	technology transfer of production of seafood snacks viz. Paratha, nuggets, cutletr, samosa and momos
24.	M/s. GrenMarine India, Thevar, Kochi	technology transfer for pre-processing and packaging of fresh fish
25.	M/s. Travancore Pickles, Nedumangad, Thiruvananthapuram	production of fish pickles
26.	M/s. Mejillon Foods, Calicut	production of frozen stuffed mussel recipes
27.	M/s. Al-Badr Lacadive Ventures JV	providing Detailed Project Report (DPR) for fish processing unit for production of tuna loins
28.	Shri Pentapalli Rambabu, Yellampeta P.O., Visakhapatnam	technology transfer for the manufacturing of insulated fish bags
29.	Smt. Shahina Nishad, Shamila Manzil, Changanasserry, Kottayam	technology transfer for production of fish pickle
30.	M/s. Eklavya Biotech Pvt. Ltd., Ghatkopar (E), Mumbai	technology transfer for production of fish collagen peptide and hydroxyapetite
31.	M/s. Al-Badr Seafoods Pvt. Ltd., Lakshadweep Islands	consultancy project for providing DPR for establishing of export oriented tuna loin freezing plant (fish processing unit) at Lakakshadweep
32.	M/s. Accelerated Freeze Drying Co. Ltd., Alappuzha	technology transfer for extraction protocol of seaweed sulphated polysaccharide and fucoxanthin from seaweed
33.	Shri P. Rambabu, Tailor, CBM High School Road, Visakhapatnam	technology transfer for insulated fish bags (Cylindrical model, Back pack model, Big, small and medium sized insulated bags, convenience bags).
34.	Presidents of Kharwa Fishermen Community and Sidi Tribal Community	transfer of technology (ToT) for preparation of fish-based value added products under two different projects

Exchanging MoA for transfer of technology of ICAR-CIFT insulated fish bag

Exchange of MoU between Director, ICAR-CIFT and President, Sidi Samaj

Exchange of MoU between Director, ICAR-CIFT and President, Kharwa Samaj

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. Samples were tested in the different laboratories at Headquarters and research center of ICAR-CIFT and test reports were sent to the concerned.

Past year in the life of ICAR-CIFT

Workshops/Short Courses/Seminars etc. conducted

Workshop on 'DOSA': A one day workshop was conducted on Indo-UK collaborative project on 'Diagnostics for one health and user driven solutions for AMR (DOSA)' at Visakhapatnam Research Centre of ICAR-CIFT on 20th September, 2018. All scientists of the Centre attended the Workshop. Representatives from ICAR-CMFRI, Visakhapatnam Regional Centre, MPEDA, EIA and State Fisheries Department have also attended the Workshop.

Important Training Programmes

Training Programme Pragmatization of SOP's of INFAAR Project: A hands on Training for Young Professionals on "Pragmatization of SOP's of INFAAR project" under the Network Project on 'Assessment of anti microbial resistance in micro organisms associated with fisheries and aquaculture in India' was organized at ICAR-CIFT, Kochi during 22-31 October, 2018. During the programme, lectures were delivered and a field visit was also made to Thrissur to get the trainees acquainted with sampling procedures. The isolation, characterization, phenotypic and molecular identification of the target organisms viz. *E. coli*, *Vibrio parahaemolyticus* and *Staphylococcus aureus* were dealt in detail.

Practical session in progress

International Training Programme on Extension Management Technique: ICAR-CIFT registers the unique distinction of organizing the prestigious International training programmes on "Extension Management Techniques for Up-scaling Technology Dissemination in Fisheries" during 9-22 November, 2018

ITEC Trainees with resource persons

sponsored by Indian Technical and Economic Cooperation (ITEC), under Ministry of External Affairs, Govt. of India. The main objective of the programme was to build the capacity of trainees on recent technological advancement in the field of harvesting and post harvesting in fisheries blended with innovative extension approaches, extension management techniques for effective technologies dissemination to the end users. The 14-day long training programme was attended by 20 senior government officials from 14 developing countries namely Algeria, Guatemala, Mauritius, Oman, Sri Lanka, Sudan, Syria, Tanzania, Tunisia, Uganda, Zimbabwe, Malawi, Afghanistan and Bangladesh spreading over, Asia, Africa and North America.

Training in progress

International Training Programme on Fish Processing: ICAR-CIFT, Kochi organized an international training programme on "Protocols for the Production of High Value Secondary Products from Industrial Fish and Shellfish Processing" during 26 November to 22 December, 2018, sponsored by ITEC under Ministry of External Affairs, Government of India. This programme was participated by ten participants from eight different countries namely, Afghanistan, Algeria, Iraq, Myanmar, Nigeria, Serbia, Sudan and Tanzania. The trainees were imparted with knowledge and skills on improved technologies related to fish processing technologies.

Assessors Training Organized by FAO at ICAR-CIFT, Kochi: Food and Agriculture organization conducted assessors training at its Nodal Centre ICAR-CIFT, Kochi during 21-25 January, 2019. About 20 Project Investigators associated with the INFAAR project from different ICAR research institutes of fisheries and animal science all over India actively participated in the training programme. Five FAO experts who imparted training to the participants included Dr. Joy Gordoncillo, Dr. Michael Treilles, Dr. Francesca Latronico, Dr. Rajesh Bhatia, Former AMR Advisor and Dr. Rajesh Dubey, National Operational Officer, FAO, India. Dr. J.K. Jena, Deputy Director General (Fisheries and Animal Sciences), ICAR, New Delhi inaugurated the programme on 21 Januray, 2019.

Dr. J.K. Jena delivering the inaugural address

Events

Secretary (DARE) & DG (ICAR) visited Veraval Research Centre of ICAR-CIFT: Dr. T. Mohapatra, Secretary (DARE) & Director General (ICAR) visited Veraval Research Centre of ICAR-CIFT and CMFRI on 7 April, 2018. During his visit he interacted with stakeholders from Seafood Export Association, Boat Owners'

Association, Krish Vigyan Kendra and fishermen community along with the scientists and visited different laboratories of both the Centres. Then he made a review of the ongoing research activities of the Centres. The meeting was also attended by many stakeholders of ICAR-CIFT and ICAR-CMFRI.

Hon'ble Director General having discussion with stakeholders and scientists

The Ethiopian delegates visiting research laboratories

Ethiopian University Delegation visited ICAR-CIFT, Kochi: A delegation from the Hawassa University, Ethiopia visited ICAR-CIFT, Kochi on 29 May, 2018. The five member delegation was led by the President, Ato Ayano Beraso Hula. The members interacted with the Dr. Ravishankar C.N., Director ICAR-CIFT and other senior personnel and discussed about mutually beneficial collaborative areas of work. The President told that the University had started a Master's Programme in Fisheries and there was need to develop capacities and infrastructure for the same. There was ample scope for fisheries which was at present on a small scale and mainly for household consumption and there is immense potential through its vast inland freshwater resources like lakes and rivers. The delegation later visited the laboratories and facilities of the Institute and had discussions with the scientists on technologies developed by ICAR-CIFT and their uses for the sector.

Director, ICAR-CIFT explaining about fish dryer to Hon'ble Minister Shri Deepak Kesarkar

Minister of State, Govt. of Maharashtra visted ICAR--CIFT, Kochi: Shri Deepak Kesarkar, Hon'ble Minister of State for Finance, Planning and Home (Rural), Government of Maharashtra visited the ICAR-CIFT, Kochi on 20 April and 2 May, 2018 and discussed with the scientists about the potential areas where ICAR-CIFT can intervene. It was decided that ICAR-CIFT will provide the design for deep sea fishing vessels for artisanal fishermen groups for empowering them and lend assistance for optimization of gillnets for reservoirs as well as craft and gear for sport fishing. It was also decided to establish 34 solar dryers in the area to support the livelihood security of fisherwomen in the area and ICAR-CIFT may intervention in post-harvest sector for establishment of incubation centres, mini processing plants and provision of technical guidance for packaging, branding and marketing that will lead the growth of fisheries sector altogether.

Establishement of model solar dried fish products: A new business model for solar dried fish products has been introduced in Kochi, by a start up firm 'M/s Aabbaa Fish Products' with the support of ICAR-CIFT, Kochi at St. James Church, Chambakara on 10 April, 2018. The design of the store, the products, and the display settings, suits the new age retailing business, and the store is the first of its kind in Kerala. All the products sold here are scientifically processed using the energy efficient and eco-friendly solar dryers developed by ICAR-CIFT. ICAR-CIFT provided all the technical support and guidance to this firm, through the Agri-Business Incubation (ABI) Centre operating at the Institute.

Shri P.T. Thomas inaugurating the Unit

The new store at Chambakara market was inaugurated by Shri P.T. Thomas, MLA in presence of Shri V.P. Chandran, Corporation Councilor, Dr. Ravishankar C.N., Director, ICAR-CIFT, Dr. Manoj P. Samuel, Head, Engineering Division, ICAR-CIFT and Dr. George Ninan, OIC, ABI Centre.

Technological Support and Launch of Table Top Fish Descaling Machine: ICAR-CIFT, Kochi has developed a motor operated table top fish descaling machine (5 kg capacity) for easy removal of scales. This machine can remove scales from almost all species/sizes of fishes ranging from marine to freshwater species like Sardine, Tilapia, Rohu etc. The table top descaling machine was launched by ICAR-CIFT at the sea food delivery and retail outlet, Town Harbour, Madom Junction, Edapally, Cochin on 11 June, 2018. In addition, ICAR-CIFT provided technological support for sea food processing and packaging. The sea food delivery and retail outlet was formally inaugurated by Dr. Ravishankar C.N, Director, in presence of Dr. George Ninan, OIC, ABI Centre and other staff members of ICAR-CIFT, Kochi.

Dr. Ravishankar C.N, Director inaugurating the sea food delivery and retail outlet

Inputs distribution and training cum demonstration on gillnet fihing

At Aliyar Reservoir, Tamil Nadu: The distribution of inputs to fishermen of Aliyar under Scheduled Tribe Component (STC) was organized as a public programme at Aliyar dam, Tamil Nadu on 18 April, 2018. The programme was well attended by representatives of Tamil Nadu Fisheries Development Corporation (TNFDC), Scientists from ICAR-CIFT and fishermen. Standardized fishing gear, coracles, inputs like weighing balance, Lifebuoy, etc. were distributed to eight fishing units operating all over the year at Aliyar dam.

At Kanjirapuzha, Kerala: The distribution programme of inputs to fishermen of Kanjirapuzha was held on 20 April, 2018. Representatives from Fisheries Department, Govt. of Kerala and ICAR-CIFT were present during the programme conducted as a part of ongoing Institute project on 'Economic evaluation of resource use efficiency and management of reservoir ecosystem'. A technical information brochure in Malayalam on gillnet fishing was distributed to the fishers. There are 17 fishermen units at Kanjirapuzha and fishing operations is undertaken all round the year. Interaction with the fishermen was held after the programme. The fishermen felt the need for a sale counter with a platform for cutting and cleaning fresh fish Wide media coverage was given to the programme in Mathrubhoomi and Malayala Manorama newspapers.

Inputs distribution

Group discussion in progress

Stakeholder Consultation Meeting: A Stakeholder Consultation meeting on 'Food fraud' supported by FSSAI, New Delhi was organized at ICAR-CIFT, Kochi on 17 April, 2018.

Fish-preneur Promotion Programme: Veraval Research Centre of ICAR-CIFT organized a 'Fish-preneur promotion programme' on 6 April, 2018. The programme conducted to promote entrepreneurship amongst women of Kharwa community and Sidi tribal groups of Veraval was attended by the Collector and District Magistrate of Gir-Somnath District and presided by Dr. Ravishankar C.N., Director ICAR-CIFT.

Institute Research Council Meeting: The Annual Research Council Meeting of the Institute was held during 10-12 April, 2018 to discuss about the ongoing research projects of the Institute and to finalize the new research programmes to be initiated in April, 2018. Accordingly 10 new research projects were approved for implementation.

Shri Tarun Shridhar, Secretary, DADF interacting with scientists

Visit of Secretary: Shri Tarun Shridhar, IAS, Secretary, Department of Animal Husbandry, Dairy and Fisheries (DAHD&F) under Ministry of Agriculture and Farmers' Welfare, Government of India visited ICAR-CIFT, Kochi along with Shri K.S. Srinivas, IAS, Chairman, MPEDA, Kochi. They had an effective interaction with scientists from ICAR-CIFT, ICAR-CMFRI and CIFNET regarding the marine fishing regulations, responsible fisheries and food safety issues. He advised that MPEDA should take a lead to bring together all the stakeholders in the sector on quarterly basis to discuss about the strategic research developments in fisheries matching with need of the hour.

ICAR-CIFT designed fishing vessels flagged off in Tamil Nadu: As a harbinger of a new revolution in deep-sea fishing in India, ICAR-CIFT, Kochi created an impact on Indian fishing sector by signing an MoU with M/s. Cochin Shipyard Limited (CSL), Kochi for providing technical consultancy in the design of 22.50 m Long liner cum Gillnetter. On 19 February, 2019 the first batch of four vessels designed by ICAR-CIFT, Kochi and constructed by CSL was flagged off by the Honorable Chief Minister of Tamil Nadu Shri Edappadi K. Palaniswami through video conferencing in a function organized at CSL.

The Honourable Chief Minister of Tamil Nadu flagging off the first vessel through video conferencing

Inauguration of new fish biochemistry laboratory by Dr. J.K. Jena

Biochemistry Laboratory of Mumbai Research Centre Inaugurated: Mumbai Research Centre of ICAR-CIFT has established an additional facility of fish biochemistry laboratory which has two sections, one for instrumental facility and the other one for routine biochemical analysis. On 2 March, 2019, Dr. J.K. Jena, Deputy Director General (Fisheries Sciences), ICAR, New Delhi inaugurated the new facility.

Industry interface programme at ICAR-CIFT, Kochi: An Industry Interface Programme was organized by the Zonal Technology Management - Agribusiness Incubation (ZTM-ABI) Centre, ICAR-CIFT, on 27 March, 2019, at Kochi for showcasing the innovations from eight fisheries research institutions under ICAR. The

Shri Alex Ninan, President, Seafood Exporters Assopciation of India (Kochi region) delivering the Chief Guest's address

event brought together innovators and entrepreneurs from the field of fisheries on a single platform. A total of 70 participants representing fisheries industry, processors, exporters, brackishwater/freshwater aquaculture/ farmers, ornamental fish breeders, cage culturists, startups, entrepreneurs, private investors and Govt. agencies, attended the programme.

Celebrations

Swachh Bharat Diwas Celebrations: As part of Gram Swaraj Abhiyan, Swachh Bharat Diwas was celebrated ICAR-CIFT, Kochi at Aliyar reservoir region, Aliyar, Tamil Nadu on 18 April, 2018.

Swachh Bharat Diwas at Aliyar reservoir region, Aliyar, Tamil Nadu

Foundation Day: ICAR-CIFT celebrated its 61st Foundation Day on 28 April, 2018. On the occasion, two MoUs were exchanged between ICAR-CIFT and M/s. HI-Q Agro Foods, Nadapuram, Kozhikode and M/s. Aabbaa Fish Products on Jack fruit processing and Solar Dryer (50-60 kg) respectively. The Institute conducted an 'Open House' programme to reach out to the common people to expose them to the innovative technologies of institute and interact with scientists. Dr. K.K. Vijayan, Director, ICAR-CIBA, Chennai was the Chief Guest of the function in which selected retired employees of the Institute were also felicitated.

Inauguration of Founbdation Day Celebrations
Exchanging of MoU to M/s Hi-Q Agro Foods by Dr. Ravishankar C.N., Director, ICAR-CIFT. Also seen is Dr. K.K. Vijayan, Director, ICAR-CIBA, Chennai

World Ocean Day: Dr. Pravin Putra, Assistant Director General (Marine Fisheries), ICAR, New Delhi inaugurated the "World Ocean Day" celebrations at Veraval Research Centre of ICAR-CIFT on 8 June, 2018. During his inaugural speech, Dr. Pravin emphasized on the challenges faced by the fishermen community due to plastic pollution and sewage dumping into the sea. He suggested to take a pledge on minimal usage of plastic products and materials in day-to-day life and start use of recyclable material to combat with the plastic pollution. Dr. K.K. Prajith, SIC of the Centre welcomed ADG

Dr. Pravin Putra addressing the staff

to the Centre and explained the various research activities. As a part of the celebrations, various competitions (Elocution, drawing etc.) were conducted at the Centre and the prizes to winners were distributed by the guest.

Shri Peter Mathias deleivering the talk

World Environment Day: World Environment Day was celebrated at ICAR-CIFT, Kochi on 5 June, 2018. Shri Peter Mathias, President, Kerala Boat Operators Association, Kollam delivered a talk on the initiatives of the Kollam Trawl Operators Association with Kerala Suchitwa Mission.

Visakhapatnam Research Centre of ICAR-CIFT promoted 'Plastic Free Oceans for a Safe Home for Aquatic Life.' In this connection an awareness march was conducted on R.K. Beach and planting of saplings in the office and residential areas at Pandurangapuram, followed by distribution of vegetable seeds to promote backyard and terrace farming as a step towards 'Grow Your Own Food at Home' scheme. Ecofriendly banner was made of natural fiber and organic paint.

International Day of Yoga: ICAR- CIFT celebrated the International Day of Yoga on the 21 June, 2018 at its Headquarters at Kochi and its Research Centres at Veraval, Visakapatanam and Mumbai. At Kochi, the guest of the day was Ms Meera Menon, Isha Foundation Volunteer. At Veraval Research Centre, Shri Thakar Abhay, Director, Abhayam, Yog Prashikshan, Veraval, served as the Yoga Guru for the session. At ICAR-CIFT, Visakhapatnam Research Centre Ms. G. Roopa, a certified Yoga trainer from Yoga village, Andhra University was the Chie Guest while at Mumbai Research Centre, Smt. Rekha Chatterjee, a professional Yoga Teacher was the Guest.

Yoga ssessions at Kochi, Veraval, Visakhapatnam and Mumbai

World Fisheris Day: ICAR-CIFT, Kochi celebrated 'World Fisheries Day' on 21 Novemeber, 2018 to create awareness on conservation of fisheries resources and protection of environment among students of fisheries. As part of the celebrations, a one day Workshop on "Responsible fishing" was organized at ICAR-CIFT. The programme was attended by 44 fisheries graduate and post graduates from local colleges in and around Kochi along with scientists and staff of the Institute.

Dr. C.N. Ravishankar, Director, ICAR-CIFT addressing the gathering

World Antibiotic Awareness Week: The World Antibiotic Awareness Week (WAAW) was observed at ICAR-CIFT, Kochi during 12-18 November, 2018. As a part of it, a series of lectures were delivered by the Scientists on various topics viz. Indian Network of Fishery and Animal Antimicrobial (INFAAR) programme and its importance, Methicillin Resistant *Staphylococcus aureus* (MRSA), Extended Spectrum Beeta Lactamase (ESBL) *E. coli*, historical development of Anti Microbial Resistance (AMR) and how it can impact the world-wide economy and GDP of under-developed and developing countries. The participants included technologists

from seafood industry and post graduate students from different colleges. On 16 November, 2018 a one-day Workshop was organized for the benefit of 26 fisherwomen of Kumbalam village, Kochi. On 19 November, 2018, Dr. Rajesh Bhatia, Regional Technical Advisor for Anti Microbial Resistance (AMR), FAO delivered an invited talk on "One health approach to combat AMR" at ICAR-CIFT, Kochi.

Participants and faculty of the programme at ICAR-CIFT. Intercation with participants at Kumbalam

Vigilance Awareness Week: The Institute observed 'Vigilance Awareness Week' during 29 October to 3 November, 2018. The observance of the week commenced on 29 October with a pledge administered by the Director to all staff members. On 31st October, a Quiz Competition was conducted. On 3rd November, 2018 Dr. Raju Narayana Swamy, IAS, Chairman, Coconut Development Board, Kochi delivered a talk on "Eradicate corruption – Build a New India'.

National Unity Day: National Unity day (Rashtriya Ekta Diwas) was observed on 31 October, 2018 as part of the birth anniversary of Sardar Vallabhai Patel. The Director and staff assembled together on the day and took National Unity Pledge.

Quami Ekta Week: Quami Ekta Week was observed during 19-25 November, 2018 and Flag Day on 22 November, 2018. On 24 November all the staff members of the Institute assembled together and took National Integration Pledge.

World Soil Health Day: On 5 December, 2018, as part of World Soil Health Day Celebrations, a special lecture was arranged on "Climate change and soil and water management practices"by Dr. Manoj P. Samuel, Principal Scientist & Head, Engineering Division in which he focused on soil pollution, soil degradation and food security.

Lecture on 'Climate change and soil and water management'

Swachh Pakhwada: Awareness programme on hygiene and sanitation was conducted at roadside fish market at Soudi, Kochi on 18 December, 2018. Pamphlets were distributed to vendors on hygienic handling of fish and the importance of sanitation. Inputs like trays for hygienic fish vending was distributed to the vendors. Another awareness programme on hygiene and sanitation was organized at Elamkunnapuzha Govt. L. P. School on 19 December, 2018. A video on the need for cleanliness was displayed to the students. About 75 students participated in the cleanliness drive organized within the school campus. A talk on "Clean energy for aqua-tourism and inland fishing" was delivered by Shri M.V. Baiju, Senior Scientist, ICAR-CIFT at Kumarakom on 21 December, 2018. Technology on "Solar boat" designed and fabricated by the Institute was explained to inland fishermen. A demonstration was conducted on 29 December, 2018 on a cost-effective techniques for converting domestic waste into manure developed at Kerala Agricultural University, Thrissur which has brought change in waste management in a few Panchayats of Alappuzha and Thrissur districts.

Awareness programme at Soudi, Kochi

Awareness programme on hygiene and sanitation at Elamkunnapuzha Govt. L. P. School

Shri M.V. Baiju delivering the lecture

Shri Mahesh Mohan demonstrating waste conversion model

Staff of Veraval RC of ICAR-CIFT join hands with Coast Guard to pick up litter during the cleanup

Veraval research Centre of ICAR-CIFT observed, "Swachhta Hi Seva" programme during 15 September - 2 October, 2018. On 15 September, 2018, 'Sewa Diwas' was celebrated and every employee devoted 2 h for cleaning and sweeping of office campus (Shram Daan). On the same day, a Swachhta pledge was taken by all the employees and an awareness talk on 'Microbiological concerns in sanitation and hygiene' was given by Dr. Toms C. Joseph, Scientist In-Charge of the Centre. In addition to general cleaning of the office premises, some additional activities were also carried out by the staff. Veraval Research Centre of ICAR-CIFT joined hands with the Indian Coast Guard to celebrate the 'International Coastal Cleanup Day', to reaffirm the commitment towards cleaner coasts and Swachh Bharat for a better tomorrow. International Coastal Cleanup Day is celebrated annually in the third Saturday of every year.

Demonstration of palm impression technique at Govt. School, Jaleshwar, Gujarat

On 26 and 27 September, 2018, talks on 'Better sanitation practices' was given by Shri Yogesh D. Kriplani, Technical Assistant of the Centre for the students of Govt. School, Jaleshwar and Govt. School, Bhidia, respectively. Also, palm impression technique was demonstrated to show the efficacy of washing with soap in reducing the count of viable bacteria on hands.

On 1 October, 2018, a talk on "Plastic Pollution'' was delivered by Dr. A.K. Jha for the students of Aditya Birla Public School, Veraval and Govt. School, Bhidia. Dr. S. Remya talked on 'Importance of sanitation and hygiene in daily life'.

Swachhta Action Plan – Fish Waste Utilization Programme of ICAR-CIFT: Under the Swachhta Action Plan, a sanction of ₹ 10.00 lakhs was received by ICAR-CIFT, Cochin for implementing the "Management and commercial utilization of waste in 20 fish markets (10/year) in urban locations" from the Council. Under the programme it was envisaged to cover 20 fish markets/fish landing centres located in six states namely Kerala, Tamil Nadu, Karnataka, Andhra Pradesh, Maharashtra and Gujarat along with two markets at Delhi. Procurement of model kit consisting of equipments/tools for demonstration of the technology on conversion of fish waste to feed/manure was made. A processing line including meat mincer for preparation of fish silage from fish waste was perfected and tested for field trials. On 30 January, 2019 the inaugural function of the programme was held at Thoppumpady fisheries harbor, Ernakulam. The Chief Guest of the programme was Shri K.K. Kunjachan, Councilor, Kochi Nagara Sabha. Dr. A.A. Zynudheen, Principal Scientist & I/c QAM Division, ICAR-CIFT, Kochi explained the technical details of the technology on "fish waste conversion to feed" and how it can be implemented at a larger scale at fish markets and harbours where tons of waste gets generated. The inaugural function was followed by a demonstration on the technology on conversion of fish waste to feed.

Inaugural address by Shri K.K. Kunjachan

International Women's Day: As part of International Women's Day Celebrations, a live webcast of the Hon'ble Prime Minister, Shri Narendra Modi's address to the nation was arranged at the Institute on 8 March, 2019. Dr. Ravishankar C.N., Director presided over the formal function in which Smt. Lakshmi Atul, Vice-president of Aries Group of Companies and Mrs. India Face of South - Queen of Substance and Mrs. India – Intelligent (2017), Mrs. United Nation Grand Prix (2018), Vice President of the prestigious IndyWood Film Carnival, Head of the Oscar Awards Consultancy and the Film Festival Promotion Divisions was the Chief Guest. A video showing 'Indian First Women Achievers during recent past' was also screened. The 'Woman Icon of ICAR-CIFT-2019' (both winner and runners) selected through opinion poll were honored during the function. The function came to an end with a graceful classical dance performance of women staff of ICAR-CIFT, depicting the 'Kerala Flood' situation towards paying tribute to the tireless effort by fishermen during the flood, rescue and rehabilitation.

The staff attending the live webcast of Hon'ble Prime Minister

Honouring the 'Women Icons' (L to R.: Dr. Pe. Jeyya Jayanthi, Dr. Ravishankar C.N., Dr. Leela Edwin, Smt. P.K. Shyma, Smt. Lakshmi Atul, Dr. Suseela Mathew and Smt. P.R. Mini

Mera Gaon - Mera Gaurav (MGMG): Sixteen group of scientists work in 76 villages in 4 states under the MGMG program at the Institute. During 2018-19 thirteen field level activities were conducted for 266 fishers. Besides visits, interface meetings and cleaning drive under Swatch Bharath have also been organised under MGMG

Training on "Value addition of fish"

Training on responsible fishing

Training on "Value addition of fish"

Natioanl Productivity Week: ICAR-CIFT, Kochi celebrated the National Productivity Week on 18 February, 2019. The programme included a talk on "Science-Technology- Society-Environment: Evolving Interfaces for Achieving Sustainability in Agricultural Sector" delivered by Dr. Jiju P. Alex, Director of Extension, Kerala Agricultural University, Thrissur. The programme was arranged with a focal theme of 'Circular Economy for Productivity and Sustainability' for this year's National Productivity Week celebration.

Dr. Jiju P. Alex delivering the lecture

Awards and Recognitions

Kerala State Energy Conservation Awards – 2018: ICAR-CIFT, Kochi bagged the Energy Conservation Commendation Certificate – 2018 in appreciation of Institute's achievements in the field of Energy Conservation and Management in the state of Kerala under the category of institutions/ organizations. Shri M.M. Mani, Hon'ble Electricity Minister, Govt. of Kerala conferred the Award to ICAR-CIFT in a function held at the Energy Management Centre, Thiruvananthapuram on 27 December, 2018.

Hon'ble Minister presenting the award

The award was received by Dr. Suseela Mathew, Principal Scientist & Head, Biochemistry & Nutrition Division, and Dr. S. Murali, Scientist, Smt. P.K. Shyma, Asst. Chief Technical Officer, Shri G. Gopakumar and Shri K.S. Babu, Technical Officers of Engineering Division, ICAR-CIFT, Kochi.

Dr. Manoj P. Samuel receiving the award from the Hon'ble Minister

Dr. Manoj P Samuel, Principal Scientist and Head, Engineering Division was conferred with "Krishi Vigyan Award" for best Agricultural Scientist by the Govt. of Kerala for the year 2017-18. Dr. Manoj was awarded on 30 December, 2018 at Thrissur by Shri V.S. Sunil Kumar, Hon'ble Minister for Agriculture, Govt. of Kerala. The award includes a plaque, cash prize and citation.

Dr. Manoj P. Sameul, Principal Scientist and Head, Engineering Division received the Dewnag Mehta Leadership Award at Hotel Taj Malabar, Kochi on 15 March, 2019.

Dr. Manoj P. Sameul, Principal Scientist and Head, Engineering Division received the Certificate of Outstanding Contribution in Reviewing by the Journal of Hydrology (Elsevier) for being within the top 10th percentile of reviewers of the journal.

Dr. G.K. Sivaraman, Principal Scientist, Microbiology, Fermentation and Biotechnology Division was awarded INSA Visiting Scientist Fellowship by Indian National Science Academy, New Delhi. Under the Fellowship Dr. Sivaraman shall undertake specific research at Whole Genome sequencing and its analysis for a period of two months.

Dr. Niladri Sekhar Chatterjee, Scientist, Biochemistry and Nutrition Division, ICAR-CIFT, Kochi received the Young Scientist Award presented by India Section of AOAC International. The prestigious annual award is instituted by AOAC International India Section to recognise outstanding contribution of young analytical chemists in India.

Dr. N.S. Chatterjee receiving the Award from Executive Director, AOAC International

Dr. S. Murali, Scientist, Engineering Division was awarded Certificate of Outstanding Contribution in Reviewing by the Journal of Food Engineering (Elsevier) in recognition of the contributions made to the quality of the journal.

Dr. S. Remya, Scientist, Veraval Research Centre of ICAR-CIFT received Best Oral Presentation award in the National Seminar on Entrepreneurship and Innovation in Agriculture for Socio-Economic Empowerment of Farmers, held during 12-13 March, 2019, at Swami Keshwanand Rajasthan Agricultural University, Bikaner for the paper titled 'Assessment of socio-economic challenges faced by Sidi tribal women in Veraval, Gujarat for entrepreneurship in fisheries sector', authored by S. Remya, Arti Joshi, Toms C. Joseph, V. Renuka, A.K. Jhaand C.N. Ravishankar.

Dr. S. Remya also got the Best Poster Presentation award in the 11th National Science Symposium on 'Recent Trends in Science and Technology', organized by Christ College, Rajkot, Gujarat, on 3 February, 2019, for the research paper titled 'Microbiological quality evaluation of vacuum packed and refrigerated stored shrimp burger' authored by S. Remya, Arti M. Joshi, Ejaz Parmar, V. Renuka, Toms C. Joseph and C. N. Ravishankar.

Smt. V. Renuka,Scientist, Veraval Research Centre of ICAR-CIFT received Best Poster Presentation award in the National Seminar on Entrepreneurship and Innovation in Agriculture for Socio-Economic Empowerment of Farmers, held during 12-13 March, 2019, at Swami Keshwanand Rajasthan Agricultural University, Bikaner for the paper titled 'Entrepreneurial development among Kharwa fisherwomen through development: A success story', authored by V. Renuka, S. Remya, A.K. Jha and Toms C. Joseph.

Smt. V. Renuka also got the Best oral presentation award in the 11th National Science Symposium on 'Recent Trends in Science and Technology', organized by Christ College, Rajkot, Gujarat, on 3 February, 2019 for the paper titled "Biochemical and shelf life evaluation of a condiment from golden anchovy (*C. Dussumieri*) by using groundnut oil" authored by Deepa Madathil, S.M. Zofair, V. Renuka and Sushri S. Behera

Post Graduate Studies

Shri C. G. Joshy, Scientist, Fish Processing Division, ICAR-CIFT, Kochi was awarded Ph.D. degree for his thesis entitled, "A study on applications of regression models in fisheries technology" by University of Kerala, Thiruvananthapuram. Shri C.G. Joshy worked under the guidance of Dr. N. Balakrishna, Professor, Dept. of Statistics, CUSAT, Kochi. His Co-Guide was Dr. Ravishankar C.N., ICAR-CIFT, Kochi.

	**Shri R.K. Renjith**, Scientist, Fishing Technology Division, ICAR-CIFT, Kochi was awarded Ph.D. degree for his thesis entitled, "Species differentiation of Family Teraponidae along Indian coast" by ICAR-Central Institute of Fisheries Education, Mumbai (Deemed to be University). Shri R.K.Renjith worked under the guidance of Dr. Ashok Kumar Jaiswar, Principal Scientist, Fisheries Resources Harvest & Post-Harvest Management Division, ICAR-CIFE, Mumbai.
	**Smt. V.A. Minimol**, Scientist, Microbiology, Fermentation and Biotechnology Division, ICAR-CIFT, Kochi was awarded Ph.D. degree for her thesis entitled, "Prevalence and molecular characterization of the pandemic clones of *Vibrio parahaemolyticus* in seafood' by ICAR-Central Institute of Fisheries Education, Mumbai (Deemed to be University). Smt. V.A. Minimol worked under the guidance of Dr. Sanat Kumar, Senior Scientist, Fisheries Resources Harvest and Post-Harvest Management Division, ICAR-CIFE, Mumbai.
	**Shri Devnanda Uchoi**, Scientist, Quality Assessment and Management Division, ICAR-CIFT, Kochi was awarded Ph.D. degree for his thesis entitled, "Proteolytic and biological amine forming bacteria from fermented fish products of North East India" by ICAR-Central Institute of Fisheries Education, Mumbai (Deemed to be University). Shri Devananda Uchoi worked under the guidance of Dr. B.B. Nayak, Principal Scientist & Head, FRHPHM Division, ICAR-CIFE, Mumbai.
	**Shri K.K. Ajeesh Kumar**, Research Fellow, Biochemistry and Nutrition Division, ICAR-CIFT, Kochi was awarded Ph.D. degree for his thesis entitled, "Proteoglycans from deep sea shark cartilage: Characterization and role in apoptosis triggered anticancer activity and allevation of osteoarthritic progression" by Cochin Unicersity of Science and Technology, Kochi. Shri K.K. Ajeesh Kumar worked under the guidance of Dr. K.K. Asha, Principal Scientist, Biochemistry and Nutrition Division, ICAR-CIFT, Kochi.
	**Shri K.V. Vishnu**, Research Fellow, Biochemistry and Nutrition Division, ICAR-CIFT, Kochi was awarded Ph.D. degree for his thesis entitled, "Developing delivery systems for omega 3 rich fish oil sateriled by chitosan-antioxidant conjugate: Formulation, stability and bioactivity evaluation" by Cochin Unicersity of Science and Technology, Kochi. Shri K.V. Vishnu worked under the guidance of Dr. Suseela Mathew, Head and Principal Scientist, Biochemistry and Nutrition Division, ICAR-CIFT, Kochi.
	**Smt. Sayana K.A.**, Research Fellow, Fishing Technology Division, ICAR-CIFT, Kochi was awarded PhD degree for her thesis entitled 'Profiling Growth and Fuel Consumption of Mechanized Trawlers of Kerala and Investigations on Efficiency of Low Drag Trawl' by Cochin University of Science and Technology, Kochi. Smt. Sayana K.A. worked under the guidance of Dr. M. P. Remesan, Principal Scientist, FT Division, ICAR-CIFT, Kochi.
	**Smt. Anju K.A.**, Research Fellow, Institute Technology Management Unit (ITMU), ICAR-CIFT, Kochi was awarded Ph.D. degree for her thesis entitled, 'Evaluation of Biogenic Amines as a quality index in Indian Squid (*Loligo duvauceli*)' by Cochin University of Science and Technology. Smt. Anju K. A. worked under the guidance of Dr.T.V.Sankar, Dir. of Research, Kerala University of Fisheries & Ocean Studies, Panangad P.O, Kochi.

	**Smt. Remya Kumari K.R.,** Research Fellow, Biochemistry and Nutrition Division ICAR- CIFT was awarded Ph.D. degree for his thesis entitled "Characterization and bioactivity evaluation of peptides of Indian squid, (*Uroteuthis duvauceli*) from the Arabian Sea" by by Faculty of Marine Sciences, Cochin Unicersity of Science and Technology, Kochi. Smt. Remya Kumari K. R. worked under the guidance of Dr. Suseela Mathew, Principal Scientist & Head, Biochemistry and Nutrition Division, Central Institute of Fisheries Technology (ICAR-CIFT), Cochin.
	**Shri. Nithin C.T.**, Research Fellow, Fishing Processing Division, ICAR-CIFT was awarded Ph.D. degree for his thesis entitled "Studies on Development of Masmin and Masmin Based Products Using Liquid Smoke Technology" by Faculty of Marine Science, Cochin University of Science and Technology (CUSAT). Shri. Nithin. C. T. worked under the guidance of Dr. T. K. Srinivasa Gopal, Professor Chair, Kerala University of Fisheries and Ocean Studies, Cochin & Former Director, ICAR-Central Institute of Fisheries Technology (ICAR-CIFT), Cochin.
	**Smt. Rajisha R.**, Senior Research Fellow, Quality Assurance and Management Division, ICAR - CIFT, Kochi awarded Ph.D. degree for her thesis entitled, "Prevalence and characterization of Ciguatoxin in fishes along Indian Coast" by Faculty of Marine Sciences, Cochin University of Science and Technology. Smt. Rajisha R. worked under the guidance of Dr. Ashok Kumar K, Principal Scientist & Head, Fish Processing Division, ICAR - CIFT, Cochin.
	**Smt. Minu P.**, who worked as Senior Research Fellow, Fishing Technology Division, ICAR-CIFT was awarded PhD degree for her thesis entitled " Phytoplankton dynamics and its influence on the optical properties of South Eastern Arabian sea" by Faculty of Marine Sciences, Cochin University of Science and Technology. Smt. Minu P. worked under the guidance of Dr. Muhamed Ashraf P, Principal scientist, Fishing Technology Division, ICAR-CIFT.
	**Smt. Aswathy Mary Varghese**, Research Fellow, Microbiology, Fermentation and Microbiology Division, ICAR-CIFT, Kochi was awarded Ph.D. degree in Molecular Biology for her thesis entitled, "Transcriptome dynamics of *Mangrovibacter* sp. during aerobic to anoxic transition" by Cochin University of Science and Technology, Kochi. Smt. Aswathy Mary Varghese worked under the guidance of Dr. Toms C. Joseph, Principal Scientist, Microbiology, Fermentation and Microbiology Division, ICAR-CIFT, Kochi and the Co-guidance of Dr. K.V Lalitha, Principal Scientist & Head (Retd.), MFB Division, CIFT, Kochi-29

Agricultural Technology Information Centre

At ATIC, arrangements were made for the visitors such as fisherpersons, 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

The 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:

Departmental Promotion Committee : 5 times

Assessment Committee : 7 times

Cases considered by the Departmental Promotion Committee

Category	Promotion	Declaration of probation & Confirmation
Scientific	10	2
Technical	11	-
Administrative	4	1
Supporting	2	-

Priority setting, Monitoring and Evaluation Cell

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

Verification of CAS reports of Scientists: The PME Cell verifies the Career Assessment Reports submitted by Scientists for their promotion and gives 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 10 to 12 April 2018 to review the progress achieved in the ongoing research projects of the Institute during 2018-19 and to discuss the research project proposals for the year 2019-20. The Institute Research Project Document for

the year 2019-20 was compiled and brought out for discussion at the Meeting. The House discussed in detail the 21 ongoing research projects, besides six completed projects and 10 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 Newsletterand two issues of Fish Tech Reporter were published during the period. Besides, the Institute Annual Report 2017-18 and Research Highlights 2017-18 (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. 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

As per annual programme of the department of official language, ministry of Home affairs, the quarterly meeting of official language implementation committee were held under the chairmanship of the Director.

Dr. Renuka, Deputy Director (Official Language) Conducted a session in two day Official Language workshop and training program in “New Directions to Official Language Management in ICAR” by the Official Language Department of Indian Council of Agricultural Research, New Delhi, was held at ICAR-Central Dry Land Agricultural Research Institute, Hyderabad on 24-25 April, 2018.’

Presentation of Mrs. Namrata Sharma, Deputy Secretary, ICAR, New Delhi
also seen Dr.J.Renuka on the dais

Participation in the meeting of TOLIC: Dr. J. Renuka, Deputy Director (Official Language), Dr. Santosh Alex, Assistant Chief Technical Officer, Dr. P Shankar, Senior Technical Officer participated in the TOLIC meeting organized on June 19, 2018.

Dr. J. Renuka, Dr. P. Shankar, Dr. Santhosh Alex attending the TOLIC meeting

Presentation on Official Language achievements: Achievements of the Official Language Implementation of ICAR-Central Institute of Fisheries Technology was presented by Dr. J. Renuka, Deputy Director (Official Language) in TOLIC meeting held at Kochi on 19th June 2018.

Dr.J.Renuka, Deputy Director (Official Language), ICAR-CIFT, Cochin's presentation in TOLIC

Sl No.	Date	Title	Beneficiaries
1.	02.06.2018	Hindi Workshop for Skilled Assistant Staff	Skilled Support Staff, ICAR-CIFT
2.	29.09.2018	Official Language Desk Workshop	Bill Section employees, ICAR-CIFT
3.	08.10.2018	Official Language Workshop for Administrative Officers and staff	Administrative officers and staff, ICAR-CIFT
4.	18.03.2019	Official language workshop organized for technical staff	Technical staff, ICAR-CIFT

Smt. Sheela M.C. Director (OL) Conducting Workshop

Dr. Suseela Mathew, Director-in Charge inaugurating the workshop

Dr. J.Renuka, Deputy Director (Official Language), ICAR-CIFT conducting the workshop for administrative staff

Dr. Santhosh Alex Asst. Chief Technical Officer conducting the workshop for technical staff

Shri. P.J. Davis, Sr. Administrative officer inaugurating the Prabodh classes

Training under HTS

Prabodh training classes were initiated from 12th July 2018 for the benefit of officials under the Hindi Teaching Scheme at the ICAR-Central Institute of Fisheries Technology, Cochin

Hindi Seminar on official language implementation: Progressive efforts

Mr. Pranab Kumar Das, IRS Principal Chief Income Tax Commissioner, Kerala inaugurating the National seminar

Organised a Seminar on Official Language Implementation on 23 July 2018 at ICAR-Central Institute of Fisheries Technology and Mr. Pranab Kumar Das, IRS Principal Chief Income Tax Commissioner, Kerala and President, TOLIC Central Government, Kochi was the chief guest.

Presidential address by Dr. C.N. Ravishankar, Director, ICAR-CIFT on Hindi Day

Shri. A.K. Choudhary, Chief guest speaking on Hindi Day

Welcome address by Dr. J.Renuka, Deputy Director (Official Language) on Hindi Day

ICAR-Central Institute of Fisheries Technology, Kochi celebrated 'Hindi Day' Mr. A.K. Choudhary, Director, CIFNET, Kochi inaugurated Hindi Diwas as chief guest. A photo exhibition of official language activities was also organised.

A Tribute to Bharat Ratna late Shri Atal Bihari Vajpayee ji in the ICAR-CIFT, Cochin First monthly anniversary of Bharat Ratna Shri Atal Bihari Vajpayee ji was organized on September 16, 2018, scientist and officials recited poems written by Shri Vajpayee ji.

Joint Official Language Meeting of Fisheries organisations located at Cochin, Kerala was held at ICAR-CIFT on October 25, 2018. Eight associate participated from different institutions such as the ICAR-Central Institute of Fisheries Technology, ICAR-Central Marine Fisheries Research Institute, Central Institute of Fisheries Nautical and Engineering Training and Central Marine Product Export Development Authority.

Dr. J.Renuka, Deputy Director (Official Language) along with other associate and address of Dr. Leela Edwin, Head of Division, Fishing Technology

Judges with Participants

Competitions of Kochi Town Official Language Implementation Committee

Poetry recitation and extempore speech competitions of TOLC organized on October 28, 2018 as part of Joint Hindi Week Celebrations.

TOLC Trophies

ICAR-Central Institute of Fisheries Technology, Kochi was honoured with the **Official Language Rolling Trophy** for the best implementation of the Official Language Policy of the Government of India for 2017-18 by the Kochi Town Official Language Implementation Committee. Dr. J. Renuka, Deputy Director (Official Language), Dr. Santosh Alex, Assistant Chief Technical Officer and Dr. P. Shankar, Senior Technical Officer received the Official Language Trophy during the award distribution ceremony of Kochi TOLIC from Prof. (Dr.) K. Ajitha, Head, Department of Hindi, Cochin University of Science and Technology, Cochin held on 15.03.2019.

'Jaladhi 2017', the science journal of the Central Institute of Fisheries Technology, published during the year 2017-18, has been awarded the **Rolling Trophy of Best Journal** of Kochi Town Official Language Implementation Committee. Dr. J. Renuka, Deputy Director (Official Language), Dr. Santosh Alex, Assistant Chief Technical Officer, and Dr. P. Shankar, Senior Technical Officer received the Rolling Trophy of Best Journal during the award distribution ceremony of Kochi TOLIC from Sri N. Jaishankar, IRS, Income Tax Commissioner, Income Tax Department, Kochi on 15.03.2019.

Workshop on Official Language and Its Implementation: As part of implementation and promotion of Official Language in Veraval Research Centre of ICAR-CIFT, a one day workshop on 'Use of official language in office' was conducted on 26 October, 2018. Dr. D.D. Goud, Hindi Officer, Office of the Principal Accountant General (G&SSA), Rajkot was the resource person for the Workshop. In the interactiuve workshop Dr. Goud spoke on the importance of Official Language in daily official work. He also gave a brief description of the History of Hindi Language and discussed about the possibilities and limitations of Official Language in official works.

Dr. Goud conducting the Workshop

Library

The Library of the Institute which is playing a vital role in providing services to support the information needs of the scientific community 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, the Library acquired 60 books and subscribed 11 scientific journals. Online databases *viz.*, ASFA (Aquatic Science and Fisheries Abstracts) and Indian Standards have also been acquired.

Library Portal: The Library home page provides a single window access to bibliographic databases developed in the library. Bibliographic databases have been developed using WINISIS and search interfaces have been developed using GenISISWeb.

Digital Repository of ICAR-CIFT: Digitization of ICAR-CIFT publications and putting them in open digital repository is an important activity of the library. During the period 239 documents have been digitized and added to the repository. At present ICAR-CIFT Digital Repository holds 3712 digital documents.

Remote access to e-resources: Remote access to subscribed e-resources has been provided to the users. 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 members of the Research Centres.

CeRA (Consortium of e-Resources on Agriculture): More than 2000 journals are available online through CeRA (Consortium of e-Resources on Agriculture). Library has supplied copies of 64 articles under DDR (Document Delivery Request) facility of CeRA (Consortium of e-Resources on Aquaculture).

Institutional membership: ICAR-CIFT library is a member of IAMSLIC (The International Association of Aquatic and Marine Science Libraries and Information Centers) 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.The Library is also an institutional member of DELNET-Developing Library Network, which coordinates with other regional, national and international networks and libraries for exchange of information and documents. Further, ICAR-CIFT Library had become an Institutional member of Current Science Association from September 2016 onwards.

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

National Digital Library of India (NDLI) Partner: ICAR-CIFT is designated as a content partner of National Digital Library of India for its contribution of digital contents.

Agricultural Knowledge Management Unit

Agricultural Knowledge Management Unit (AKMU) caters to meet the ITC needs of the institute by providing and maintaining the Internet, E-mail, 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 250 users. ICAR-CIFT is presently connected with 1000 mbps lease line under National Knowledge Network (NKN) provided by Govt. of India and 20 mbps MPLS from BSNL to provide all the ICT services around the clock for the employees of the Institute.

AKMU provides K7 Enterprise Security through the server for protecting from malware threats and other external sources of threats, thus improving the ICT efficiency. It also act as a gateway to protect from intrusion attacks to prevent the leakage of confidential data by adding 250 clients in the system.

AKMU properly manages ICAR-CIFT Website and it is available in the url www.cift.res.in. It highlights overall research activities and achievements of the institute and act as an interface between institute and end users. The contents of the Institute Website are periodically updating. The information on training programmes, recruitments of temporary staff, tender notices and other circulars of the institute are periodically uploading in the Institute Website to the transparency of the working condition. ICAR-CIFT has IP based video conferencing facility. It is being operated and maintained effectively by 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 CIFT. It contains personal, professional and referential attributes of personnel along with information on plan wise cadre strength and institutional parameters for different categories of CIFT. The information on institute cadre strength and details of individual employees in PERMISnet is periodically updated. As per the provision given, CIFT provided user name and password to the Regional Centres to update the information in PERMISnet on periodical basis and also maintaining social accounts.

AKMU also gives real time reply to queries received from farmers, students, entrepreneurs, researchers and others in the agricultural and allied sectors to e-Krishi Munch, a public interface platform developed by ICAR for stakeholders.

AKMU also provides input to KM Portal developed by ICAR by updating details of institute higher authorities contact information, sophisticated analytical instrumentation facility and online transaction details of the institute.

NABL Activities

ICAR-CIFT laboratories are accredited to ISO/IEC 17025: 2005 by NABL in the field of Chemical, Mechanical and Biological testing since the year 2005. Dr. A.A. Zynudheen, Principal Scientist and HOD-in-Charge, Quality Assurance and Management Division serves as the Quality Manager and Dr.Satyen Kumar Panda, Principal Scientist serves as the Technical Manager of NABL in the Institute. For the smooth functioning of the NABL activities in the Institute, an NABL Cell is constituted by Director with Smt. P.K.Shyma (ACTO, Engineering Division), Smt. N.C. Shyla (Technical Officer, AKMU), Shri. Rahul Ravindran (Technical Assistant, FP Division), Shri. G. Vinod (Sr. Technician, FP Division) and Shri. Ajith Chellappan (Sr. Technician, QAM Division) as members.

Re-assessment of the testing laboratories of ICAR-CIFT conducted during 24-25 November, 2018 and the NABL accreditation of the laboratories as per ISO/IEC 17025: 2005 was renewed up to 14 December, 2020. Total recommended scope of accreditation for testing is 266 parameters, which includes testing of 205 Chemical parameters, 52 Biological parameters and Nine Mechanical parameters. The National Referral Laboratory facility in ICAR-CIFT, Kochi is also accredited as per ISO/IEC 17025: 2005. The Laboratories participated in more than 10 Proficiency Test programmes in the year. Inter-Laboratory Comparison was conducted for pesticides and proximate composition of fish matrix. The laboratory conducted internal audits at planned intervals to conform the requirements of the management system and documents. Management Review Meeting was conducted as per schedule.

During the year 2018-19, a total of 1868 samples including NABL, Non-NABL samples were analyzed and total revenue of ₹ 45.95 lakhs was realised.

Committees

Quinqennial Review Team

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

Members

1. Dr. K. Venkatesh Murthy, Senior Principal Scientist, CFTRI, Mysuru, Karnataka
2. Dr. V.C. George, Director, Aquaculture Department, SH College, Kochi, Kerala
3. Prof. B.A. Shyamsunder, College of Fisheries, Mangaluru, Karnataka
4. Dr. Krishna Srinath, Former Director, ICAR-DRWA, Bhubaneswar, Odisha
5. Shri S.S. Rajpathak, Vice President, M/S Garware Wall Ropes Ltd., Pune, Maharashtra

Member Secretary: Dr. Leela Edwin, Principal Scientist, ICAR-CIFT

Research Advisory Committee

Chairman: Dr. Bhaskaran Manimaran, Professor, Centre for Fisheries Managament, Planning and policy, TNFU OMR Campus, Padur P.O., Tamil Nadu

Members

1. Dr. B. Hanumanthappa, Professor, College of Fisheries, KVA&FSU, Mangaluru, Karnataka
2. Dr. Sajan George, Former Dean, KUFOS, Kochi, Kerala
3. Dr. Sreenath Dixit, Director, Prinmcipal Scientist & Deputy Head, IDC, ICRISAT, Patancheru, Telangana
4. Dr. K.S.M.S. Raghava Rao, Chief Scientist, Food Engineering, CSIR-CFTRI, Mysuru, Karnataka
5. Shri P.P. Surendran, DGM, Matsyafed, Thiruvananthapuram, Kerala
6. Dr. P. Pravin, Asst. Director General (M. Fy.), ICAR, New Delhi
7. Dr. Ravishankar C.N., Director, ICAR-CIFT, Cochin, Kerala

Member Secretary: Dr. R. Anandan, Principal Scientist, ICAR-CIFT

Institute Management Committee

Chairman: Dr. Ravishankar C.N., Director, ICAR-CIFT

Members

1. Shri H.S. Veerappa Gowda, Former Director of Fsieheries, Govt. of Karnataka, Bengaluru, Kerala
2. Shri P. Sahadevan, Additional Director of Fisheries, Govt. of Kerala, Thiruvananthapuram, Kerala
3. Dr. G. Sugumar, Former Dean, CFRI, Thoothukudy& Director Incharge, DIVTF, Ramanathapuram, Tamil Nadu
4 Dr. Rani Palaniswami, OIC, ICAR-CIFRI Regional Centre, Kochi, Kerala
5. Dr. S.V. Alavandi, HOD, ICAR-CIBA, Chennai, Tamil Nadu
6 Dr. S. Kalavatrhy, Principal Scientist, ICAR-CPCRI Regional Station, Kayamkulam, Kerala
7. Dr. K.V. Rajendran, HOD, ICAR-CIFE, Mumbai, Maharashtra
8. Shri K.S. Shaiji, Kalathil House, Edavanakkadu P.O., Ernakulam, Kerala
9. Smt. K. Samyuktharani, Kayakkalakath Sivasthithi Bhavan, Puthiyangadi P.O., Kozhikode, Kerala
10. Assistant Director General (M. Fy.), ICXAR, New Delhi
11. Assistant Finance and Accounts Officer, ICAR-CPCRI, Kasaragod, Kerala

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 Technical Assistant
6. Shri D.L. Pattanaik, Lower Division Cler`k
7. Shri P. Raghavan, Skilled Support Staff
8. Shri M.V. Rajan, Auxillary Staff

Member Secretary: Shri. M.N. Vinodh Kumar, Asst. Admn. Officer, ICAR-CIFT

Institute Joint Staff Council

Chairman: Dr. Ravishankar C.N., Director, ICAR-CIFT

Members (Official side)

1. Dr. M.M. Prasad, HOD, MFB
2. Dr. P. Manoj P. Samuel, HOD, Engg.
3. Dr. George Ninan, Principal Scientist
4. Shri K.S. Sreekumaran, Fiance & Accounts Officer

Secretary (Official Side)

Shri P.J. Davis, Senior Administrative Officer

Members (Staff Side)

1. Shri G. Vinod, Senior Technician
2. Shri K.B. Subukuttan, AAO
4. Shri K.R. Rajasaravanan, Skilled Support Staff
5. Shri K.S. Ajith, 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.	Investigations on fish behavior and responsible fishing systems	Dr. V.R. Madhu	Kochi, Visakhapatnam & Veraval	Kochi Visakhapatnam Veraval	Dr. Leela Edwin Dr. Saly N. Thomas Dr. M.P. Remesan Shri M.V. Baiju Shri S. Chinndurai Dr. R.K. Renjith Shri P.N. Jha Dr. K.M. Sandhya Dr. S. Monalisha Devi Shri N. Rajendra Naik Dr. R. Raghu Prakash Dr. U. Sreedhar Dr. K.K. Prajith Shri G. Kamei
2.	Enhancement of life of fishing materials using nanotechnology	Dr. P. Muhamed Ashraf	Kochi	Kochi	Dr. Leela Edwin Dr. Saly N. Thomas Shri S. Chinnadurai
3.	Assessing environmental aspects of fish, fishery products and effects of chemical hazards	Dr. G.K. Sivaraman	Veraval, Kochi& Mumbai	Veraval Kochi Mumbai	Dr. A.K. Jha Smt. V. Renuka Dr. S. Remya Dr.M.M.Prasad Shri R.K. Nadella Shri K.A. Basha Dr. L.N. Murthy Dr. S. Visnuvinayagam Dr. A. Jeyakumari Smt. U. Parvathy
4.	Food safety hazards of fish and fishery products: Assessment and mitigation measures	Dr. S.K. Panda	Kochi	Kochi	Dr. K. Ashok Kumar Dr. Femeena Hassan Dr. G.K. Sivaraman Dr. J. Bindu Dr. C.O. Mohan Smt. S.J. Laly Dr. N.S. Chatterjee Dr. Pankaj Kishore Dr. T.K. Anupama Smt. E.R. Priya Smt. V.A. Minimol Shri Devnanda Uchoi Dr. K. Nagalakshmi Smt. T. Muthulakshmi

5.	Optimization of harvesting techniqus for mmesopelagics in the south eastern Arabian Sea	Dr. M.P. Remesan	Kochi	Kochi	Dr. A.A. Zynudheen Shri P.N. Jha Shri R.K. Renjith Shri K.K. Anas Shri N. Rajendra Naik
6.	Development of region and species specific pots/ traps	Dr. K.K. Prajith	Veraval, Kochi& Visakhapatnam	Veraval Kochi Visakhapatnam	Shri G. Kamei Dr. M.P. Remesan Shri S. Chinnadurai Dr. S. Monalisha Devi Dr. U. Sreedhar
7.	Technological interventions for enhancing utilization of secondary raw aterials of aquatic origin	Dr. A.A. Zynudheen	Kochi, Mumbai & Veraval	Kochi Mumbai Veraval	Dr S.K. Panda Dr P.K. Binsi Dr. C.G. Joshy Kum. H. Mandakini Devi Shri Devananda Uchoi Shri K. Sathish Kumar Dr. K. Elavarasan Smt. E.R. Priya Dr. K. Nagalakshmi Dr. S. Visnuvinayagam Dr. A. Jeyakumari Smt. U. Parvathhy Smt. V. Renuka
8.	Interventions in processing and preservation of commercial and unconventional fishery resources	Dr. George Ninan	Kochi, Mumbai & Visakhapatnam	Kochi Mumbai Visakhapatnam	Dr. A.A. Zynudheen Dr. J. Bindu Dr. C.O. Mohan Dr. P.K. Binsi Smt. S.J. Laly Dr. C.G. Joshy Kum. H. Mandakini Devi Shri Devananda Uchoi Dr. Anuj Kumar Dr. K. Elavarasan Smt. S.S. Greeshma Smt. K.R. Sreelakshmi Dr. A. Jeyakumari Smt. U. Parvathy Dr. P. Viji
9.	Biodegradable packaging materials for fish and fishery products	Dr. J. Bindu	Kochi, Veraval & Visakhapatnam	Kochi Veraval Visakhapatnam	Shri S. Sreejith Shri K. Sathish Kumar Dr. T.K. Anupama Smt. K. Sarika Smt. E.R. Priya Dr. A.K. Jha Dr. S. Remya Smt. V. Renuka Dr. Jesmi Debbarma
10.	Development of processing protocols for emerging farmed fishery resources	Dr. P.K. Binsi	Kochi, Viaskhapatnam & Mumbai	Kochi Visakhapatnam Mumbai	Kum. H. Mandakini Devi Shri Devananda Uchoi Dr. Anuj Kumar Shri K. Sathish Kumar Dr. K. Elavarasan Dr.T.K. Anupama Smt. K. Sarika Smt. K.R. Sreelakshmi Smt. V.A. Minimol Dr. P. Viji Dr. A. Jeyakumari Smt. U. Parvathy

11.	Development of active and intelligent packaging system for fish and shellfishes	Dr. C.O. Mohan	Kochi & Veraval	Kochi Veraval	Dr. C.N. Ravishankar Dr. K. Ashok Kumar Dr. P.Muhamed Ashraf Dr. S.K. Panda Dr. C.G. Joshy Dr. Anuj Kumar Dr. K. Elavarasan Dr. Pankaj Kishore Smt.K.R. Sreelakshmi Dr. K. Nagalakshmi Dr. S. Visnuvinayagam Dr. S. Remya
12.	Economic evaluation of resource use efficiency and management of reservoir ecosystem	Dr. V. Geethalakshmi	Kochi	Kochi	Dr.Nikita Gopal Dr. Femeena Hassan Smt. Pe. Jeyya Jeyanthi Shri V Chandrasekar
13.	Novel approaches for value addition and safety assessment of fishery resources of east coast	Dr. B. Madhusudana Rao	Visakhapatnam & Mumbai	Visakhapatnam Mumbai	Dr. P. Viji Dr. Jesmi Debbarma Dr. L.N. Murthy Shri K.A. Basha
14.	Design and development of tools and technologies for energy and water se optimization infish processing industries	Dr. Manoj P. Samuel	Kochi & Visakhapatnam	Kochi Visakhapatnam	Dr. K. Ashok Kumar Dr. George Ninan Dr. C.G. Joshy Dr. S. Murali Dr. D.S. Aniesrani Delfiya Smt. P.V. Alfiya Dr. K. Rejula Dr. Jesmi Debbarma
15.	Fishing technological interventions for sustainable marine ecosystem services along the east coast of India	Dr. R. Raghu Prakash	Visakhapatnam & Kochi	Visakhapatnam Kochi	Dr. U. Sreedhar Dr. Jesmi Debbarma Shri M.V. Baiju Dr. V.R. Madhu Smt. P. Jeyanthi
16.	Occurrence, distribution and molecular characteristics of emerging and re-emerging pathogens in seafood and its environment	Dr. M.M. Prasad	Kochi, Visakhapatnam & Mumbai	Kochi Visakhapatnam	Dr. Toms C. Joseph Dr. G.K. Sivaraman Shri V. Radhakrishnan Nair Dr. S. Visnuvinayagam Dr. V. Murugadas Shri C.G. Joshy Shri K.A. Basha Shri R.K. Nadella Smt. S.S. Greeshma Smt. T. Muthulakshmi Shri S. Ezhil Nilavan Shrti Abhay Kumar Dr. B. Madhusudana Rao
17.	Evolving SMART EDP model for livelihood security of small scale fisherfolk through fish-preneurship	Dr. A.K. Mohanty	Kochi, Visakhapatnam & Mumbai	Kochi Visakhapatnam Mumbai	Dr. S. Ashaletha Dr. George Ninan Dr. Pe. Jeyya Jeyanthi Dr. V.K. Sajesh Dr. K. Rejula Dr. B. Madhusudana Rao Dr. L.N. Murthy

18.	Seaweeds of Indian coast as source of bioactive compounds for developing nutraceuticals/ functional foods	Dr. Suseela Mathew	Kochi	Kochi Veraval Visakhapatnam	Dr. R. Anandan Dr. V. Geethalakshmi Dr. K.K. Asha Dr. N.S. Chaterjee Dr.Anuj Kumar Dr. H. Mandakini Devi Dr. T.K. Anupama Shri C.S. Tejpal Shri K.K. Anas Smt. Lekshmi R.G. Kumar Dr. A.K. Jha Dr. Jesmi Debbarma
19.	Develping a rapid detection kit for formaldehyde contamination in seafood	Smt. S.J. Laly	Kochi	Kochi	Dr. S.K. Panda Smt. E.R. Priya
20.	Development of moisture soaker sachets/pads from aquatic weed Water hyacinth (Eichhoprnia crassipes) using super abosorbant polymers for fish packaging application	Smt S. Sreejith	Kochi	Kochi	Dr. P. Muhamed Ashraf Smt. K. Sarika
21.	Specific technological problems and mitigation measures in fish and fishery products of Maharashtra region	Dr. L.N. Murthy	Mumbai	Mumbai	Dr. S. Visnuvinayagam Dr. A. Jeyakumari Smt. U. Parvathy Dr. Abhay Kumar
22.	Studies on fishing operations and energy use for formulation of guidelines for selected small scale marine fisheries	Dr. Leela Edwin	Kochi	Kochi	Dr. Saly N. Thomas Shri M.V.Baiju Dr.N. Manju Lekshmi Shri P.N. Jha Dr. K.M. Sandhya
23.	Development of “Chito-Pro”: A product of chitin-protein derivatives as bio-functional supplement using in vitro gastrointestinal digestion process	Dr. K. Elavarasan	Kochi	Kochi	Dr. A.A. Zynudheen Shri C.S. Tejpal
24.	Development of seaweed supplemented bioactive yoghurt	Dr. Anuj Kumar	Kochi	Kochi	Dr. H. Mandakini Devi Dr. Pankaj Kishore
25.	Development of colourimetric nano-biosensor strips for detection of food-borne pathogens	Shri R.K. Nadella	Kochi	Kochi	Dr. M.M. Prasad Dr. C.O. Mohan Shri S. Ezhil Nilavan
26.	Molecular diversity of pathogens associated with aquatic system and harnessing aquatic nichwe for beneficial bacteria or products	Dr. V. Murugadas	Kochi, Thiruvananthapuram and Mau	Kochi Thiruvananthapuram	Dr. M.M. Prasad Dr. Toms C. Jospeh Dr. G.K. Sivaraman Shri V. Radhakrishnan Nair Shri R.K. Nadella Shri K.A. Basha Smt. S.S. Greeshma Smt. T. Muthulakshmi Shri S. Ezhil Nilavan Dr. E. Sreekumar

27.	Evalauating FTIR spectroscopy and chemometric models in high-throughput authentication of species and geographical origin of shrimp	Dr. N.S. Chatterjee	Kochi	Kochi	Dr. Tom C. Jospeh
28.	Novel biomlecules for food and nutritional applications from marine resources	Dr. K.K. Asha	Kochi	Kochi	Dr. Suseela Mathew Dr. R. Anandan Dr. N.S. Chatterjee Shri C.S. Tejpal Smt. R.G.K. Lekshmi Shri K.K. Anas Smt. V.A. Minimol
29.	Examining occupational structure, labour productivity and labour migration in the fisheries sector	Dr. Nikita Gopal	Kochi	Kochi	Dr. V. Geethalaksmi Dr. A. Suresh Dr. M.V. Sajeev Dr.Pe . Jeyya Jeyanthi Shri V. Chandrasekar
30.	A study on dynamics of fish consumption in Kerala with reference to emerging health, safety and quality issues	Dr. M.V. Sajeev	Kochi	Kochi	Dr. A.K. Mohanty Dr. A. Suresh Dr. V.K. Sajesh Dr. K. Rejula
31.	Assessing input and service delivery system for marine fiseries development in Kerala	Dr. A. Suresh	Kochi	Kochi	Dr. A.K. Mohanty Dr. Nikita Gopal Dr. V. Geethalakshmi Dr. M.V. Sajeev Dr. Pe. Jeyya Jeyanthi Shri V.Chandrasekar Dr. V.K. Sajesh Dr. K. Rejula
Indian Council of Agricultural Research (ICAR) Projects					
32.	Agri-business Incubation	Dr. George Ninan	Kochi, Visakhapatnam & Mumbai	Kochi Visakhapatnam Mumbai	Dr. C.O. Mohan Dr. N.S. Chatterjee Smt. Elizabeth Paul* Shri C. Shyam Kumar* Shtri A.C. Praveen* Smt. P.R. Sudha* Smt. E.B. Lovely* Dr. B. Madhusudana Rao Dr. L.N. Murthy
33.	All India Network project on Fish health	Dr. K. Ashok Kumar	Kochi	Kochi	Dr. S.K. Panda
34.	Investigations on ghost fishing by derelict traps and gillnets in selected areas of Indian waters and mitigations measures	Dr. Saly N. Thomas	Kochi	Kochi	Dr. K.M. Sandhya Dr. P. Muhamed Ashraf
National Innovations in Climate Resilient Agriculture (NICRA) Project					
35.	Global warming potential (GWP) of mechanized fishing methods of India and mitigation strategies: Analysis using Life Cycle Assessment (LCA) – Data Envelopment Analysis (DEA) approach	Dr. Leela Edwin	Kochi & Visakhapatnam	Kochi Visakhapatnam	Dr. V.R. Madhu Shri M.V. Baiju Shri V. Chandrasekar Shri P.N. Jha Dr. R. Raghu Prakash

Department of Biotechnology (DBT) Projects					
36.	Evalauating cost and benefits of prophylactic health products and novel alternatives on small holder aquaculture farmers in Asia and Africa	Dr. Toms C. Joseph	Kochi	Kochi	Shri Bibin Das* Kum. T.R. Lakshmi*
37.	Diagnostics for one health and user driven solutions for AMR (DOSA)	Dr. Ravi Krishnan, IIT, Delhi Dr. Till Bachmann, Univ. Edinburgh, UK	Kochi, Delhi, Silchar, Bangaluru, Edinburgh, Bardford, Southampton,) and London (UK)	Kochi	Dr. G.K. Sivaraman
38.	Does antimicrobial resistance (AMR) in livestock contribute to AMR in people in NE India? An inter-disciplinary study investigating antibiotic use, drivers of AMR and transmission dynamics	Dr. B.Shomes ICAR-NIVEDI, Assam Dr. Mark Holmers, University of Cambridge, UK	Kochi Assam UK	Kochi	Dr. G.K. Sivaraman
39.	Screening lytic phages from diverse marine and aquatic niche for controlling bacterial pathogens associated with aquaculture and post harvest fish quality	Dr. B. Madhusudana Rao	Kochi Visakapatanam	Kochi	Dr. M.M. Prasad Dr. G.K. Sivaraman Dr. V. Murugadas Dr. S. Visnuvinayagam
Department of Science and Technology (DST) Projects					
40.	Development of clam cluster an clam processing facility at Perumbalam village, Thycattusserry block, Cherthala taluk, Alappuzha	Dr. Nikita Gopal	Kochi	Kochi	Dr. J. Bindu Shri V. Chandrasekar Shri S. Sreejith Kum. K.H. Sreedevi* Shri James J. Pulikottil*
41.	Livelihood enhancement of Sidi tribal women and Kharwa fisherwomen of veraval in Gujarat through the implementation of improved fish post harvest technolgies	Dr. S. Remya			Dr. C.N. Ravishankar Dr. C.O. Mohan Dr. A.K. Jha
42.	Determining seasonal occurrence of multiclass endocrine disrupting chemicals in the fishes, crustaceans and mollusks of the Vembanad urban estury: Risk assessment by an untargeted metabolomics appraoch	Dr. N.S. Chatterjee	Kochi	Kochi	

Indian National Centre for Ocean Information (INCOIS) Projects					
43.	Studies on ecological linkages between plankton production and *Acetes* sp. along Gujarat coast	Dr. V.R. Madhu	Veraval	Veraval	Dr. K.K. Prajith Kum. Vadher Kiran* Shri Muchhal Haresh*
44.	Vaidation and dissemination of ocean state forecast advisories along Gujarat coast	Dr. V.R. Madhu	Kochi &Veraval	Kochi Veraval	Dr. K.K. Prajith Shri G. Kamei Shri K.V. Vinod*
UNDP-Global Environment Facility Project					
45.	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*
National Fisheries Development Board (NFDB) Project					
46.	National surveillance programme for aquatic animal diseases	Dr. V. Murugadas	Kochi	Kochi	Dr. Toms C. Joseph Shri K.A. Basha Dr. S. Ashaletha Shri P.G. Akhil Nath* Shri P. Shaheer*
ICAR-National Fellow Project					
47.	Biomodulation of marine biopolymers for the preparation of biomaterials of healthcare importance	Dr. R. Anandan	Kochi	Kochi	Dr. P.R. Sreerekha* Smt. Divya K. Vijayan*
National Bank for Agriculture and Rural Development (NABARD) Project					
48.	Assessment of role and impact of fisheries cooperatives in enhancing the livelihood and resource management capabilities of fisherfolk in India	Dr. Nikita Gopal	Kochi	Kochi	Smt. Pe. Jeyya Jeyanthi Shri V. Chandrasekar Shri G. Jayesh*
47.	Development of computer vision based technology for automating fish abundance data generation for characterizing fisheries stock	Dr. R. Raghu Prakash	Visakhapatnam & Kochi	Kochi	Dr. V.R. Madhu Shri C.G. Joshy Shri P.N. Jha
Ministry of Food Processingt Industries (MOFPI) Project					
49.	Design and development of hot air assisted continous Infrared drying system for high value fish and fishery products	Dr. D.S. Anisesrani Delfiya	Kochi	Kochi	Dr. Manoj P. Samuel Dr. S. Murali Smt. P.V. Alfiya Shri K. Prashob*

WorldFish					
50	Establishing value chain for coastal and small indigenous freshwater fish species: Towards nutritional security for rural population	Dr. Suseela Mathew	Kochi	Kochi	Dr.C.N.Ravishankar Dr.Suseela Mathew, Dr. M.M.Prasad, Dr. A.K.Mohanty, Dr.R.Anandan, Dr.GeorgeNinan, Dr.S.K.Panda, Dr.L.N.Murthy, Dr.K.K.Asha, Dr.M.V.Sajeev, Dr.C.O.Mohan, Dr.V.Murugadas, Dr.C.G.Joshy, Dr.N.S.Chatterjee, Dr.K.Elavarasan, Mr.Tejpal.C.S
* Research Fellow					

List of Personnel in ICAR-CIFT

(As on 31st March, 2019)

Managerial Personnel

Director: Dr. C.N. Ravishankar

Heads of Division

Biochemistry and Nutrition Division	:	Dr. Suseela Mathew, Principal Scientist
Fish Processing Division	:	Dr. K. Ashok Kumar, Principal Scientist
Microbiology, Fermentation & Biotechnology	:	Dr. M.M. Prasad, Principal Scientist
Fishing Technology Division	:	Dr. Leela Edwin, Principal Scientist
Extension Information & Statistics Division	:	Dr. A.K. Mohanty, Principal Scientist
Engineering Division	:	Dr. Manoj P. Samuel, Principal Scientist
Quality Assuranceand Management i/c	:	Dr. A.A. Zynudheen, Principal Scientist

Senior Administrative Officer	:	Shri P.J. Davis
Finance & Accounts Officer	:	Shri K.S. Sreekumaran

Visakhapatnam Research Centre	:	Dr. R. Raghu Prakash, Principal Scientist
Mumbai Research Centre	:	Dr. L.N. Murthy, Principal Scientist
Veraval Research Centre	:	Dr. Toms C. Joseph, Principl Scientist

Scientific Personnel

Principal Scientist

1. Dr. T.V. Sankar (On deputation)
2. Dr. Saly N. Thomas
3. Dr. M.P. Remesan
4. Dr. Nikita Gopal
5. Dr. V. Geethalakshmi
6. Dr. R. Anandan
7. Dr. J. Bindu
8. Dr. P. Muhamed Ashraf
9. Dr. George Ninan
10. Dr. S. Ashaletha
11. Dr. Femeena Hassan
12. Dr. A. Suresh
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14. Dr. V.R. Madhu
15. Dr. K.K. Asha
16. Dr. S.K. Panda

Senior Scientist

Shri M.V. Baiju
Dr. M.V. Sajeev
Dr. C.O. Mohan

Scientist

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2. Dr.Pe.Jeyya Jeyanthi
3. Dr. P.K. Binsi
4. Shri V. Chandrasekar
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6. Dr. V. Murugadas
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8. Dr. S. Visnuvinayagam
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11. Dr. K.M. Sandhya
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23. Smt. Lekshmi R.G. Kumar
24. Smt. E.R. Priya
25. Dr. R.K. Renjith
26. Smt. K. Sarika
27. Shri P.N. Jha
28. Dr. K. Elavarasan
29. Shri S. Chinnadurai
30. Smt. T. Muthulakshmi
31. Shri C.S. Tejpal
32. Smt. S.S. Greeshma
33. Shri C.S. Tejpal
34. Dr. Devananda Uchoi
35. Dr. K. Rejula
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37. Shri K.K. Anas
38. Shri S. Ezhil Nilavan
39. Dr. V.S. Minimol
40. Smt. PV. Alfiya
41. Dr. D.S. Aniesrani Delfiya
42. Smt.Rehna Raj

Technical Personnel

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8. Shri Sajith K. Jose
9. Shri P.V. Sajeevan
10. Smt. P.A. Jaya
11. Shri V.K. Siddique
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4. Shri M.N. Vinodh Kumar
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7. Shri P.M. Rizwan

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14. Shri P.N. Nikhil Das
15. Shri A. Vinod
16. Shri K.S. Ajith
17. Smt. M.G. Soudamini

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9. Shri Lalit Oram

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4. Smt. V. Renuka

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2. Shri G. Kingsely

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3. Smt. S.J. Laly

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2. Smt. Priyanka P. Bait

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- Stephen Hawking