ANNUAL REPORT
2017-18

ICAR-Central Institute of Fisheries Technology

(Indian Council of Agricultural Research)
CIFT Junction, Matsyapuri P.O, Kochi - 682 029
(An ISO 9001-2008 certified; ISO/IEC 17025-2005 accredited institution)

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ICAR-CIFT Annual Report 2017-2018

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ICAR-Central Institute of Fisheries Technology
CIFT Junction, Matsyapuri P.O, Kochi - 682 029

Phone : 91 (0)484 - 2412300
Fax : 91 (0)484 - 2668212
E-mail : cift@ciftmail.org
aris.cift@gmail.com
Website : www.cift.res.in

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Seagrapes (*Caulerpa racemosa*) used for the preparation of seaweed-supplemented biscuits.

Published by : **Dr. Ravishankar C.N.**
Director, CIFT

Compilation : **Dr. A.R.S. Menon**
Dr. B. Madhusudana Rao
Dr. G.K. Sivaraman
Smt. U. Parvathy

Editing : **Dr. Leela Edwin**
Dr. K.K. Asha
Dr. C.O. Mohan
Dr. A.R.S. Menon

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Dr. Santhosh Alex
Dr. P. Shankar

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निदेशक के डेस्क से

भाकृअनुप केंद्रीय मात्स्यिकी प्रौद्योगिकी संस्थान के जीवनकाल में एक अतिरिक्त सक्रिया वर्ष संपन्न। संस्थान का 2017-18 का वार्षिक रिपोर्ट आपके सामने प्रस्तुत करते हुए मुझे खुशी हो रही है। इस साल भी संस्थान ने शोध कार्य और सुधरित प्रौद्योगिकियों के हस्तांतरण का कार्य जारी रखा।

मत्स्यन प्रौद्योगिकी प्रभाग की प्रमुख उपलब्धि भारत सरकार के नीली क्रांति योजना में प्रभाग का सहयोग था एवं गहरे समुद्री मत्स्यन यानों की अभिकल्पना के लिए कोचिन शिपयार्ड से सहयोग किया। अन्य उपलब्धियाँ इस प्रकार है, क्षय प्रतिरोध को बढाने के लिए नानो टाइटेनियम आक्साइड सिरियम आक्साइड एवं भिन्न मिश्रणों में मैगनीज डाईआक्साइड द्वारा बोट निर्माण स्टील का सतही सुधार, केंद्र द्वारा प्रयोजित योजना के तहत अंडमान और निकोबार प्रशासन के साथ एम ओ यू हस्ताक्षर किया गया, बे आफ बंगाल में 40 mm चौकोर मेश कोड एंड में मत्स्य प्रजातियों का धारण और बहिष्करण लक्षण का निर्धारण, निम्न खींच और एच डी पी इ मत्स्य ट्राल आदि के पकड़ लक्षण पर तुलनात्मक अध्ययन।

मत्स्य संसाधन प्रभाग ने उभरते मत्स्य प्रजातियां, रुढिमुक्त मात्स्यिकी संपदाएं और मात्स्यिकी रददी के प्रभावी उपयोग पर संसाधन प्रौद्योगिकियों को विकसित करने की कोशिश की। प्रमुख अध्ययन इस प्रकार हैं, पफर मत्स्य का हिमीकृत प्रौद्योगिकी, धुँआ के सुगंध वाले चिप्स और निले टिलोपिया से मत्स्य फिंगर, तुरंत बेटर और ब्रेडेड किया गया उत्पाद मिक्स, जातीय आर टी इ मत्स्य उत्पादों, आर टी ई टूना का सुविधा दाम अनुपात का आंकडा, गन्ने से मत्स्य रद्दी का जैव सैलेजिंग आदि। समुद्री शैवाल, पी एल ए आधारित बयोण्लास्टिक जिसमें भिन्न चिकनी मिट्टी को जोड़ा गया, आक्सीजन स्केवेंजर का विकास, स्वच्छता सूचक, और स्वर्णिम नानो कण आधारित तापमान दुरुपयोग सूचकों का अध्ययन किया गया।

गुणता आश्वासन एवं प्रबंधन प्रभाग ने मत्स्य में अमोनिया और फारमाल्डीहाइड मिलावट को पता लगाने के लिए कागज आधारित, द्रत जांच किट विकसित कर मान्यीकृत किया। यह किट प्रर्वतन अधिकारियों द्वारा उपयोग किया जाता है। अम्लीकृत मत्स्य और झींगा अचार में कोल्ड फिल और होल्ड प्रक्रिया के मान्यीकरण और तटीय मत्स्यन इलाकों में केडमियम के हाट स्पाट को पहचानने में सेफालोपोड पर जियो संदर्भित आकडों के संग्रहण पर ध्यान दिया आहार जनित रोगाणुओं के मेट्रिक्स आधारित भिन्न रिकवरी, बाज़ार और बंदर गाहों से मत्स्य और कवच मत्स्य में आहार जनित रोगाणुओं पर अध्ययन किया गया। सिगुआ टाक्सिन की उपस्थिति के लिए केरल, कर्नाटक और गुजरात क्षेत्र से इकटठे नमूनों को विश्लेषित किया गया। खेतीकृत स्वच्छ पानी मत्स्य, खेतीकृत खारा पानी मत्स्य, जंगली समुद्री झींगा, कटल मत्स्य और समुद्री मत्स्य के 16 प्रजातियों के चित्राधारित मार्गनिर्देश तैयार किया गया।

सूक्ष्म जैविक, किण्वन और जैव प्रौद्योगिकी प्रभाग द्वारा किए गए अध्ययन से यह पता चला कि कोचिन क्षेत्र में सूखे मत्स्य के 3.3% में *सालमोनेल्ला* उपस्थित था और आहार नमूनों में *सालमोनेल्ला* टिफिमूटियम, *सालमोनेल्ला* उरबाना, *सालमोनेला* पारटिफि बी और *सालमोनेला* के *सालमोनेल्ला* सालामे सेरोकिस्म पाया गया। हैचरी और जलकृषि खेती नमूनों में 7.8 *विब्रियो हारवाई* पाया गया। *थियोबासिलस एक्सासूलिस*, सल्फर आक्सीकारक जीवाणु को जलकृषि खेती से पृथकक किया गया और एलगिनेट बीड द्वारा गतिहीन करने के लिए अनुकूलतम किया गया। अमोनिया आक्सीकरण जीवाणु विविधता के लिए जलकृषि खेती नमूनों का मेटाजेनोमिक विश्लेषण से यह पता चला कि क्लोरोफलेक्सि प्रबल फैलम था, इसके बाद प्रोटियो जीवाणु तीन संभावित कोरम सेनसिंग *बासिलस* प्रजाति, जो कि गैरजीवीय के लिए आतिरिक्त था ताकि पीनस मोबीऐन को सुरक्षित रखें। *विब्रियो हारवाई* घाव से पश्च लाखे को पहचान गया। 10

समुद्री आहार और जलीय पार्यावरण नमूनों से *क्रोनोबैक्टर सकाजाकि* को पहचाना गया। भारत के समुद्री आहार और जलीय पर्यावरणों *सी. सकाजाकि* का यह पहला रिपोर्ट था। गुजरात से लवणित सूखे मत्स्य से पृथक्क किए गए मिथैसिलीन रेसिस्टेंट स्टाफलोकोकै स्ट्रेन (एम आर एस ए) का ड्राफट जीनोम सीक्वेंस सफलतापूर्वक पूरा किया गया और इसे अंर्तराष्ट्रीय सार्वजनिक डोमेन में प्रस्तुत किया गया।

जीव रसायन और पौष्टिक प्रभाग ने थियामिन और टोक्सिन लोड किए गए वानिला अम्ल कैटोसन के विकास पर जोर दिया और स्क्वालीन के लिए संभावित डेलिवरी पद्धित के लिए पेक्टिन आधारित बहु मिश्रण पर जोर दिया। अध्ययन से यह पता चला कि सारडीन से सूपर क्रिटिकल फलूयिड निचोड द्वारा निचोडे गए ओमेगा 3 और आमेगा 6 फैटी अम्ल पारंपरिक निचोड तरीकों की तुलना में बेहतर उपज दिया (*सरगासम* प्रजाति) से सूपर क्रिटिकल फलूयिड निचोड तरीके से पूरे समुद्री शैवल फूकोज़ातिन और लिपिड निचोड़ा गया। प्रभावी स्ट्रेटेजी के रूप में एंथोसियानिन के फंसाव के लिए अयोजित जेलेशन तरीके द्वारा कैटोसन नानोकण तैयार किए गए। ताकि उनके इन विवो जैव उपलब्धता और इन विट्रो स्थिरता बढाया जाए। उच्च चर्बी एलकोहाल पिलाए परीक्षणात्मक चूहों में एंथोसियानिन लोड किए नानो कणों के ओरल अनुपूरण में हैपोलिपेडिमिक प्रभाव रहा। और यह गेस्ट्रिक मूकोसा के खिलाफ एच सी एल एथनाल प्रेरित क्षति को सुरक्षित करता है। *कापाफैसस अलवारेंज*, लाल समुद्री शैवल से गर्म एलकेलिन पानी उपचार से समुद्री बयोपॉलीमर, कारीगीन्न निचोडा गया और एफ टी आइ आर स्पेक्ट्रास्कोपी द्वारा लक्षणीकृत किया गया। मत्स्य आहार उद्योग में उपयुक्त आहार इंगिडिमेट के रूप में समुद्री शैवाल रद्दी को लक्षणीकृत और मूल्यांकित किया गया। स्क्वालीन से एक दर्द निवारण बाम्म विकसित किया गया। साथ में कोलैजन, कैटोसन और एलगिनेट से चमडा मोस्ट्यूराइजिंग लोशन तैयार किया गया।

अभियांत्रिकी प्रभाग ने आधुनिक, स्वास्थयपरक, ीताधारित मत्स्य वेंडिंग कियोस्क को अभिकल्पित, विकसित और वाणिज्यीकृत किया। नया अभिकल्पित बहु उद्दश्य (मत्स्य शुष्कन, पानी तापन और विधुत) और तापीय परिवंर्तन पद्धित, जिसमें बयोमास हीटर बैक आप था, इसका निष्पादन का मूल्यांकन किया गया। इसके अलावा मौजूदा भा कृ अनु प के मा प्रौ सं और एल पी जी हाइब्रिड ड्रायर के पुनः अभिकल्पित किया गया। मत्स्य के लिए ऊर्जा और दाम प्रभावी इनप्रारेड ड्रायर अभिकल्पित और विकसित किया गया। भा कृ अनु प के मा प्रौ सं हस्त चालित मत्स्य डीस्केलिंग मशीन को भिन्न मत्स्यों के प्रचालन अवस्थाओं के लिए चलाया गया। पेलटियर आधारित 12 v बैटरी से चालित नमूना इकट्ठा करना और 5 v क्षमता के परिवहन ठंडा उपकरण भी विकसित किया गया।

विस्तार, सूचना और सांख्यिकी प्रभाग ने अपने अध्ययन में मत्स्य उद्यमकर्ता विकास की क्षमता और मजबूरियों को पहचाना। यह परिवार का सहयोग और चुने हुए क्षेत्र में पारंपरिक मत्स्या उत्पादों का विपणन है। प्राशासनिक और वैधिक बाधाएँ एक समस्या हैं। सरकार द्वारा मधुवारों के लिए उद्यमकर्ता विकास के अवसर हैं। व्यक्तिगत आकर्षण, स्वभाव नियंत्रण और व्यावसायिक ओपान मत्स्य उद्यम के लिए प्रभावित किया। हौज पिद्धत के मूल्य चेन में वे सात नोड और एक्टरों को पहचान। हौज मात्स्यिकी में उपयुक्त अवसर एवं समस्याओं के लिए पेस्टेल विश्लेषण किया गया। चूलियार में मत्स्य प्रजाति के उपयोगिता के लिए और बयोमास के लिए कोएफिाएंट और वी पी ए विश्लेषण यह दर्शाया कि म्रिगाल प्रजातियों के शेषण के लिए कोई गुंजाइ नहीं है। भा कृ अनु प के मा प्रौ सं की प्रौद्योगिकियों से यह पता चला कि ज्यादातर उद्यम/औद्यौगिक प्रयोग के लिए थे। कोंजोएंट विश्लेषण द्वारा उपभोक्ता वरीयता यह दर्शाया कि एचण्मकुलम और कोल्लम में मत्स्य खरीदने के लिए महत्वपूर्ण घटक आय है। डी एस टी सी परियोजना के तहत पेरूमबलम गाँव में सीपी संसाधन सुविधा का निर्माण शुरु किया गया और दो मांस कवच पृथक्क को अभिकल्पित और संविरचित मत्स्यन और समुद्री प्रचाल, मत्स्य समुद्र का पहचान, मत्स्यन यान और गिअर और मत्स्य संसाधन को केरल के नौ तटीय जिलों से दस्तावेज किया गया।

मैं इस अवसर पर सभी सहकर्मियों को सहयोग और उत्तम काम के लिए साधुवाद देता हूँ और मत्स्य उद्योग, मत्स्य कृपक, मत्स्य संसाधन उद्योग, मत्स्य उपभोक्ता, राज्य सरकार और भा कृ अनु प को इन गतिविधियों को चलाने पर धन्यवाद करता हूँ।

(रविशंकर सी.एन.)
निदेशक

कोच्चि
30 जून 2018

From the Director's desk

One more fruitful year in the life of ICAR-Central Institute o Fisheries Technology. I am highly delighted to put before you the Annual Report of the Institute for the year 2017-18. This year also the Institute continued its endeavors in research and transfer of improved technologies.

The most significant achievement of the Fishing Technology Division was the association of the Division in the Blue Revolution Scheme of the Govt. of India by associating with M/s Cochin Shipyard Ltd. in designing deep sea fishing vessels. Other achievements were surface modification of boat building steel using nano titanium oxide- cerium oxide–manganese dioxide mixtures in different combinations to enhance corrosion resistance, signing MoA with Department of Fisheries, Andaman and Nicobar Administration to design up to 19 m FRP fishing craft for fishermen in the Andaman and Nicobar islands under the centrally sponsored scheme and design of 7.6 m to 14 m fishing crafts of various sizes. The retention and exclusion characteristics of fish species at trawls attached with 40 mm square mesh codend in Bay of Bengal, comparative study on catch characteristics of the low drag and HDPE fish trawls, etc. were also studied.

The Fish Processing Division attempted to develop processing technologies and value added products from emerging fish species, unconventional fishery resources and efficient utilization of fishery waste. Notable studies included freeze chill technology for pufferfish, smoke flavoured chips and fingers from Nile tilapia, instant battered and breaded product mix, ethnic RTE fish products, estimation of benefit-cost ratio of RTE tuna, bio-silaging of fish waste using sugarcane etc. Seaweed and PLA-based bioplastic incorporating different clays, development of oxygen scavengers, freshness indicator and gold nano particles-based temperature abuse indicators were also studied.

The Quality Assurance and Management Division successfully developed and validated a paper strip-based rapid detection kit for checking ammonia and formaldehyde adulteration in fish which is widely been used by enforcement authorities. The division also focused on validation of cold fill and hold process in acidified fish and prawn pickle and collection of geo-referenced data on Cephalopods to identify hot spots of cadmium in coastal fishing grounds. Studies were conducted on matrix-based differential recovery of food-borne pathogens, monitored food-borne pathogens in fish and shellfish species from markets and from harbors. Analyzed samples procured from Kerala, Karnataka and Gujarat region for the presence of ciguatoxin. Pictorial guidelines were prepared for 16 species of fish including farmed freshwater fish, farmed brackishwater shrimp, wild marine shrimp, cuttlefish and marine fish.

The studies carried out at Microbiology, Fermentation and Biotechnology Division revealed that *Salmonella* occurred in 3.3% of dry fish in Cochin region and *Salmonella* Typhimurium, *Salmonella* Urbana, *Salmonella* Paratyphi B and *Salmonella* Salamae serotypes of *Salmonella* were found in seafood samples. *Vibrio harveyi* was detected in 7.8% of hatchery and aquaculture farm samples. *Thiobacillus aquaesulis*, a potential sulphur oxidizing bacteria was isolated from an aquaculture farm and further optimization was carried out for immobilization using alginate beads. Metagenomic analysis of aquaculture farm samples for ammonia oxidizing bacterial diversity revealed that Chloroflexi was the dominant phylum followed by Proteobacteria. Three potential quorum sensing *Bacillus* spp., as an alternate to antibiotics to protect *Peneaus monodon* post-larvae from *Vibrio harveyi* infection, were identified. *Cronobacter sakazakii* was detected in 10 seafood

and aquatic environment samples. This is a first report on detection of *C. sakazakii* in seafoods and aquatic environments from India. Draft genome sequence of two Methicillin Resistant Staphylococci (MRSA) strains (ST 1 and ST 39) isolated from salted dry fish from Gujarat was completed successfully and submitted to international public domain (ASM).

The Biochemistry and Nutrition Division gave emphasis on the development of thiamine and pyridoxine-loaded vannilic acid-grafted chitosan and pectin-based multiple emulsion as a potential delivery system for squalene. The studies revealed that Omega-3 and Omega-6 fatty acids extracted using super critical fluid extraction from sardine gave better yield and quality of fatty acids when compared to conventional extraction methods. Fucoxanthin and lipid from brown seaweed (*Sargassum* sp.) was extracted by super critical fluid extraction method. Chitosan nano particles were prepared by ionic gelation method for the entrapment of anthocyanin as an effective strategy to enhance their *in vivo* bio-availability and *in vitro* stability. Oral supplementation of anthocyanin-loaded nano particles were found to have hypolipidemic effect in high fat-alcohol fed experimental rats and also protected gastric mucosa against HCl-ethanol induced damage. A marine biopolymer, carrageenan was extracted from the red seaweed *Kappaphycus alvarezii*, by hot alkaline water treatment and characterized by FTIR Spectroscopy. Characterized and evaluated seaweed waste as a suitable feed ingredient in fish feed industry. A pain relieving balm with squalene as an active component was also developed, besides a skin moisturizing lotion with collagen, chitosan and alginate as main ingredients.

The Engineering Division designed, developed and commercialized modern, hygienic and refrigeration-enabled mobile fish vending kiosk. Performance evaluation of the newly designed multi-purpose (fish drying, water heating and electricity) solar thermal conversion system with biomass heater backup was carried out. Further, redesigned the existing ICAR-CIFT solar-LPG hybrid dryer with notable innovations. Energy and cost-efficient infrared dryer for fish was designed and developed. Performance evaluation of ICAR-CIFT hand-operated fish descaling machine was conducted to optimize operating conditions for various fishes. A Peltier-based 12 V battery-operated specimen collection and transport cooling device of 5 L capacity was also developed.

The Extension, Information and Statistics Division through their studies identified that the perceived strength and weakness of the fish entrepreneurship development are family support and marketing of traditional fish products in the selected study area and administrative and legal hurdles are the major threats. The opportunity is the Government funded livelihood schemes for the fisherfolk on entrepreneurship development. The Entrepreneurial Intention (EI) for the fisheries enterprise was influenced by personal attraction, perceived behavioral control and professional option. They also identified seven nodes and actors prevailing in the value chain of reservoir system. PESTLE analysis was carried out towards identifying the concerns and opportunities in the reservoir fisheries. The K-Co-efficient and VPA analysis for the suitability of fish species and biomass available for exploitation showed that at Chulliyar, there is scope for exploitation of the mrigal species. The technologies of ICAR-CIFT showed that majority were towards entrepreneurship/industrial application. The consumer preference using conjoint analysis revealed that income is the significant factor in determining the fish purchasing behavior in Ernakulam and Kollam. The construction of the clam processing facility at Perumbalam village under the DST-SEED project has been initiated and two meat-shell separator prototypes have been designed and fabricated. ITKs relevant to the fisheries sector, specifically with reference to fishing and oceanographic parameters, fish shoal identification, fishing craft and gear and fish processing have been documented from nine coastal districts of Kerala.

I take this opportunity to compliment all my colleagues for their immense support and creditable work, and thank the fishing industry, fish farmers, fish processing industry, fish consumers, state governments and the ICAR for all the help rendered in successfully carrying out our activities.

(Ravishankar C.N.)
Director

Kochi
30 June, 2018

कार्यकारी सारांश

- नानो टाइटेनियम ओक्साइड टाइटेनियम आक्साइड सेरियम आक्साइड-मैंगेनीज डाईआक्साइड के भिन्न संयोजनों से पोत के निर्माण के लिए उपयोग किए जानेवाले स्टील का सतही संशोधन किया गया। परिणाम 0.01:0.005:0.005 Mno: Ceo:TiD था। इसका अच्छा क्षय प्रतिरोध था।
- नानो कॉपर आक्साइड, जिंक आक्साइड और टैटानियम आक्साइड से उपचार किए गए जलकृषि जाल समुद्री पर्यावरण अवस्था में अच्छा जैव परिदूषण प्रतिरोध दर्शाया।
- सागर माला के नीली क्रांति योजना के तहत गहरे समुद्री मत्स्यन यानों के अभिकल्पना विकास के लिए मेसर्स कोचिन शिपयार्ड लिमिटेड से साझेदारी किया गया।
- मात्स्यिकी विभाग, अंदमान और निकोबार प्रशासन के साथ निम्नलिखित काम के लिए एम ओ यू पर हस्ताक्षर किए गए। 1. केंद्रीय प्रायोजित योजना के तहत 2.74 लाख रू में अंदमान और निकोबार द्वीप समूह के मछुवारों के लिए 19 m एफ आर पी मत्स्यन यान को अभिकल्पित करना। 2. नीली क्रांति योजना के तहत भिन्न आकारों में 7.6 m से 14 m मत्स्यन क्राफ्ट को अभिकल्पित करना।
- रिग किए गए जालों में गहरे समुद्री क्लोम जाल परिक्षण में अधिक पकड मिला 0.5 (53.16), इसके बाद 0.4 (23.56) और 0.6 (23.26) लटकन अनुपात था, पकड के भिन्न तरीकों में वेज और फंसाव में, वेज और फंसाव (37.26) और वेज (29.61) में ज्यादा पकड मिला, इसके बाद गिलिंग (20.26), फँसाव (12.39) और गिलिंग और फँसाव (4.6) था।
- निम्न खींच और HDPE मत्स्य ट्रालों का तुलनात्मक अध्ययन और पकड लक्षण पर काम हुआ। निम्न खींच और HDPE मत्स्य ट्रालों का औसत CPUE 17.34 Kgh^{-1} और 10.58 Kgh^{-1} रहा। हालांकि निम्न खींच ट्राल में CPUE उच्च था। यह बहु वेरिएंट जांच जैसे एम डी एस और अनोसिम जैसे प्रकट नहीं हुआ।
- बे आफ बंगाल में 40mm चौकोर मेश कोड एंड के ट्राल के मत्स्य प्रजातियों का इकट्ठा करना और छुडाने के लक्षणों का मूल्यांकन किया गया। कुल मत्स्य पकड़ में 81.4% को ट्राल कोड एंड में रखा गया और 18.2% को छोड़ा गया, अवलोकन की अवधि में 40mm चौकोर मेश कोड एंड में अलग किए गए पकड, कुल पकड का 17.8% था।
- पफर मत्स्य की कवच आयु में हिमीकृत प्रौद्योगिकी और नोनी फल (*मेरिंडा सिट्रिफोलिया*) का प्रभाव यह दर्शाया कि हिमीकृत अवस्था में नियंत्रित मूल्यों की तुलना में पफर मत्स्य दो दिनों की कवच आयु विस्तार दर्शाया।
- त्रेड्फिन ब्रीम (*नेमिटेरस जापोनिकस*) सॉसेज में आहार रेशों को जोडने से (गेहूं रेशा, और रेशा/रेशा और सैलियुम फाइबर) यह और रेशों के लिए सकारात्मक नतीजा दर्शाया।
- खाने के लिए तैयार उत्पादों का सुविधा खतरा अनुपात यह दर्शाया कि टी एफ एस डिब्बा और लचीले थैलियों में एल्लो फिन टूना के खपत में कम खतरा है।
- तालाब में पाले गए नीला टिलोपिया, की तुलना में पिंजरे में पाले गए नीला टिलोपिया रंग गंध और दिखावट में उच्च स्वीकार्यता दर्शाया।
- सुरिमि में 0.45% मगनिशियम क्लोराइड और 0.1 – 0.2% सोडियम क्लोराइड का उपयोग अच्छा संरचनात्मक गुण दर्शाया।
- बेटर और ब्रेड किए गए मत्स्य उत्पाद से मत्स्य आटा विकसित किया गया। इसका अच्छा पुनः जलयोजन क्षमता था। अच्छा संरचनात्मक और संवेदी स्वीकार्यता था।
- PLA द्वारा निर्मित जैव ण्लास्टिक फिल्म जो भिन्न मिट्टी जैसे मोंट्मोरिलैट, हेलोसाइट और बेनटोनाइट को मिलाकर बनाया गया, यह टिलोपिया के संवेष्ठन के लिए उपयुक्त रहा।

- भिन्न स्तरों में (1 - 5%) सेल्लूलोज नानो फाइबर से बने पालीएक्टिक एसिड फिल्म, स्पाट सिर मुलेट (*लिसा पारसिया*) के हिमीकृत संचयन के लिए उपयुक्त पाया गया।
- पाल्म शीथ ट्रे, श्रिंक और स्ट्रेच ओवर रैप में मिल्क मत्स्य (*चानोस चानोस*) का हिमीकृत संचयन अध्ययन से यह पता चला कि पाल्म शीथ ट्रे निम्न तापमान संचयन अवस्थाओं में मत्स्य के स्फुटकर संवेष्ठन के लिए उचित जैव अवनति सामग्री था।
- 200 मेश आकार के लोह चूर्ण 120 मेश लोह चूर्ण की तुलना में आक्सीजन स्केवेंजर की क्षमता को बढाया।
- कैटोसन द्वारा संश्लेषित स्वर्णिम नानो कण को हिमीकृत अवस्था में जाने या अनजाने संवेष्ठित स्वच्छ उत्पाद का पता लगाने के लिए उपयोग किया जा सकता है।
- पापेन आधारित हाइड्रोस्लेट के गुणों पर कटल मत्स्य (*सीपिया फरोनिस*) के हिमीकृत संचयन का प्रभाव प्रौटिमोलिसिस के साथ उच्च सस्सेण्टिबिलिटी दर्शाया।
- गन्ने की रददी से मत्स्य रददी के जैव साइलेंजिग को अनुकूलतम किया गया।
- चार भिन्न प्रवासी मत्स्य प्रणलियों से मत्स्य हडडी तेल निचाडने के लिए प्राटोकोल को ओप्टीमैज किया गया।
- समुद्री शैवाल निचोड आधारित जैव अवनति सूचर को विकसित और लक्षणीकृत किया गया।
- पाली लैक्टिक अम्ल से जैव अवनत सक्रिय झिल्लियाँ विकसित किया गया। इसके साथ अदरक तेल जोडा गया, मत्स्य संवेष्ठन उपयोग के लिए।
- आलू स्टार्च आधारित झिल्लियाँ तैयार किया गया जिसमें एंथोसियानिन शामिल है, यह स्कविड के संवेष्ठन में काम में आता है।
- मत्स्य में बुद्धिपरक संवेष्ठन प्रयोग के लिए एंथोसियानिन आधारित स्वच्छता सूचक विकसित किए गए।
- *सल्मोनेला एंटरिका*, *लिस्टरिया मोनोसाइटोजेनेस* और *एस्चेरीचिया कोलाई* ओ 157: एच 7 के रूप में संघीय विनियम संहिता (21 सीएफआर 114) में जरूरी एच 7 के रूप में वनस्पति जीवाणु संबंधी रोगजनकों के 5 लॉग कटौती के लिए अम्लीकृत मत्स्य और झींगा अचार में शीत भरने और वहन की प्रक्रिया का सत्यापन किया गया।
- 3-ट्यूब विधियों का उपयोग करते हुए *एल. मोनोसाइटोजेनेस* और *एस. एंटरिटिडिस* युक्त खाद्यजान्य रोगजनकों की प्राप्ति से पता चला है कि परंपरागत प्लेट विधि की तुलना में पीसीआर खोज उत्तम है।
- तटीय मत्स्यन स्थलों में कैडमियम के हॉटस्पॉट की पहचान के लिए सेफलोपोड्स (एन = 36) पर भूसंदर्भित आंकडे एकत्र किए गए।
- विभिन्न ऊतकों (मांसपेशी, पाचन ग्रंथियों और स्पर्शक) में कैडमियम जैवसंचय को अंकित किया गया और यूरोटोथिस सिंगलेंसिस की मांसपेशियों में उच्चतम संकेंद्रण (8.7 9 ± 0.1 पीपीएम) अवलोकित किया गया।
- खाद्यजन्य रोगजनकों की मैट्रिक्स-आधारित विभेदक प्राप्ति पर अध्ययन क्रमशः कच्चे मत्स्य, झींगा और स्क्विड नमूने से 65%, 54%, और 60% प्राप्ति को सूचित किए।
- तेवरा बाजार और कोचिन मात्स्यिकी बंदरगाह से प्राप्त 30 मत्स्य और शेलफिश प्रजातियों के नमूनों में खाद्यजन्य रोगजनकों की निगरानी अध्ययन 5.38 – 8.11 लॉग सीएफयू/जी के मेसोफिलिक जीवाणु भार का संकेत दिया।
- गुजरात के नवबंदर क्षेत्र से एकत्रित कच्चे, लवणित और शुष्कित चमड़े के जैकेट (*सॉम्बरबेराइड्स प्राजाति*) के 15 नमूनों में लवणित और शुष्कित नमूनों में उच्च खमीर और फफूंद गिनती (1.2×10^3 सीएफयू/जी) दिखायी दी। कोई रोगजनक जीवाणु नहीं मिला।
- हवा में संवेष्ठित किए गए एचडीपीई, प्रटलित पाउच की तुलना में *एसकॉमबरोमोरस कमर्सन* (सेरफ़िश) स्टीक्स के संशोधित वायुमंडल संवेष्ठन में सीओ$_2$ और एन$_2$ के 60:40 अनुपात का उपयोग करने से निधानी आयु 8-9, 5-6 और 2-3 दिनों तक बढ़ जाती है।
- 6.81% लवणित और शुष्कित मत्स्य उत्पादों (एन = 40) में, पानी की गतिविधि 6.81% की एफएसएसएआई निर्धारित सीमा से ऊपर थी और 26.67% नमूनों में लवण मात्रा 12% से कम थी।

- त्रिपुरा से प्राप्त किण्वित मत्स्य उत्पाद सभी प्रमुख खाद्यजन्य रोगजनकों से मुक्त थे, लेकिन फासा शेडल में 0.8-1.2 पीपीएम में आर्सेनिक और 'पुथी श्वास' में लेश स्तर (1.0-1.9 पीपीएम) को खोजा गया।
- तीन मत्स्यन बंदरगाहों और एक जलीय कृषि खेत की स्वच्छता की स्थिति स्वच्छता संकेतक जीवाणु की उपस्थिति को भिन्न डिग्री में प्रकट किए और उपयोग के लिए उपलब्ध पानी प्रदूषण का प्रमुख स्रोत है।
- केरल, कर्नाटक और गुजरात से प्राप्त 26 नमूनों के विश्लेषण से पता चला कि सिगुएटॉक्सिन के लिए कोई भी नमूना सकारात्मक नहीं था।
- मत्स्य में अमोनिया और फोरमालडिहैड मिलावता की जांच के लिए एक पेपर स्ट्रिपआधारित तेज खोज किट 350 मिलीग्राम/किग्रा के एलओडी के साथ विकसित किया गया।
- विभिन्न स्थानों के मत्स्य अचार में, पीएच 4.00-4.30 की सीमा में था, (अकेले ठोस टुकड़ों के लिए) aw 0.866-0.931 था, अम्लता 0.99-1.26% पाई गई और लवण मात्रा 4.03-8.60% थी।
- आरएपीडीपीसीआर द्वारा *वी. पैराहाइमोलिटिकस* की अनुवांशिक समानता ने 80 प्रतिशत विशिष्ट समानता स्तर पर कुल आठ विशिष्ट आरएपीडी प्रतिमान के साथ तीन विशिष्ट समूहों दिखाए।
- भारी धातुओं के लिए जाँच किए गए कुल 132 नमूने आर्सेनिक (बीडीएल 16.2 पीपीएम), कैडमियम (बीडीएल-1.41 पीपीएम), और लीड (बीडीएल-0.20 9 पीपीएम) की उपस्थिति को दिखाए।
- शीत संग्रहण के दौरान 5 मिनट के वहन समय के लिए 400 एमपीए पर उच्च दबाव वाले मलेट की सूक्ष्मजीव वैज्ञानिक गुणवत्ता में परिवर्तन 5.62 लॉग सीएफयू/जी की एरोबिक प्लेट गिनती को दिखायी जो शीतसंग्रहण के 32 दिनों के बाद भी निर्धारित सीमा से कम बनी हुई थी।
- मत्स्य के 16 प्रजातियों के लिए चित्रीय दिशानिर्देश तैयार किए गए जिनमें खेती किए ताजे पानी के मत्स्य, खेती किए खारे पानी के झींगे, जंगली समुद्री झींगे, कटलफिश और समुद्री मत्स्य शामिल थे।
- कोच्चि में जांच किए 3.3% शुष्क मत्स्य में *साल्मोनेला* मौजूद था। *साल्मोनेला* टाइफीमुरियम, *साल्मोनेला* उरबाना, *साल्मोनेला* परटाइफी बी और *साल्मोनेला* सलामा कोच्चि के समुद्री खाद्य नमूने में पाए गए *साल्मोनेला* के सीरोटाइप थे।
- 1/2 ए, 3 ए और 1/2 बी, 3 बी, 7 कोच्चि के समुद्री खाद्य नमूने में पाए गए *लिस्टरिया मोनोसाइटोजेनेस* के सेरोग्रुप हैं।
- जांच किए हैचरी और खेत किए के नमूनों में *विब्रियो हरवेई* 7.8 पाया गया।
- टी 334, टी 311, टी 304, टी 3481 और एमआरएसए के टी 127 स्पा प्रकार अपतरण केन्द्रों और कोट्टायम जिले के खुदरा बाजारों में पाए गए।
- *तयोबासिलस एक्वाएसुलिस*, खेत से पृथक किए एक संभावित सल्फर ऑक्सीकरण जीवाणु को स्थिरीकरण अध्ययन के लिए अनुकूलित किया गया।
- अमोनिया ऑक्सीडाइजिंग जीवाणुवीय विविधता के लिए जलकृषि खेत के नमूनों के मेटाजेनोमिक विश्लेषण से पता चला कि फाईलम क्लोरोफ्लेक्सी प्रमुख प्रोटीओंबैक्टेरिया के बाद प्रमुख फाईलम के रूप में है।
- नौ टायरोसिनस उत्पन्न एक्टिनोमाइसेज जलीय पर्यावरण से अलग किए गए।
- तीन *बेसीलस* प्राजाति, *विब्रियो हरवेई* संक्रमण से *पेनेस मोनोडन* पश्च-डिंभक की रक्षा के लिए प्रतिजैविक के विकल्प के रूप में एक संभावित कोरम क्वोचिंग जीवाणु की पहचान की गई है।
- *वी. पैराहाइमोलिटिकस* के 58 रोगजनक पृथक के ओ. सेरोटाइपिंग से पता चला कि वे सीरोटाइप ओ 1, ओ 2, ओ 3, ओ 4, ओ 5, ओ 7, ओ 10 और ओ 12 से संबंधित हैं।
- *क्रोनोबैक्टर सकाज़ाकी* को 10 समुद्री खाद्य और पर्यावरण के नमूनों से अलग किया गया।
- *स्टेफिलोकोकस वरनेरी*, *एस. हेमोलिटिकस*, *एस. एक्सलोसस*, *एस. सिमुलान*, *एस. ऑरिक्युलरिस* और *एस. एपीडेरमीडीस* को गुजरात के वेरावल के समुद्री खाद्य से पहचाना किए कोएगुलेस नकारात्मक स्टेफिलोकोकी थे।

- गुजरात के लवणित शुष्क मत्स्य से दो मेथिसिलिन प्रतिरोधी स्टाफिलोकोकी (एमआरएसए) पृथक (एसटी 1 और एसटी 39) का एक मसौदा जीनोम अनुक्रम पूरा किया गया।
- परीक्षित 48 झींगे नमूनों में से ड्ब्ल्यू एस एस वी के लिए तीन नमूने सकारात्मक पाए गए।
- प्रतिसूक्ष्मजीवी प्रतिरोध के लिए मत्स्य और मात्स्यिकी पर्यावरण से अलग किए *ई. कोली* जांच की गई और एरिथ्रोमाइसिन (84%), नलिदिक्सिक अम्ल (40%), टेट्रासाइक्लिन (32%) और सेफज़ोलिन (28%) की ओर अधिकतम प्रतिरोध देखा गया।
- थायामिन और पाइरोडॉक्सिनभारित वैनिलिक अम्लग्राफ्टेड काइटोसन विकसित किया गया।
- पेक्टिनआधारित बहुविध पायसनी स्क्वालीन और एंथोसाइनिन के लिए संभावित वितरण प्रणाली के रूप में विकसित की गई।
- स्क्वालीन पूरक में समृद्ध मत्स्य का तेल सइशछ (एमआरएनए) और लिपिड चयापचय के एंजाइमों की प्रोटीन निचोड़ को प्रभावित करता है।
- पारंपरिक निष्कर्षण विधियों की तुलना में सार्डिन से सुपरक्रिटिकल तरल निष्कर्षण का उपयोग करके निकाले गए ओमेगा-3 और ओमेगा-6 वसा अम्ल बेहतर उपज और वसा अम्ल की गुणवत्ता को प्रदान किए।
- सुपर क्रिटिकल तरल निष्कर्षण विधि द्वारा भूरे समुद्री शैवाल (*सर्गासम* प्रजाति) से फ्यूकोक्सैंथिन और लिपिड को निष्कर्षित किया गया।
- काइटोसैन नैनो कणों को एंथोसाइनिन के प्रवेश के लिए आयनिक जेलेशन विधि द्वारा विवो जैवउपलब्धता और *इन विट्रो* स्थिरता में वृद्धि करने के लिए एक प्रभावी रणनीति के रूप में तैयार किया गया। एंथोसाइनिनभारे नैनो कणों के मौखिक पूरक को उच्च वसाअल्कोहल खिलाएं प्रयोगात्मक चूहों में हाइपोलिपिडेमिक प्रभाव पाया गया और एचसीएलइथेनॉल प्रेरित क्षति के खिलाफ गैस्ट्रिक श्लेष्मा को भी संरक्षित किया गया।
- एक समुद्री बायोपॉलिमर, कैरागीनन को लाल समुद्री शैवाल कप्पाफिकस अल्वारेज़ी से गर्म क्षारीय जल उपचार द्वारा निष्कर्षित किया गया और एफटीआईआर स्पेक्ट्रोस्कोपी द्वारा लक्षण चित्रण प्राप्त किया गया।
- समुद्री शैवाल अपशिष्ट को मत्स्य चारा उद्योग में एक उपयुक्त चारा घटक के रूप में लक्षण चित्रण और मूल्यांकन किया गया।
- बायोएक्टिव कोलेजन पेप्टाइड्स हथौड़ा सिर शार्क (*स्फिने मोक्करन*) से त्वचा कोलेजन के अम्ल घुलनशील अंश के एंजाइमेटिक पाचन के माध्यम से, इसके बाद 94% मूल सफाई प्रतिक्रिया के साथ कॉलम क्रोमैटोग्राफिक प्रभाजन तैयार किए गए।
- एक सक्रिय घटक के रूप में स्क्वालीन के साथ एक दर्द राहत बाम विकसित किया गया। सीसस कूड्रांगुलरीस निचोड़ को एक अतिरिक्त घटक के रूप में जोड़ा गया जिसमें हड्डी के घाव को भरने गुण होते है।
- कोलेजन, काइटोसैन और एल्जीनेट मुख्य सामग्री के साथ एक त्वचा मॉइस्चराइजिंग लोशन विकसित किया गया।
- आधुनिक, स्वच्छ और प्रशीतन सक्षम मोबाइल मत्स्य वेंडिंग कियोस्क का अभिकल्प, विकसित और व्यावसायीकरण किया गया।
- बायोमास हीटर बैकअप के साथ नए अभिकल्प किए गए बहुउद्देश्य (मत्स्य शुष्कन, जल ताप और बिजली) सौर थर्मल रूपांतरण प्रणाली का निष्पादन मूल्यांकन किया गया।
- उल्लेखनीय नवाचारों के साथ मौजूदा भा कृ अनु प-के मा प्रौ सं सौर एलपीजी हाइब्रिड शुष्कक को फिर से अभिकल्प किया गया।
- मत्स्य के लिए ऊर्जा और लागत प्रभावी इन्फ्रारेड ड्रायर का अभिकल्प और विकसित किया गया।
- विभिन्न मत्स्यों के लिए परिचालन स्थितियों को अनुकूलित करने के लिए भा कृ अनु पके मा प्रौ सं हाथ संचालित मत्स्य डिस्केलिंग मशीन का निष्पादन मूल्यांकन आयोजित किया गया।
- 5 ली क्षमता का पिल्टियर आधारित 12 वी बैटरी संचालित नमूना संग्रह और परिवहन शीतलन उपकरण विकसित किया।
- चयनित अध्ययन क्षेत्र में पारिवारिक समर्थन और पारंपरिक मत्स्य उत्पादों का विपणन मत्स्य उद्यिमता विकास की अनुमानित ताकत और कमजोरी है। प्रशासनिक और कानूनी बाधाएं प्रमुख खतरे हैं। उद्यिमता विकास पर मछुआरों के लिए सरकार द्वारा वित्त पोषित आजीविका योजना एक अवसर है।

- मात्स्यिकी उद्यम के लिए उद्यमी इरादा व्यक्तिगत आकर्षण, अनुभव का व्यवहार नियंत्रण और पेशेवर विकल्प से प्रभावित था।
- जलाशय प्रणाली की मूल्य श्रृंखला में प्रचलित सात बुनियादी बातें और पात्रों की पहचान की गई। और आर्थिक मूल्यांकन के लिए, पारिस्थितिक तंत्र के उपयोग और गैरउपयोग दोनों मूल्यों की भी पहचान की गई।
- जलाशय मात्स्यिकी में चिंताओं और अवसरों की पहचान करने के लिए पेस्टल विश्लेषण किया गया।
- शोषण के लिए उपलब्ध मत्स्य प्रजातियों और बायोमास की उपयुक्तता के लिए सहकुशल और वीपीए विश्लेषण से पता चला है कि चुलीयार में, मृगल प्रजातियों के शोषण की गुंज़ाइश है।
- भा कृ अनु पके मा प्रौ सं की प्रौद्योगिकियों ने दिखाया कि बहुमत उद्यमशीलता/औद्योगिक अनुप्रयोग की ओर थे। बड़े मेश पर्सिन और रिंगसीन बढ़ती मत्स्यन दक्षता श्रेणी में उच्च सामाजिक और आर्थिक प्रभाव को दिखाएं।
- संसाधन बचत प्रौद्योगिकियों के अधीन, सागर कृपा और बेहतर प्रणोदकों के लिए आय स्तर और रोजगार उत्पादन उच्च मूल्यांकन किया गया।
- ट्रॉवलरों द्वारा उपयोग की जाने वाली औसत क्षमता क्रमशः एर्नाकुलम और कोल्लम में 0.72 और 0.74 थी। एर्नाकुलम और कोल्लम में क्रमशः ट्रॉलरों की आर्थिक दक्षता 0.53 और 0.64 थी, जिसका अर्थ यह है कि उच्च तकनीकी दक्षता पर चल रहे कुछ जहाजों में कम आर्थिक दक्षता दिखाई देती है।
- स्टोकास्टिक फ्रंटियर प्रोडक्शन फंक्शन मॉडल ने खुलासा किया कि ईंधन और श्रम की लागत मत्स्यन की क्षमता का निर्धारण करने वाले प्रमुख महत्वपूर्ण कारक हैं। कॉन्जेंट विश्लेषण का उपयोग कर उपभोक्ता वरीयता से पता चला कि एर्नाकुलम और कोल्लम में मत्स्य खरीद व्यवहार निर्धारित करने में आय महत्वपूर्ण कारक है।
- डीएसटीसीईड परियोजना के अधीन पेरुंबलम गांव में क्लैम प्रसंस्करण सुविधा का निर्माण शुरू किया गया है।
- दो मांसकवच विभाजक प्रोटोटाइप अभिकल्पित और संरचित किए गए हैं।
- मात्स्यिकी क्षेत्र से संबंधित आईटीके, विशेष रूप से मछली पकड़ने और महासागरीय मानकों के संदर्भ में, मछली शोल पहचान, मत्स्यन यान और गियर और मत्स्य प्रसंस्करण को केरल के नौ तटीय जिलों से प्रलेकित किया गया है।

Executive Summary

- Surface modification of boat building steel was done by using nano titanium oxide - cerium oxide – manganese dioxide mixtures in different combinations. The results showed the combination 0.01:0.005:0.005 MnO: CeO: TiO with good corrosion resistance.
- Multi-location field evaluation of nano copper oxide coated PE-PANI aquaculture nettings showed excellent fouling resistance and the technology is ready for commercialization.
- Associated with M/s Cochin Shipyard Ltd. for design development of deep sea fishing vessels under Blue Revolution scheme or Sagarmala.
- Signed MoA with Department of Fisheries, Andaman and Nicobar Administration: (1). To design 19 m FRP fishing craft for fishermen in the Andaman and Nicobar islands under the centrally sponsored scheme, and (2). To design 7.6 m to 14 m fishing crafts in various sizes under the Blue Revolution Scheme.
- Deep sea gillnet trials revealed maximum catch in nets rigged at 0.5 (53.16%) followed by 0.4 (23.56%) and 0.6 (23.26%) hanging ratio. Among different modes of capture, wedging and entangling (37.26%) and wedging alone (29.61%) contributed the most to the catches.
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- Comparison study and catch characteristics of the low drag and HDPE fish trawls were carried out. The average CPUE of the low drag and HDPE fish trawls were 17.34 $kg.h^{-1}$ and 10.58 $kg.h^{-1}$, respectively. Though the CPUE was higher in the low drag trawl, the species composition of the catches were not significantly different as manifested by multivariate tests like Multi-Dimensional Scaling (MDS) and ANOSIM.
- Retention and exclusion characteristics of fish species at trawls attached with 40 mm square mesh codend in trials at Bay of Bengal was assessed. Of the total fish catch 81.4% was retained in the trawl codend and 18.2% was excluded. Overall catch excluded with 40 mm square mesh codend, during the period of observations was about 17.8% of the total catch.
- The selection properties of *Johnius carutta* in 40 mm square mesh codend was worked out using covered codend method. The L50 value was worked out as 13.8 cm and the optimum mesh size for use in the codend was estimated as 50.6 mm.
- The effects of freeze-chill technology and noni (*Morinda citrifolia*) fruit extract on the shelf life of pufferfish indicated two days of shelf life extension in treated samples compared to control samples under chilled condition.
- Incorporation of dietary fibre (wheat fibre, oats fibre or psyllium fibre) in threadfin bream (*Nemipterus japonicus*) sausage indicated positive results for oat fibres.
- The benefit-risk ratio of consuming Ready To Eat (RTE) tuna products indicated a low risk of consuming yellowfin tuna in TFS cans and retortable pouches.
- The cage-reared Nile tilapia showed higher overall acceptability compared to pond-eared counterpart, in terms of colour, flavor, and appearance. Bleeding of Nile tilapia prior to storage improved colour and functional properties of proteins.
- The use of magnesium chloride along with sodium chloride (0.45%) in the range of 0.1-0.2% in wash water yielded surimi with better textural properties.

- An instant mix for battered and breaded fishery products using fish flour was developed with satisfactory rehydration capacity and good textural and sensory acceptability.
- Bioplastic films from PLA manufactured by incorporating different clays like Montmorillonite, Halloysite and Bentonite at different levels were found suitable for packaging of tilapia.
- Polylactic acid films incorporating cellulose nanofibers at different levels (1-5%) were found to be suitable for chilled storage of flathead mullet (*Liza parsia*) fish.
- Chill storage studies of milkfish (*Chanos chanos*) in palm sheath trays with shrink and stretch overwrap demonstrated palm sheath trays as an ideal biodegradable material for retail packaging of fish in low temperature storage conditions.
- Use of iron powder with 200 mesh size enhanced the efficiency of oxygen scavenger compared to 120 mesh iron powder.
- Gold nano particles synthesized using chitosan can be used to distinguish freshly packed products from frozen stored products.
- Chill storage of cuttlefish (*Sepia pharaonis*) skin enhanced the susceptibility towards proteolysis with increase in storage period.
- A modified method for bio-silaging of fish waste using sugarcane waste as the source of sugar was developed.
- Optimized a protocol for the extraction of fish bone oil from four different migratory fish species.
- Developed and characterized seaweed extract-based bio-plastic.
- Developed and characterized seaweed extract-based biodegradable suture.
- Developed a technology for extracting seafood flavour peptides from shrimp.
- Prepared gelatin hydrolysates having promising antioxidant and functional properties from the skin and scale of solefish.
- Developed a technology for making dried fish fingers from tilapia mince.
- Standardized microwave vacuum drying technology for drying fish, shrimp and squid shreds, with superior quality products.
- Developed technology for making gravads and smoke flavoured chips and fingers from Nile tilapia.
- Studies on the effect of 5-MeV electron beam (0, 2.5, 5, 7.5 kGy) irradiation and vacuum packaging on the shelf life of headless vannamei (*Litopenaeus vannamei*) stored at 2 °C indicated that control and 2.5 kGy treated vannamei had a shelf life of upto 12 days and 14 days, respectively while 5.0 kGy and 7.5 kGy treated samples were rejected on 28th day.
- Studies on the effect of vacuum packaging and E-beam irradiation on the quality and shelf life of peeled vannamei during chilled storage (2 °C) indicated that control, 2.5 kGy and 5.0 kGy treated peeled vannamei had a shelf life of 10 days, 13 days, 18 days, respectively, while 7.5kGy treated sample was rejected on 23rd day.
- Shelf life study of Modified Atmospheric Pressure (MAP) packed chill stored headless vannamei shrimp and seerfish steaks indicated a shelf life of 10 days for vannamei and 14 days for seerfish.
- Evaluation of the efficacy of bulk zinc oxide in combination with chitosan against seafood pathogenic and spoilage bacteria indicated it to be a suitable alternative for controling pathogenic and spoilage bacteria.
- Validation of cold fill and hold process in acidified fish and prawn pickle for 5 log reduction of vegetative bacterial pathogens such as *Salmonella enterica*, *Listeria monocytogenes* and *Escherichia coli* O157:H7 as required in Code of Federal Regulations (21 CFR 114) was carried out.
- The recovery of food-borne pathogens comprising of *L. monocytogenes* and *S. enteritidis* using 3-tube methods reveal that PCR detection is better in comparison to conventional plating method.

- Geo-referenced data on Cephalopods (n=36) were collected to identify hotspots of cadmium in coastal fishing grounds.
- The Cd bio-accumulation in various tissues (muscle, digestive glands and tentacles) were estimated and highest concentration (8.79±0.1 ppm) was observed in muscle of *Uroteuthis singhlensis*.
- Studies on matrix-based differential recovery of food-borne pathogens indicated 65%, 54%, and 60% recovery from raw fish, shrimp and squid samples, respectively.
- Monitoring study of food-borne pathogens in 30 fish and shellfish species sampled from Thevara market and Cochin Fisheries Harbor indicated mesophilic bacterial load of 5.38-8.11 log CFU/g.
- Samples (15 Nos.) of raw, salted and dried, and dried Leather Jacket (*Scomberoides* spp.) from Navabandar Region of Gujarat showed higher yeast and mold count ($1.2x10^3$ CFU/g) in salted and dried samples. No pathogenic bacteria were detected.
- Use of 60:40 ratio of CO_2 and N_2 in modified atmosphere packaging of *Scomberomorus commerson* (Seerfish) steaks extended the shelf life by 8-9, 5-6 and 2-3 days, compared to air packed LDPE, laminated pouches.
- In 6.81% of salted and dried fishery products (n=40), the water activity was above the FSSAI prescribed limit of 6.81% and salt content was less than 12% in 26.67% of samples.
- Fermented fishery products sourced from Tripura were free from all major food-borne pathogens, but arsenic was detected at trace levels (1.0 - 1.9 ppm) in 'Puthi shidal' and 0.8 - 1.2 ppm in 'Phasa shidal'.
- Hygiene status of three fishing harbours and one aquaculture farm revealed the presence of hygiene indicator bacteria to a varying degree and water available for use as major source of contamination.
- Analysis of 26 samples procured from Kerala, Karnataka and Gujarat revealed none of the samples as positive for ciguatoxin.
- Paper strip-based rapid detection kits for checking ammonia and formaldehide adulteration in fish was developed with LoD of 350 mg/Kg.
- In fish pickles from various locations, pH was in the range of 4.00-4.30, a_w was 0.866-0.931 (for solid pieces alone), acidity was 0.99-1.26% and salt content was 4.03-8.60%.
- Genetic similarity of *V. parahaemolyticus* by RAPD-PCR showed three distinct groups with a total of eight distinct RAPD pattern at 80% similarity level.
- A total of 132 samples screened for heavy metals showed the presence of arsenic (BDL-16.2 ppm), cadmium (BDL-1.41 ppm), and lead (BDL-0.209 ppm).
- Changes in microbiological quality of high pressure treated mullet at 400 MPa for 5 min. holding time during chilled storage showed aerobic plate count of 5.62 log CFU/g which remained less than the prescribed limit even after 32 days of chilled storage.
- Pictorial guidelines were prepared for 16 species of fish that included farmed freshwater fish, farmed brackishwater shrimp, wild marine shrimp, cuttlefish and marine fish.
- *Salmonella* was present in 3.3% of dry fish in Kochi region. *Salmonella* Typhimurium, *Salmonella* Urbana, *Salmonella* Paratyphi B and *Salmonella* Salamae were the serotypes of *Salmonella* found in seafood samples of Kochi.
- 1/2a, 3a and 1/2b,3b,7 were the serogroups of *Listeria monocytogenes* found in seafood samples of Kochi.
- *Vibrio harveyi* was found in 7.8% of hatchery and farm samples.
- t334, t311, t304, t3481 and t127 *spa* types of MRSA were found in landing centers and retail markets of Kottayam district.
- *Thiobacillus aquaesulis*, a potential sulfur oxidizing bacteria isolated from acquaculture farm was optimized for immobilization studies.

- Metagenomic analysis of aquaculture farm samples for ammonia oxidizing bacterial diversity revealed that Phylum Chloroflexi was the dominant Phylum followed by Proteobacteria.
- Nine tyrosinase producing Actinomycetes were isolated from aquatic environment.
- Three *Bacillus* spp., a potential quorum quenching *Bacillus* as an alternative to antibiotics to protect *Penaeus monodon* post-larvae from *Vibrio harveyi* infection is identified.
- O Serotyping of 58 pathogenic isolates *of V. parahaemolyticus* revealed that they belonged to Serotypes O1, O2, O3, O4, O5, O7, O10 and O12.
- *Cronobacter sakazakii* was isolated from 10 seafood and environment samples screened.
- *Staphylococcus warneri*, *S. haemolyticus*, *S. xylosus*, *S. simulans*, *S. auricularis* and *S. epidermidis* were the coagulase negative Staphylococci identified from seafood of Veraval, Gujarat.
- Draft genome sequence of two methicillin resistant Staphylococci (MRSA) isolate (ST 1 and ST 39) from salted dry fish from Gujarat was completed.
- Three samples were found to be positive for WSSV out of 48 shrimp samples tested.
- *E. coli* isolates from fish and fishery environment were screened for antimicrobial resistance and maximum resistance was observed for erythromycin (84%), nalidixic acid (40%), tetracycline (32%) and cephazolin (28%).
- Thaimine and pyridoxine-loaded vannilic acid-grafted chitosan was developed.
- Squalene powder developed had oxidative stability of four months.
- Pectin-based multiple emulsion was developed as a potential delivery system for squalene and anthocyanin.
- Fish oil rich in squalene supplementation effects the mRNA and protein expression of enzymes of lipid metabolism.
- Omega-3 and Omega-6 fatty acids extracted from sardine using super critical fluid extraction method gave better yield and quality of fatty acids when compared to conventional extraction methods.
- Fucoxanthin and lipid from brown seaweed (*Sargassum* sp.) was extracted by super critical fluid extraction method.
- Chitosan nano particles were prepared by ionic gelation method for the entrapment of anthocyanin as an effective strategy to enhance their *in vivo* bio-availability and *in vitro* stability. Oral supplementation of anthocyanin-loaded nano particles were found to have hypolipidemic effect in high fat-alcohol fed experimental rats and also protected gastric mucosa against HCl-ethanol induced damage.
- A marine biopolymer, carrageenan was extracted from the red seaweed *Kappaphycus alvarezii*, by hot alkaline water treatment and characterized by FTIR Spectroscopy.
- Characterized and evaluated seaweed waste as a suitable feed ingredient in fish feed industry.
- Bioactive collagen peptides were prepared through enzymatic digestion of acid soluble fraction of skin collagen from hammerhead shark (*Sphyrnae mokkaran*) followed by subsequent column chromatographic fractionation with 94% radical scavenging activity.
- A pain relieving balm with squalene as an active component was developed. *Cissus quadrangularis* extract was added as an additional component which has healing property in bone ailments.
- A skin moisturizing lotion was developed with collagen, chitosan and alginate as main ingredients.
- Modern, hygienic and refrigeration-enabled mobile fish vending kiosk was designed, developed and commercialized.
- Performance evaluation of the newly designed multi-purpose (fish drying, water heating and electricity) solar thermal conversion system with biomass heater backup was carried out.
- Redesigned the existing ICAR-CIFT solar-LPG hybrid dryer with notable innovations.

- Energy and cost efficient infrared dryer for fish was designed and developed.
- Performance evaluation of ICAR-CIFT hand-operated fish descaling machine was conducted to optimize operating conditions for various fishes.
- Developed Peltier-based 12 V battery-operated specimen collection and transport cooling device of 5 L capacity.
- The perceived strength and weakness of the fish entrepreneurship development are family support and marketing of traditional fish products in the selected study area. Administrative and legal hurdles are the major threats. The opportunity is the Government funded livelihood schemes for the fisherfolk on entrepreneurship development.
- The Entrepreneurial Intention (EI) for the fisheries enterprise was influenced by personal attraction, perceived behavioral control and professional option.
- Seven nodes and actors prevailing in the value chain of reservoir system were identified, and for the economic valuation, both use and non-use values of ecosystem were also identified.
- PESTLE analysis was carried out for identifying the concerns and opportunities in the reservoir fisheries.
- The K-Co-efficient and VPA analysis for the suitability of fish species and biomass available for exploitation showed that at Chulliyar, there is scope for exploitation of the mrigal species.
- The technologies of ICAR-CIFT showed that majority were towards entrepreneurship/industrial application. Large mesh purseine and ringseine showed higher social and economic impact on the increasing fishing efficiency category.
- Under the resource saving technologies, income level and employment generation rated high for Sagar Kripa and improved propellers.
- The mean capacity utilized by trawlers was 0.72 and 0.74 in Ernakulam and Kollam, respectively. The economic efficiency of trawlers was 0.53 and 0.64, respectively in Ernakulam and Kollam, implying that certain vessels operating at high technical efficiency shows low economic efficiency.
- The Stochastic Frontier Production Function Model revealed that cost of fuel and labour are the major significant factors determining the fishing capacity. The consumer preference using conjoint analysis revealed that income is the significant factor in determining the fish purchasing behavior in Ernakulam and Kollam.
- The construction of the clam processing facility at Perumbalam village under the DST-SEED project has been initiated.
- Two meat-shell separator prototypes have been designed and fabricated.
- ITKs relevant to the fisheries sector, specifically with reference to fishing and oceanographic parameters, fish shoal identification, fishing craft and gear and fish processing have been documented from nine coastal districts of Kerala.

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 1 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 31 March, 2018

Category	Sanctioned	Filled
RMP/Director	1	1
Scientific	95	82
Technical	127	86
Administrative	81	53
Supporting	63	38
Auxiliary	5	3
Total	**372**	**263**

Budget allocation and expenditure

(For the year 2017-2018 – All values in INR in Lakhs)

Budget Head	Allocation	Expenditure
Establishment charges	2745.00	2743.63
Pension and Retirement Benefits	385.00	384.83
Grants for Creation of Capital Assets	268.00	268.00
Traveling Allowances	50.00	50.00
Research and Operational Expenses	232.00	231.99
Administrative Expenses	559.38	559.38
Miscellaneous Expenses	31.00	30.99
Tribal Sub Plan	10.00	9.95
North East Hill	5.00	4.76
Total	**4285.88**	**4283.53**

ICAR-CIFT

www.cift.res.in

Veraval

Research Centre
Matsyabhavan, Bhidia Plot
Veraval- 362269, Gujarat
Ph. 02876231297,
Fax: 02876231576
ciftvrc_ad1@sancharnet.in

Mumbai

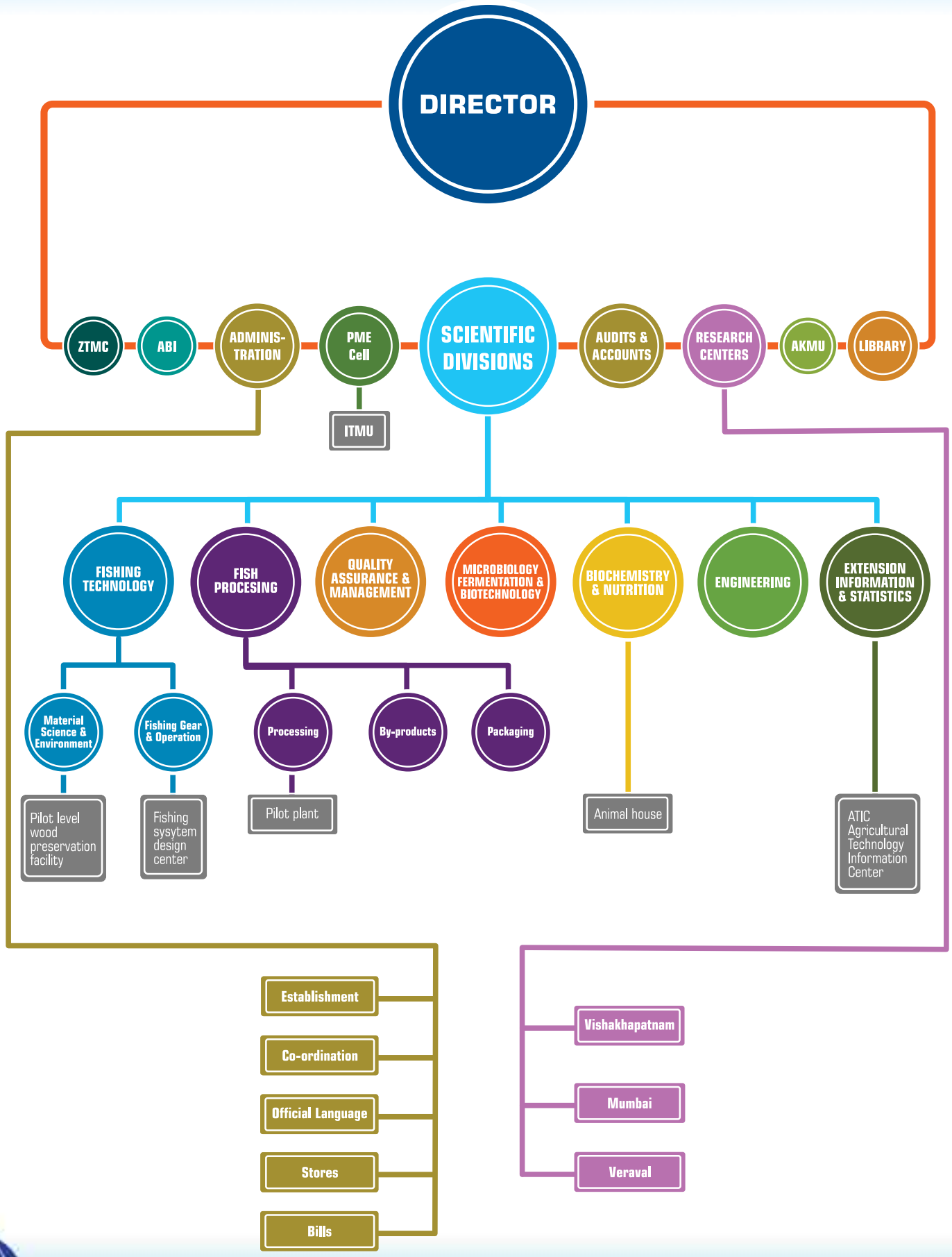
Research Centre
CIDCO Administrative Building
Ground Floor, Sector I, Vashi,
Navi Mumbai- 400703, Maharashtra
Ph. 022 27826017, Fax: 022 27827413
ciftmum@bom.nic.in

Visakhapatnam

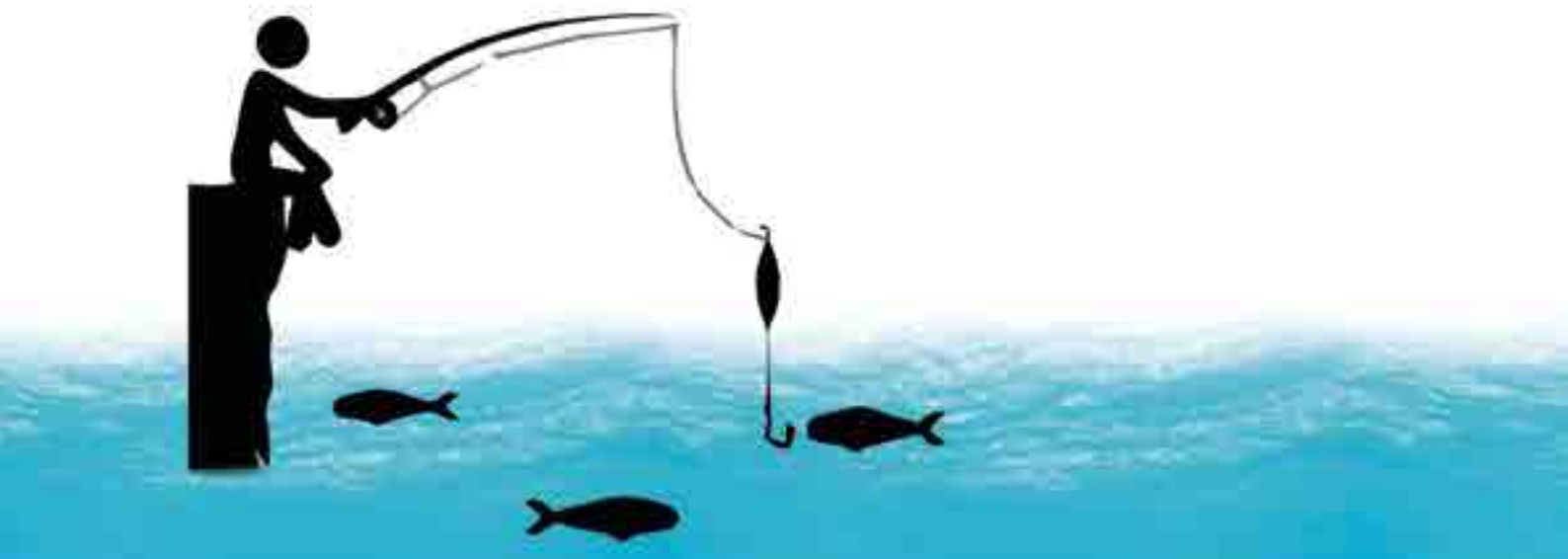
Research Centre
Ocean View Layout,
Pandurangapuram,
Andhra University P.O.
Visakhapatanam- 530003, Andhra Pradesh
Ph. 08912567856, Fax: 08912567040
cift@itpvis.ap.nic.in

Kochi

Headquarters
CIFT Junction, Willingdon Island
Matsyapuri P.O., Cochin-682029, Kerala
Ph: 0484-2412300; Fax: 091-484-2668212
aris.cift@gmail.com; cift@ciftmail.org


DIRECTOR
ZTMC
ABI
ADMINIS-TRATION
PME Cell
ITMU
SCIENTIFIC DIVISIONS
AUDITS & ACCOUNTS
RESEARCH CENTERS
AKMU
LIBRARY
FISHING TECHNOLOGY
FISH PROCESING
QUALITY ASSURANCE & MANAGEMENT
MICROBIOLOGY FERMENTATION & BIOTECHNOLOGY
BIOCHEMISTRY & NUTRITION
ENGINEERING
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

- Design, development and standardization of deep sea fishing vessel and gear systems for commercial operation
- Service life enhancement of fishing materials through application of nano particles and its impact on environment
- Investigations on fish behaviour and responsible fishing systems
- Optimization of harvest and post harvest techniques for mesopelagics in the south western Arabian Sea
- Development of region and species-specific pots/traps
- Fishing technological interventions for sustainable marine ecosystem services along the east coast of India

Externally funded projects

- Green fishing systems for tropical seas
- Assessment of food loss from selected gillnet and trammel net fisheries in India

Most significant achievements

- Surface modification of boat building steel was done by using nano titanium oxide - cerium oxide – manganese dioxide mixtures in different combinations. The results showed the combination 0.01:0.005:0.005 MnO: CeO: TiO with good corrosion resistance.
- Multi-location field evaluation of nano copper oxide coated PE-PANI aquaculture nettings showed excellent fouling resistance and the technology is ready for commercialization.
- Associated with M/s Cochin Shipyard Ltd. for design development of deep sea fishing vessels under Blue Revolution Scheme of Sagarmala.
- Signed MoA with Department of Fisheries, Andaman and Nicobar Administration: (1). To design 19 m FRP fishing craft for fishermen in the Andaman and Nicobar islands under the centrally sponsored scheme, and (2). To design 7.6 m to 14 m fishing crafts in various sizes under the Blue Revolution Scheme.
- Deep sea gillnet trials revealed maximum catch in nets rigged at 0.5 (53.16%) followed by 0.4 (23.56%) and 0.6 (23.26%) hanging ratio. Among different modes of capture, wedging and entangling (37.26%) and wedging alone (29.61%) contributed the most to the catch followed by gilling (20.26%), entangling (12.39%) and gilling and entangling (4.6%).
- A study using both ‘J’ and ‘Circle’ hooks in hand line fishing revealed 25% escapement from ‘J’ hooks. Comparison between ‘J’ and ‘Circle’ hook has shown that in both types of hooks, the pattern of hooking was almost same and in the case of ‘Circle’ hook, lower lip hooking was 12.5% while in ‘J’ hook it was 6.25%. In ‘J’ hook, 10.7% fishes caught had severe bleeding while no fishes caught by the ‘Circle’ hook recorded severe bleeding. Post-release survival was 100% in fishes caught by both type of hooks.

- Comparison study and catch characteristics of the low drag and HDPE fish trawls were carried out. The average CPUE of the low drag and HDPE fish trawls were 17.34 kg.h^{-1} and 10.58 kg.h^{-1}, respectively. Though the CPUE was higher in the low drag trawl, the species composition of the catches were not significantly different as manifested by multivariate tests like Multi-Dimensional Scaling (MDS) and ANOSIM.
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- The selection properties of *Johnius carutta* in 40 mm square mesh codend was worked out using covered codend method. The L50 value was worked out as 13.8 cm and the optimum mesh size for use in the codend was estimated as 50.6 mm.

Chief findings

Institute projects

Design, development and standardization of deep sea fishing vessel and gear systems for commercial operation

Finalization of hull form, general arrangement, structural design, powering and deck equipment for combination fishing

The hull form of 24.0 m L_{OA} multi-purpose fishing vessel with 7.0 m breadth and 2.85 m depth was completed. The general arrangement plan, structural design and powering calculation were prepared. The specification of winch required for the operation of gillnet and long line for deep sea fishing is also completed. The gillnet hauler has a capacity to haul 8 km of gillnet having 1.5 tons load. The line hauler with a capacity to hold 25 km 3 mm monofilament long line and a line setter in the aft are provided. The accommodation and wheel house design was also completed. The 3D model was run in the CFD software to arrive at the resistance. The powering calculation is completed and the main engine power of the vessel is 250 hp. The stability of the vessel was analyzed and found to be satisfying all requirements. The hull plate have a thickness of 8 mm, side shell thickness is 8 mm and the hull frame size is 65 x 65 x 8 mm. The bar keel size is 300 mm x 20 mm.

The research finding led to the commercialization of the technology for design and construction of 22.5 m vessel for fishermen from Tamil Nadu. Under the Blue Revolution Scheme, design of a 22.5 m long liner cum gillnetter for deep sea fishing is completed under an MoA with M/s Cochin Shipyard Limited for providing the detailed design of the vessel. Completed the structural design and the construction of 16 numbers of 22.5 m vessels started at the Shipyard on 29 January, 2018. The vessel is designed to undertake deep sea long lining and gillnetting with an endurance of 20 days and will be equipped with RSW tanks of three cubic meter capacity as well as insulated fish store for 30 tons of fish. The design is approved by India Register of Shipping.

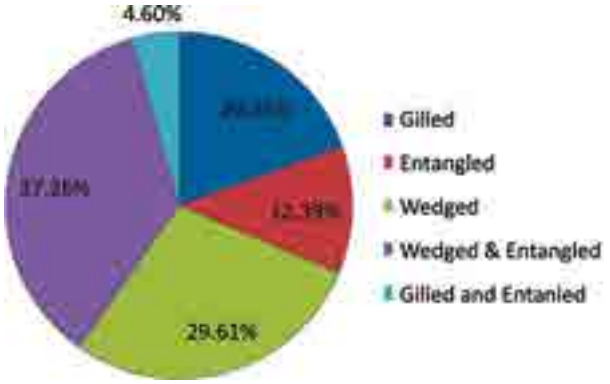
Field trials and performance of deep sea gillnets

Twenty seven field trials of experimental gillnet (twine specification 210×9×3 mm and three hanging coefficient 0.4, 0.5 and 0.6 with mesh size 140 mm) were conducted onboard Sagar Harita. Total catch (kg), Catch per trip (kg/trip), Catch per area of net employed (kg/1000^2 m) and Catch per soaking time (kg/hr) were 276.8 kg, 10.32 kg, 9.59 kg and 2.76 kg, respectively. Maximum catch was recorded in nets rigged at 0.5 (53.16%) followed by 0.4 (23.56%) and 0.6 (23.26%) hanging ratio. Among different modes of capture, wedging and entangling (37.26%) and wedging alone (29.61%) contributed the most to the catches.

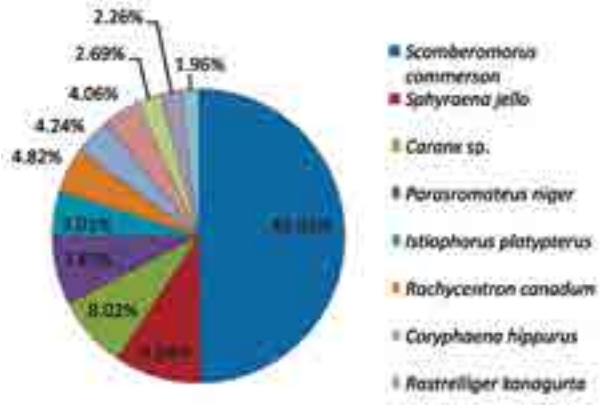
The catch was mostly contributed by *Scomberomorus commerson* (49.92%) followed by *Sphyraena jello* (9.64%), *Caranx* sp. (8.02%), *Parasromateus niger* (7.67%), *Istiophorus platypterus* (5.01%), *Rachycentron canadum* (4.82%), *Coryphaena hippurus* (4.24%) and *Rastrelliger kanagurta* (4.06%).

Fabrication and field trials of long lines for deep sea fishing

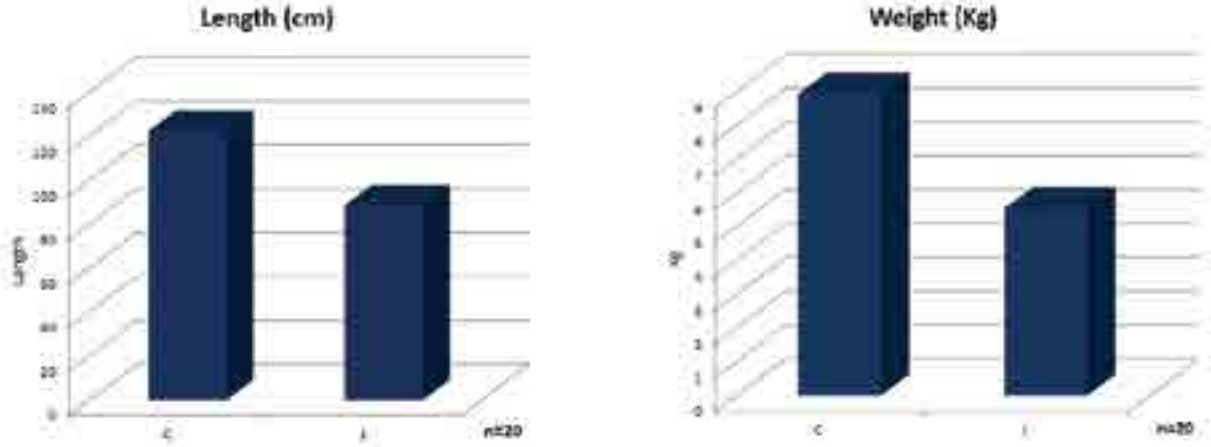
A study using 'J' and 'Circle' hooks was conducted for catch characteristics. The catch was higher in the 'Circle' hooks. The escapement from the operations (n=20) was about 25% and was observed only from 'J' hooks.



Percentage of fish caught by different mode in deep sea gillnet



Catch composition in deep sea gillnet



Comparison of length and weight of catch landed by 'Circle' and 'J' hook

Catch during the long lining at deep sea from M.V. Skipper II-based field trials

Long line operations were carried out along east coast in collaboration with CIFNET, Chennai, during 6 June, 2017 to 2 February, 2018 on-board M.V. Skipper-II. Duration of each trip was five days and six trips were conducted. During the trips, 98 fishermen from Tamil Nadu were trained in long lining using hydraulic line hauler and setter. A total of 110 hooks were used for deep sea long lining from F.V. Sagar Harita and the hooking rate in the experiment was 10%.

Data collection from combination crafts

Data was collected from combination deep sea crafts operating from Nizampatnam carrying out trawling and deep sea gillnetting. About 150 mechanized boats operate from Nizampatnam of which 20 operate both gillnet and trawl based on resource availability and season. Five crafts operate trawl net, gillnet and long line based on resource availability and season.

One of the deep sea crafts operating from Nizampatnam

Survey of tuna long liners

The overall long line commercial vessel catch collected from both Visakhapatnam and Kakinada including both targeted yellowfin tuna and non-targeted species was analyzed for understanding the month-wise distribution of catch. Good catch of long line resources was observed in the month of December, which contributed 17.4% (4.41/1000 hooks) of the total catch followed by the month of January (3.94/1000 hooks and 15.6%) and November (3.7/1000 hooks and 14.6%). The lowest hooking rates were reported in the month of August (1.58/1000 hooks) which formed only 6.25% of the total catch. Studies on seasonal abundance indicate post-monsoon as the peak season by registering a hooking rate of 3.49/1000 hooks (43.5%) followed by pre-monsoon 2.27/1000 hooks (28.3%) and monsoon 2.26/1000 hooks (28.2%).

Survey of deep sea fishing crafts of Andhra Pradesh

A detailed survey was conducted to understand the line fishing systems and semi pelagic trawling systems prevailing in Andhra Pradesh coast namely, Visakhapatnam, Kakinada, Machilipatnam and Nizampatnam. The traditional crafts being used are mostly the one which is 32-36 ft L_{OA} with a 10 HP OBM. In certain landing centres in North Andhra Prasdesh, they are using two 10 hp engines for troll lining and venturing into deeper waters. The IBM boats are of 60 ft in L_{OA}. The widths of these vessels are of 10-12 ft fitted with a 20 hp inboard engine. The mechanized fishing vessels operating off Andhra Pradesh coast are capable of trawling, long lining and gillnetting. The use of vertical lines is seen in the rocky areas of Andhra coast mostly in and around Kakinada coast. They are also used in and around the oil rig areas. The main line is around 175-200 m in length tied with a 2-5 kg stone at the end. The branch line is 1.75 to 2 m in length and tied with an artificial hook with silver plastic strips covering the hook.

Artificial hook with silver plastic strips covering the hook

Service life enhancement of fishing materials through application of nano particles and its impact on environment

Corrosion resistant nano manganese, titanium and cerium oxide coating over boat building steel

Thin coating of nano TiO_2-CeO_2-MnO_2 was given over boat building steel. SEM evaluation showed that the pores were covered and grain boundaries occupied with nano materials. Nano coated boat steel showed that the treatment with 0.01:0.005:0.005 MnO: CeO:TiO had good corrosion resistance.

Nano material-incorporated phosphating over boat building steel

Phosphating is an age old technique to coat steel and other metals. Generally chromate and zinc phosphates are used to coat the surface. In the present study we have incorporated nano zinc oxide and nano cerium oxide and their corrosion characteristics were evaluated. XRD results showed the presence of nano cerium and zinc oxide in the matrix. SEM and AFM results revealed that the pores were completely closed due to

the incorporation of nano cerium and zinc oxide. The surface characteristics also improved. Electrochemical evaluation revealed that the treatment with 0.04% each of nano zinc and cerium oxide exhibited excellent corrosion inhibition.

Multi-location field evaluation of nano copper oxide coated PE-PANI aquaculture nettings

Poly aniline-nano copper oxide coated aquaculture cage nettings developed were exposed to marine environments of Visakhapatnam, Veraval and Kochi. The results revealed excellent fouling resistance over the nano copper oxide treated nettings compared to control. Biomass accumulation was significantly lower in treated panels than in untreated ones. The technology can be disseminated to the end users.

Exposed untreated and treated nettings

Antifouling strategies using nano copper, titanium and zinc oxide mixture on polyethylene cage nettings

An experiment was carried out with multiple nano mixtures *viz*. CuO, ZnO and TiO_2 over polyethylene cage nettings. In nine treatments the preliminary evaluation showed that K2, K3 and K5 had good inhibition efficiency after two months. Repeated the experiments with K0, K1, K2, K3 and K5 for longer duration. After four months exposure studies results revealed that 0.01:0.01:0.01% each of CuO, ZnO and TiO_2, respectively (K5) exhibited excellent biofouling resistance.

Studies on nano material mixture-incorporated hydrogel on PE-PANI webbing materials and its fouling resistance under marine environments

Polyaniline coated polyethylene was treated with nano mixture (ZnO+CuO)-incorporated hydrogel. The hydrogel was synthesized successfully over PE-PANI nettings as evidenced by its colour and spectral characteristics. SEM evaluation showed that the hydrogel was formed uniformly and bonded well. The samples exposed in the Cochin estuary showed lowest biomass accumulation compared to control. Two months exposure showed better performance by the treatment with 0.02% CuO and 0.01% ZnO-incorporated hydrogel.

Antifouling strategies on polyethylene cage nets using nano titanium and copper oxide

Carried out studies on the leaching of nano copper oxide (0.01%) and titanium oxide (0.02%) from poly aniline treated nets. Leaching was monitored from 0 to 1080 h. Initially it showed higher concentration of copper (0.006 ppm) and later it was decreased.

Application of nano biocides for wood preservation: Application of CNSL with nano copper oxide to control degradation of rubber wood

Rubber wood was treated with CNSL and nano copper oxide in different concentrations. The treated panels were exposed in the Cochin estuary to evaluate the degradation pattern of the wood. Mechanical strength panels were evaluated before and after exposure. The panels showed loss of strength due to the treatment than control. After one month of exposure the strength reduction was significantly lower in treated panels (2.4 to 3.3) than control (10KN). The results showed that the treated panel was resistant to degradation.

Impact of nano materials on marine fouling and boring organisms: Studies on the seasonal settlement pattern of biofoulers and dominant species

Aini (*Artocarpus hirsutus*) wood panels were exposed to Cochin estuary to study the biofouling organism biodiversity in long term and short term panels. Panels were retrieved monthly and analyzed the biofouling diversity and biomass accumulation. Major foulers were Barnacles, Bryozoans and Modiolus. Besides, other associated non-fouling fauna like Polyclad worm, Amphipods, Isopods, Crabs, and *Nereis* sp. were found.

Investigations on fish behavior and responsible fishing systems

Field trials with improved ICAR-CIFT semi-pelagic and bottom trawls: Trawl geometry studies using sensors

Field experiments were conducted on-board M.F.B. Matsyakumari-II to study the trawl mouth opening using acoustic sensors (Trawlmaster-NOTUS) with reference to towing speed, operational depth, warp/depth ratio

and direction of current during fishing operations. Trawls were operated at different speeds (2.7, 3.0, 3.3 and 3.8 Knots), warp/depth ratio (6:1, 7:1 and 8:1) and depths (10 and 20 m). For HDPE trawl, the maximum total area of opening (96.58 m^{-2}) was recorded at 6:1 warp/depth ratio with the towing speed of 3.8 knots. Similarly, for UHMWPE the maximum opening (107.68 m^{-2}) was recorded at the towing speed of 3.8 knots at a warp/depth ratio of 6:1. Towing speed and warp/depth ratio significantly affected the mouth opening of the trawl. The mouth opening of both the trawls were found to increase linearly with the speed of tow.

Demonstration of operational efficiency of off-bottom trawl system

Experimental demonstrations of off-bottom trawl system (OBTS) was conducted in a private trawler off-Chapora coast. For this experiment, a 22 m, four seam HDPE OBTS trawl having codend mesh size of 40 mm fitted with 65 kg suberkrub otter boards was used. A total of five demonstration hauls of one hour duration were conducted at depths ranging between 10 to 12 m. The targeted commercial catch recorded for the OBTS was 70.3% and non-targeted low value catch was 29.7% to the total catch. The CPUE realized for the trawl system was 15.5 ± 6.9 (S.E.) kg/h. To examine the length classes of species caught by the net, 13 species of commercial importance in the catches were chosen for analyses. The mean size of the fish was calculated and it was compared with minimum legal size (MLS) proposed for Kerala and the results are given in the Table.

Size variation in different species caught

S. No	Species	Mean size (cm)	MLS (cm) (Mohamed *et al.*, 2014)
1	*Sardinella longiceps*	11.86	10
2	*Rastrelliger kanagurta*	16.89	14
3	*Pampus argenteus*	21.70	13
4	*Trichiurus lepturus*	47.84	46
5	*Lactarius lactarius*	10.82	10
6	*Epinephelus diacanthus*	13.21*	18
7	*Megalaspis cordyla*	9.00*	19
8	*Selar crumenophthalmus*	17.10	16
9	*Otolithes ruber*	24.60	17
10	*Otolithes cuvieri*	12.40*	16
11	*Portunus pelagicus*	14.90	9
12	*Portunus sanguinolentus*	12.70	7
13	*Uroteuthis duvauceli*	14.08	8

*Below Minimum Legal Size

Field trials of off-bottom trawls at Veraval

A total of 19 fishing trials with 22 m off-bottom trawl with 40 mm square mesh codend was carried out at a depth of 25 m during the period. Average duration of each tow was 1.5 hours. Catch data showed that the trawl design was highly species-specific and was constituted mostly of pelagic fishes. The average catch per haul was 2.9 kg. *Sardinella albella* was the major catch in the season (26.18 kg), followed by pufferfish (8.42 kg), *Alepes djedaba* (3.78 kg) and *Megalaspis cordyla* (3.6 kg). Jelly fish incidence was comparatively low during the season.

Behavioural lab facility at ICAR-CIFT, Kochi

The construction of the fish behaviour laboratory is in progress. Supply order for the purchase of software required for behaviour analysis is placed. A design for studying the movement of fishes in relation to the fishing gear using a gantry arrangement was finalized and submitted to the CPWD. The civil works of the laboratory is nearing completion.

Status of gears used in recreational fisheries in India: Post-release survival estimates of selected species during recreational fishing

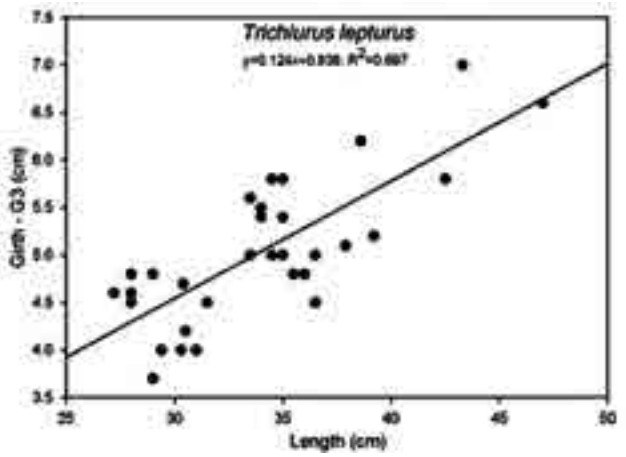
A study was conducted on hooking pattern, extent of bleeding and survival of Genetically Improved Farmed Tilapia (GIFT) caught by 'J' hooks (Hook No. 19) and 'Circle' hooks (Hook No. 12) at two aqua tourism sites in Njarakal, Kerala. Hooking location, presence and extent of bleeding were noted and the fishes were tagged and released to floating cages. Incidence of mortality was observed for 72 h. In both types of hooks, the pattern of hooking was almost same and in the case of 'Circle' hook, lower lip hooking was 12.5% while in 'J' hook it was 6.25%. Since there was no deep hooking, the extent of bleeding at the hooking point was also very minimal. In 'J' hook, 10.7% fish caught had severe bleeding while in fish caught by the 'Circle' hook no severe bleeding was recorded. No mortality was recorded within 72 h of post-release in GIFT. Low physical injury coupled with less handling time and sturdy nature of fish could be the reasons for no mortality and the very small mouth opening of tilapia would have prevented deep hooking.

Design development of fishing craft for recreational fisheries

Based on the inputs from the surveys carried out along the major recreational fisheries spots, a design for an indigenous craft which could be used for recreational fisheries was finalized. The main particulars of the sport fishing boat which was conceptualized is as follows: L_{OA} = 7.0 m, Breadth = 2.45 m, Depth = 1.50 m, Main engine: 20 hp OBM, Material: Fibre Glass, Speed: 10 knots, Buoyancy chamber, and Cost: ₹ 6.0 lakhs.

Design improvement and prototype development of responsible trawl systems

Studies were conducted to determine the length-girth relationship of trawl resources caught along the Kochi coast. Morphometric measurements of 15 commercially important species were taken for deriving the relationships. Girths were measured at three different locations and the maximum girth used for deriving the relationship. Girth values of the measured fishes ranged from 8.7% to 41.7% of the total length of the species. The relationship of the girth and length of *Trichiurus lepturus* is given in Figure.



Length-girth relationship with equation for *Trichiurus lepturus*

Gear selectivity studies

Trawl codend selection parameters in respect of *Johnius carutta* were estimated. The optimum mesh size calculated was 5.06.

Retention and exclusion characteristics of fish species in 40 mm square mesh codend

Retention and exclusion characteristics of fish species to trawls attached with 40 mm square mesh codend in trials at Bay of Bengal was studied. A 26 m multi-seam demersal trawl fitted with experimental square mesh codends was used and overall performance of the codends during the experimental tows were evaluated. Of the total fish catch 81.4% was retained in the trawl codend and 18.15% was excluded. Overall catch excluded with 40 mm square mesh codend, during the period of observations was about 17.8% of the total catch.

The size characteristics of the catch retained and escaped for a few commercial species was studied. Total of 60% of the Sciaenids caught during the operations were below 14 cm of which 14% escaped into the cover codend. Total of 36% of the ribbonfish caught during the operations were below 36 cm of which 22% escaped into the cover codend. Total of 90% of the *Nebea maculata* caught during the operations were below 14 cm of which 45% escaped into the cover codend. Total of 71% of the ribbonfish caught during the operations were below 17 cm of which 35% escaped into the cover codend. Total of 55% of the goatfish caught during the operations were below 14 cm of which 27% escaped into the cover codend. Total of 40% of the ponyfishes caught during the operations were below 9 cm of which 32% escaped into the cover codend. Total of 89% of the squids caught during the operations were below 10 cm of which 50% escaped into the cover codend.

Whole trawl selectivity estimates for selected species

Design of a 27 m bottom trawl with pockets in different sections was used to determine the escapement of shrimp from the different regions of the trawl net. It was observed that shrimp escaped from wing portion with a mesh size 80 mm and the size of shrimp was 60 mm TL. Length frequency of shrimp caught in the codend was compared with those found escaped at wing and belly. Shrimp escaped through wing portion were larger in size than those found escaped at belly which indicates that large meshes at wing portion (80 mm) facilitate escapement of comparatively bigger prawns, which is not desirable, whereas most of the smaller prawns escaped from the belly region. The percentage of escaped catch to total catch was 1.2%.

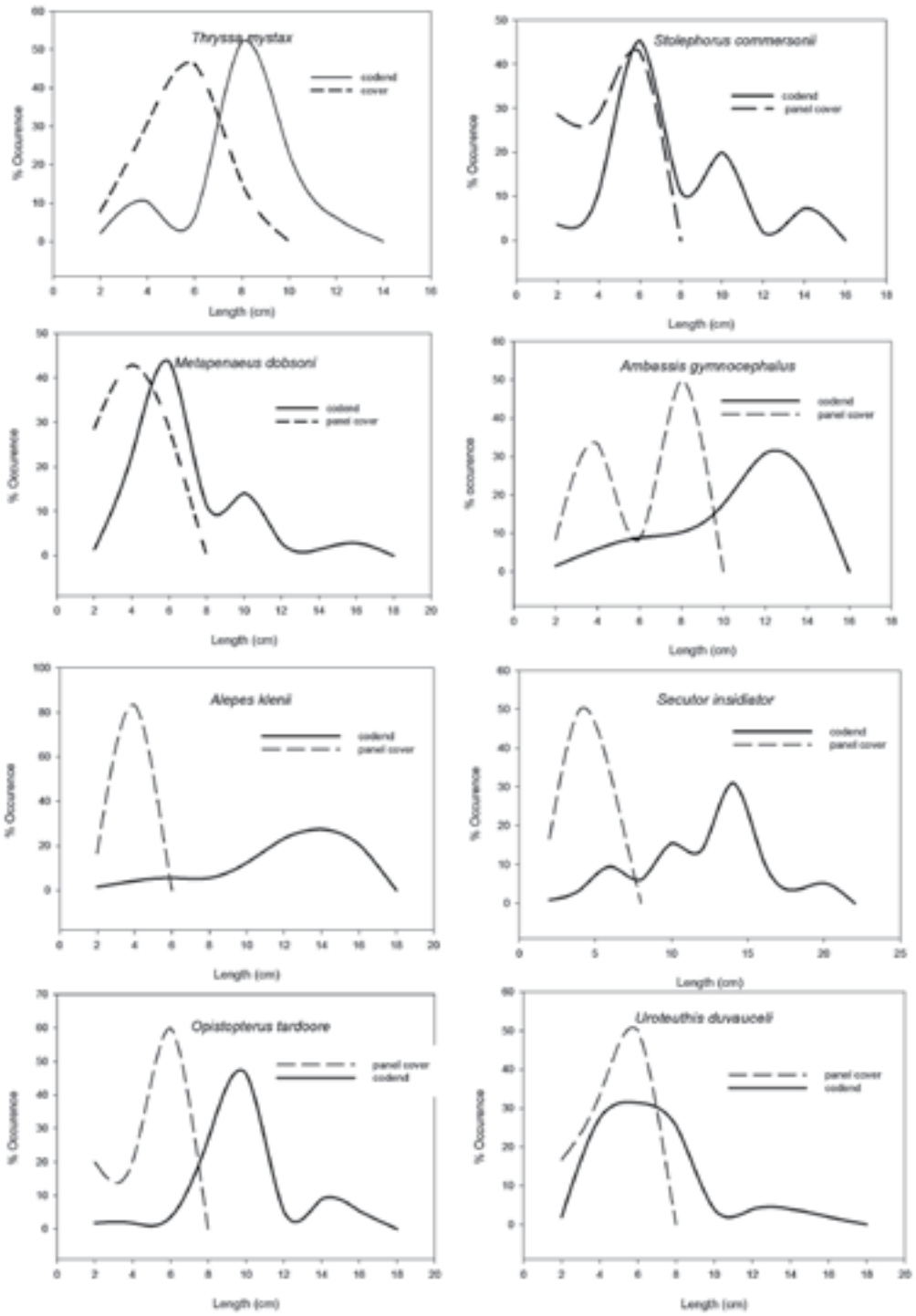
Field trials using low drag trawls

Field trials were carried out on-board FV Matsyakumari to compare the catch characteristics of the low drag and HDPE fish trawls. A total of 32 and 31 hauls each were carried out using the low drag and HDPE

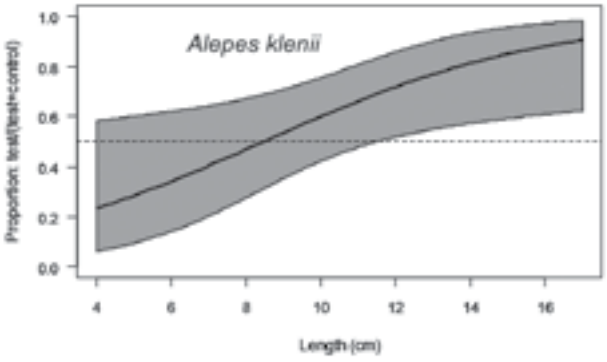
trawl, respectively. In both the trawls, jellyfish formed the major catch, which is an artifact of the seasonal abundance of the species during these months. Since the high catches of jellyfishes, skewed the CPUE, it was omitted for CPUE calculations. The average CPUE of the low drag and HDPE fish trawls were 17.34 $kg.h^{-1}$ and 10.58 $kg.h^{-1}$, respectively.

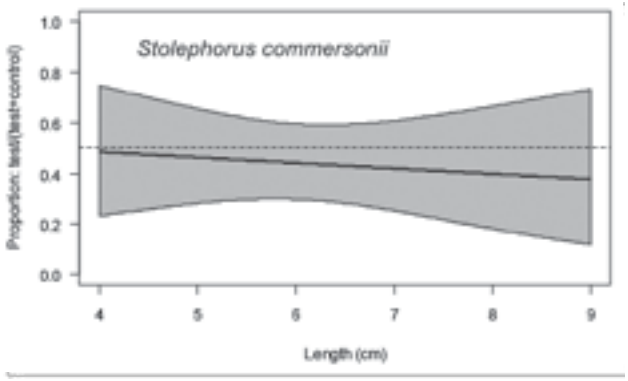
GLMM approach to compare the selection properties in trawl nets

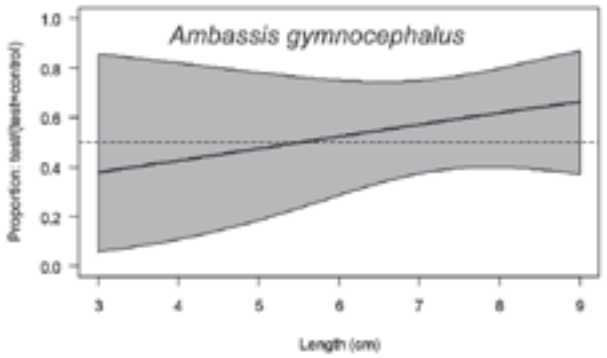
The Generalized Linear Mixed Modelling (GLMM) approach was worked out for the the species retained in the trawl net with and without panel. For each haul and species, the proportions of each length class caught in the control off-bottom trawl (trawl net without SMP) relative to the total number caught by the control



Length-frequencies of major species retained in the codend and cover of panel



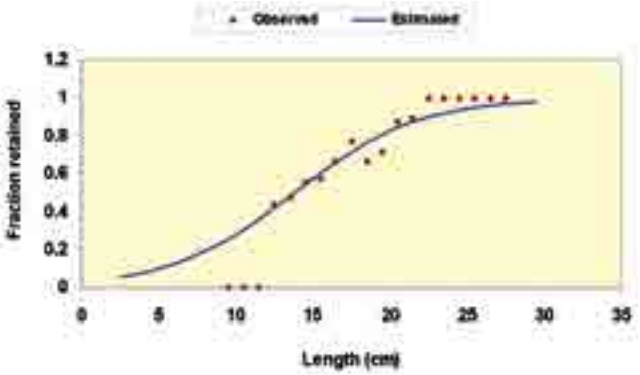




Selection curves of three species

and the experimental trawl (trawl with SMP) were analyzed using a GLMM with multi-variate normal random effects, using Penalized Quasi-Likelihood (glmmPQL). The GLMM-PQL method was applied to catches of *Alepes klenii*, *Stolephorus commersonii* and *Ambassis gymnocephalus*, the most abundant species, represented in sufficient numbers, both in the control and the experimental trawl net. The catches of fish (measured to nearest 0.5 cm) from test (codend of the SMP fitted trawl) and control (trawl net without SMP) were compared. The selection curves for the three species are shown in the Figures.

The selection properties of *Johnius carutta* in 40 mm square mesh codend was worked out using covered codend method. The L50 value was worked out as 13.8 cm and the optimum mesh size for use in the codend was estimated as 50.6 mm. The details of the different parameters and the selection curve are as follows: Mesh size and codend type - 40 mm Square; Number of hauls - 20; Total number of samples retained – 800; Total number of samples escaped – 567; Value of L50 (cm) - 13.8; Selection Range (cm) - 8.8; Selection Factor - 3.5; Selection Ratio - 0.6; S1 (Intercept) - 3.5; S2 (Slope) - 0.2; L25 (25% retention length) - 9.4; L50 (50% retention length) -13.8; L75 (75% retention length) - 18.2; Length at first sexual maturity LFM50 (cm) - 17.5; and Optimum mesh size based on LFM50 (cm) - 5.06.



Selection curve of *Johnius carutta*

Estimation of trawl codend selectivity of selected species: Selectivity properties of square mesh panels in trawls

The escapement pattern and the length-frequencies of species in 40 mm square mesh panel installed trawl were studied. The length-frequency distributions of *A. klenii*, *A. gymnocephalus*, *Dussumieria acuta*, *L. spadiceus*, *Metapenaeus dobsoni*, *O. tardoore*, *Secutor insidiator*, *Stolephorus commersonii*, *Thryssa mystax* and *U. duvauceli* were studied.

Retention and exclusion characteristics of species in 40 mm square mesh panels

A 24.47 m off-bottom trawl was used for the experimental fishing operation. 40 mm Square Mesh Panel (SMP) of dimensions 1m x 1m was fixed on the anterior dorsal side of the codend and a cover net with length of 1.5 m and mouth opening of 1m x 1m was attached to the panel to collect and quantify the escapees from the square mesh panel. The area of the panel was approximately 8.5% of the total area of the codend. A 24.7 m trawl of the same design, but without the SMP was used as the control gear to estimate the efficacy.

Species retained in the codend

Sl. No.	Species	CPUE ($kg.h^{-1}$)
1	*Pampus argenteus*	2.38
2	*Ambassis gymnocephalus*	2.05
3	*Lagocephalus* sp.	1.78
4	*Uroteuthis duvauceli*	0.85
5	*Stolephorus indicus*	0.85
6	*Metapenaeus dobsoni*	0.74
7	*Leiognathus splendens*	0.74
8	*Thryssa mystax*	0.58
9	*Charybdis lucifera*	0.46
10	*Alepes djedaba*	0.41
11	*Megalaspis cordyla*	0.30
12	*Oratosquilla nepa*	0.26
13	*Scomberomoroides tol*	0.23
14	*Therapon jarbua*	0.22
15	*Thryssa dussumeri*	0.19

Species retained in the square mesh panel cover

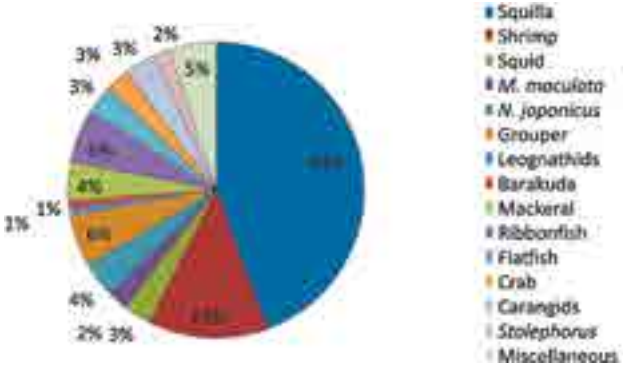
Sl. No.	Species	CPUE ± SE ($gm.h^{-1}$)
1	*A. gymnocephalus*	36.65±15.4
2	*Stolephorus* sp.	29.46±19.4
3	*M. dobsoni*	18.49±9.6
4	*O. nepa*	14.61±9.4
5	*A. kleinii*	8.76±5.4
6	*Thrissa mystax*	2.19±4.4
7	*O. tardoore*	2.09±2.8
8	*D. acuta*	2.54±2.1
9	*Lagocephalus* sp.	3.676±0.6
10	*A. djadaba*	2.75±1.5
11	*S. alballa*	0.81±2.6
12	*S. insidiator*	2.55±0.8
13	*R. kanagurta*	2.72±0.8
14	*S. guttatus*	2.46±0.0
15	*L. splendens*	1.87±0.4

The composition of the catches in the codend, cover of the SMP and the control codend are given in Tables. The CPUE of the most important species to the total catch is given and these are the main species contributing to the total. The total escapement from the square mesh panel (catch retained in the cover) was 0.15 kg. h^{-1}.

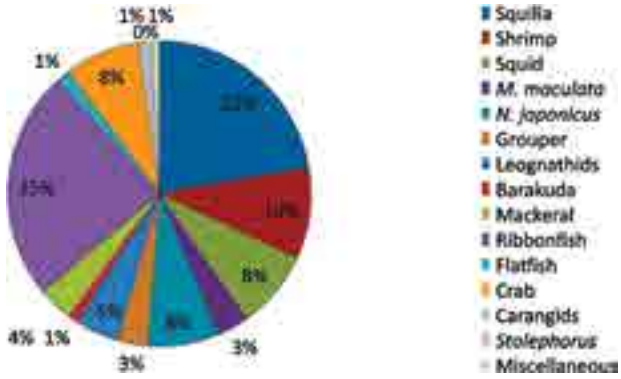
Field trials and study on the exclusion characteristics of BRDs

The trawl net attached with squilla BRD grid was rigged with 27 m bottom trawl. The experimental and control net yielded average CPUE of 31.81 kg/h and 28.63 kg/h, respectively. The average CPUE of upper and lower codends of experimental net were 11.6 kg/h and 17.03 kg/h, respectively. The catch composition of upper codend was dominated by squilla (42.28%) followed by shrimp (12.48%), ribbonfish (5.53%) and grouper (5.45%) whereas, lower codend catch was dominated by ribbonfish (23.98%) followed by squilla (21.8%), shrimp (9.47%), squid (8.13%) and crab (7.88%). The catch composition of control net was dominated by squilla followed by *N. japonicus*, shrimp and squid.

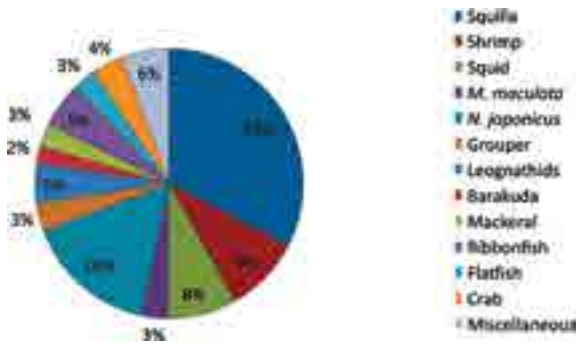
The exclusion pattern of squilla showed that in the upper codend catch, the squilla catches were 193.9% higher than that the lower codend. The average length of squilla in upper codend was found to be 11.521±2.488 mm, whereas lower codend showed 8.637±2.181 mm. The average length of squilla in control



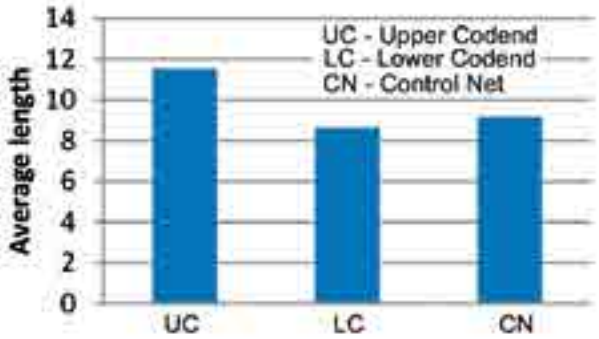
Catch in upper codend



Catch in lower codend



Catch in control net



Average length of squilla caught in different codends

net was 9.179±1.618 mm and the squilla in the upper codend was 133% bigger in average length than squilla caught in lower codend.

Catch composition of dolnet fishery along Northwest coast of India

Design details and catch composition of dolnets operated from Versova and Madh fish landing centers of Maharashtra were collected and recorded. Characterization of the catches were also done. Average size of dolnet gear ranged from 15-18 meters in total length. L_{OA} of dolnetters ranged from 5 m to 12 m in length and operated around 4-8 m depth. The catch mainly consisted of *Harpodon nehereus* (15%), *Pampus argenteus* (20%), *P. chinensis* (10%), *Lepturacanthus savala* (10%), *Johnius* sp. (7%), *Amystus* sp. (2%), *Portunus* sp. (5%), Seerfish (10%), *Charybdis* sp. (5%), *Arius maculatus* (10%) and *Acetes* sp. (6%). About 5-10% of discards from the dolnet comprised of sea snake, plastic debris, low value fish and juveniles of commercially important species.

Efficacy of different acoustic pingers in preventing depredation and dolphin entanglement in ring seines

The contract research project on "Studies on efficacy of acoustic pingers in preventing depredation and dolphin entanglement in ring seine" was taken up by signing an MoU between ICAR-CIFT and M/s Tile Marine, a private organization to study the efficacy of different acoustic pingers in preventing depredation and dolphin entanglement in ring seines. A structured proforma was prepared to collect the details of Cetacean sighting/interaction. The details like fishing location, depth of operation, gear details, area of dolphin bite, traditional measures to prevent dolphin interaction, cost of repair of the gear etc. were included. Preliminary observations showed that interaction of dolphins is less in pinger-assisted fishing when compared to non-pinger assisted fishing. Small gillnet fishing units in Njarackal landing centre were surveyed for incidents of damage due to dolphin attack. All the 20 units surveyed (100%) reported attack by dolphins. The monofilament nets were torn horizontally and vertically causing holes ranging from few cm to approx 1 m at the top and sides. Data collection of damage in gillnets is being continued.

Optimization of harvest and post harvest techniques for mesopelagics in the south western Arabian Sea

Fabrication of mesopelagic trawls

Designed and fabricated a 33 m two seam deep sea trawl for mesopelagics. The net is for bottom trawling intended to catch mesopelagics and other common deep sea resources like *Psenopsis cyanea* and *Synagrops philippinensis*. The extension piece and the codend is given an inner lining made of nylon net with 10 mm mesh size, which is the recommended mesh size for Myctophids world-wide. A 28 m mesopelagic trawl was also designed and fabricated.

Pelagic myctophid trawl ready for operation

Identification and documentation of mesopelagic components

The catch of mesopelagics comprised by *Myctophum spinosum* (Average length; 4±1.07 cm, Average weigth; 6.1±0.62 g) and *Myctophum obtusirostre* (Average length; 2.53±0.79 cm, Average weigth; 5.3±0.55 g). Samples were also collected from commercial deep sea shrimp trawler. Species were identified followed by length-weight measurement. The dominant species were *Neoscopilus microchir* (Average length; 15±0.3 cm, Average weight; 56.16±3.2 g) and *Diaphus watasei* (Average length; 11.62±0.41 cm, Average weigth; 24.85±3.2 g). Apart from Myctophids other group of deep sea fishes were also recorded *viz*. Cusk eal (Ophidiidae), *Lepidocybium* sp. (Gempylidae), *Cytopsis rosea* (Zeidae), *Gadomus* sp., rattails (Macrouridae) etc.

Neoscopilus microchir ***Diaphus watasei*** ***Myctophum spinosum*** ***Myctophum obtusirostre***

Some of the species caught during the trial operations

Development of region and species-specific pots/traps

Survey for region-specific pots and traps

A total of 40 pots and traps designs were recorded during the survey carried out at Gujarat, Maharashtra, Goa, Kerala, Tamil Nadu, Andhra Pradesh, Odisha and Diu (Union Territory). Organized marine pot fishery is recorded from Tamil Nadu, and in the rest of the states. Organized commercial crab trapping was observed at Maharashtra.

Survey of existing fishing traps

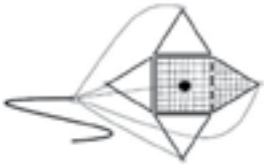
Survey was conducted on fishing pots/traps at Mahanadi estuarine system in and around Paradeep, Odisha. Not many traps are beeing used in these estuarine areas. Only a few bamboo traps are used for the capture of air breathing fishes. A marine crab trap was designed with traditional split bamboo mouth opening and new funnel guiding opening. Almost all the crabs (100%) were trapped in the funnel shaped mouth opening. The trap was tested for 20 days in the fishing harbour area. The catches mainly comprised of *Letjanus indicas*, *Chelenodon patoca*, *Charybdis lucifer* and *Epinephelus coioides*. In Visakhapatnam district the fishermen are using traditional traps for crabs targeting mainly *Scylla* spp. Two 60 cm bamboo poles are bend like bows

Map showing the details of survey on fishing ports and traps

Gargoor fish trap

Two Bucket model fish trap

Fold and take fish trap



Foldable pyramid crab trap

Modified Gargoor fish trap

Bucket model fish trap

and tied in the form of a cross. To this a HDPE 30 mm webbing piece is tied. This crab trap is usually operated at inshore rocky areas or the harbour areas.

Schematic diagram showing the fishing trap operation

Fishing technological interventions for sustainable marine ecosystem services along the east coast of India

LCA analysis of fishing systems

An inventory analysis on production stage for trawlers operating in Visakhapatnam and Kakinada in Andhra Pradesh and Paradeep in Odisha was conducted. Primary data for assessment of LCA for trawl systems was collected from three categories of trawlers.

Structural changes in fishing systems

Documented operational details of longline gear operated by commercial mechanized and motorized crafts off Andhra coast. Documented design details of motorized crafts involved in tuna long lining and line diagrams were made on Autocad.

Winch and pulley system

Designed and developed hand-operated winch and guide pulley systems for motorized crafts involved in tuna long lining. The winch can be operated manually for shooting and hauling of the lines with ease.

Fish storage facility for motorized craft

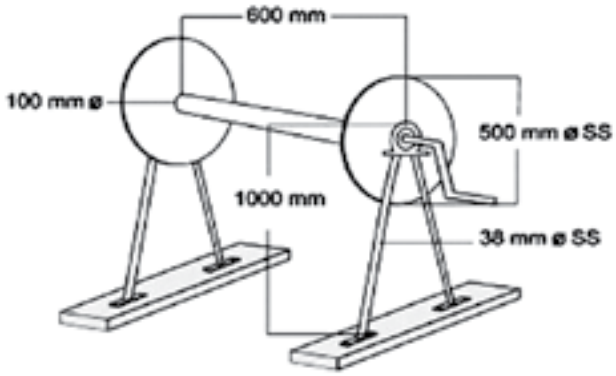
An improved design for storage facility for incorporating insulated ice box in the existing designs of motorized boat engaged in tuna long lining was carried out. The new design will help in storing the catch in a hygienic condition and maintaining the quality of tuna, thus enabling better price for the catch.

Economic/Bench marking of fishing systems

The product and cost relationships of fishing systems were assessed using production functions (Total Product, Average Product and Marginal Product) and cost functions (Total Cost, Average Cost and Marginal Cost). The input-input relationships and input-output relationships were studied for the data collected.

As part of input utilization, the age-engine power and L_{OA} engine power were compared and contrasted

Trawlers operating from Visakhapatnam



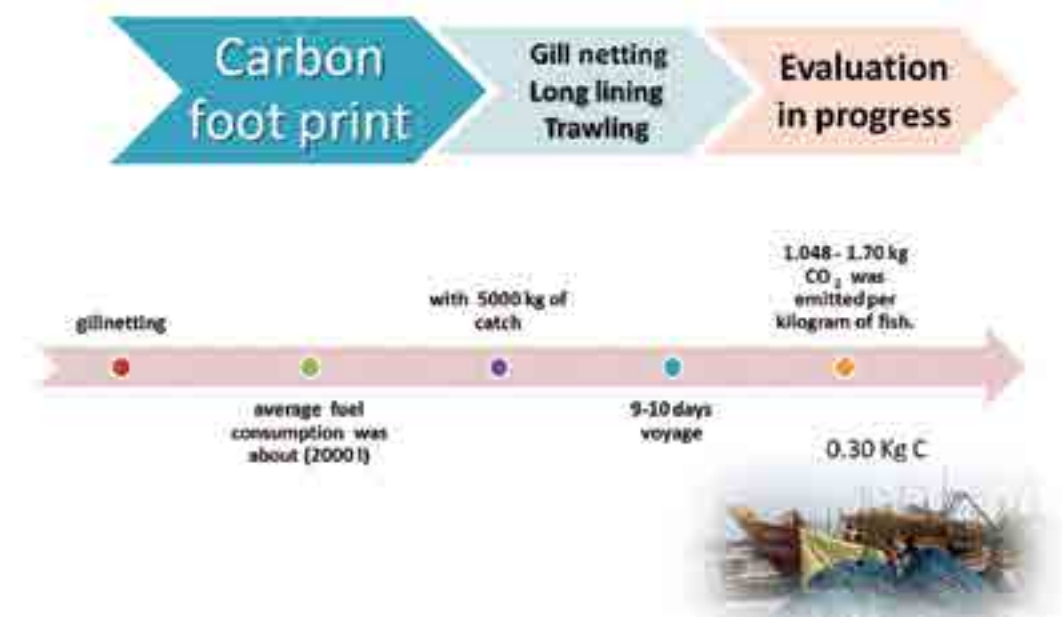
Winch and pulley system developed

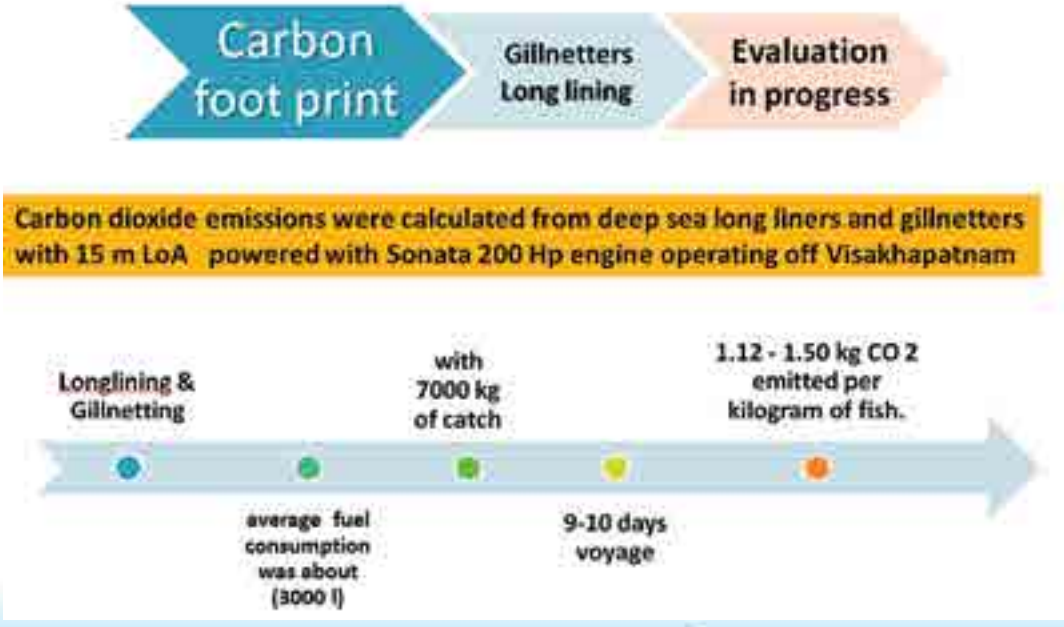
Insulated ice box installed in fishing boats

for the trawlers at Kakinada, Andhra Pradesh. An exponential increase in engine power was noticed in the marine fishing system, which is more prominent among trawlers. The increase in engine power was observed from 36 ft fleet size onwards. And the engine power was high in the 45, 50 and 52 ft. The vessel size showed positive correlation with the L_{OA} (Co-efficient = 0.89).

Estimation of carbon foot print from fishing systems

Carbon foot prints were estimated from stand-alone and combination fishing systems. Pre-harvest phase consisted of vessel construction and maintenance and provision of fishing gear; harvest phase included harvest from mechanized and motorized craft. The functional unit selected was 1 kg of marine fish to the consumer. Fuel consumption was 0.49 l/kg. The C and CO_2 emitted were 0.38 kg C/kg and 1.5 kg CO_2/kg of fish. The highest consumption of energy and the highest emissions of CO_2 were observed from the harvest phase. The fuel and electricity consumption and C and CO_2 emissions were high for mechanized landings and low for motorized landings. Reduction in energy consumption and subsequent emissions is possible in mechanized craft by increasing the fuel efficiency of marine diesel engines, controlling craft speed, and reducing the drag.





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
- Novel approaches for value addition and safety assessment of fishery resources of east coast
- Development of moisture soaker sachets/pads from aquatic weed Water hyacinth (*Eichhornia crassipes*) using super absorbant polymers for fish packaging application
- Specific technological problems and mitigation measures in fish and fishery products of Maharashtra region

Most significant achievements

- The effects of freeze-chill technology and noni (*Morinda citrifolia*) fruit extract on the shelf life of pufferfish indicated two days of shelf life extension in treated samples compared to control samples under chilled condition.
- Incorporation of dietary fibre (wheat fibre, oats fibre or psyllium fibre) in threadfin bream (*Nemipterus japonicus*) sausage indicated positive results for oat fibres.
- The benefit-risk ratio of consuming Ready To Eat (RTE) tuna products indicated a low risk of consuming yellowfin tuna in TFS cans and retortable pouches.
- The cage-reared Nile tilapia showed higher overall acceptability compared to pond-reared counterpart, in terms of colour, flavor, and appearance. Bleeding of Nile tilapia prior to storage improved colour and functional properties of proteins.
- The use of magnesium chloride along with sodium chloride (0.45%) in the range of 0.1-0.2% in wash water yielded surimi with better textural properties.
- An instant mix for battered and breaded fishery products using fish flour was developed with satisfactory rehydration capacity and good textural and sensory acceptability.
- Bioplastic films from PLA manufactured by incorporating different clays like Montmorillonite, Halloysite and Bentonite at different levels were found suitable for packaging of tilapia.
- Polylactic acid films incorporating cellulose nanofibers at different levels (1-5%) were found to be suitable for chilled storage of flathead mullet (*Liza parsia*) fish.
- Chill storage studies of milkfish (*Chanos chanos*) in palm sheath trays with shrink and stretch overwrap demonstrated palm sheath trays as an ideal biodegradable material for retail packaging of fish in low temperature storage conditions.

- Use of iron powder with 200 mesh size enhanced the efficiency of oxygen scavenger compared to 120 mesh iron powder.
- Gold nano particles synthesized using chitosan can be used to distinguish freshly packed products from frozen stored products.
- Chill storage of cuttlefish (*Sepia pharaonis*) skin enhanced the susceptibility towards proteolysis with increase in storage period.
- A modified method for bio-silaging of fish waste using sugarcane waste as the source of sugar was developed.
- Optimized a protocol for the extraction of fish bone oil from four different migratory fish species.
- Developed and characterized seeweed extract-based bioplastic.
- Developed and characterized seeweed extract-based biodegradable suture.
- Developed a technology for extracting seafood flavour peptides from shrimp.
- Prepared gelatin hydrolysates having promising antioxidant and functional properties from the skin and scale of solefish.
- Developed a technology for making dried fish fingers from tilapia mince.
- Standardized microwave vacuum drying technology for drying fish, shrimp and squid shreds, resulting in superior quality products.
- Developed technology for making gravads and smoke flavoured chips and fingers from Nile tilapia.
- Studies on the effect of 5-MeV electron beam (0, 2.5, 5, 7.5 kGy) irradiation and vacuum packaging on the shelf life of headless vannamei (*Litopenaeus vannamei*) stored at 2 °C indicated that control and 2.5 kGy treated vannamei had a shelf life of upto 12 days and 14 days, respectively while 5.0 kGy and 7.5 kGy treated samples were rejected on 28th day.
- Studies on the effect of vacuum packaging and E-beam irradiation on the quality and shelf life of peeled vannamei during chilled storage (2 °C) indicated that control, 2.5 kGy and 5.0 kGy treated peeled vannamei had a shelf life of 10 days, 13 days, 18 days, respectively while 7.5kGy treated sample was rejected on 23rd day.
- Shelf life study of Modified Atmospheric Pressure (MAP) packed chill stored headless vannamei shrimp and seerfish steaks indicated a shelf life of 10 days for vannamei and 14 days for seerfish.
- Evaluation of the efficacy of bulk zinc oxide in combination with chitosan against seafood pathogenic and spoilage bacteria indicated it to be a suitable alternative for controling pathogenic and spoilage bacteria.

Chief findings

Institute projects

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

Changes during chilling of secondary raw material and its effect on properties of protein hydrolysate

Effect of chill storage of cuttlefish (*Sepia pharaonis*) skin on the properties of its papain-derived hydrolysate was investigated for a period of 16 days. Susceptibility of cuttlefish skin protein towards proteolysis by papain increased with the storage period. Hinter colour parameters indicated a decrease in lightness and an increase in the yellowness and redness of cuttlefish skin protein hydrolysate during chill storage period. TVBN, TMA and TBA were found to be poor quality indicators for cuttlefish skin during chill storage. Blue discolouration in some of the skin samples were observed during the chill storage period. The fresh cuttlefish skin was cleaned in chilled water, blast frozen in an air blast freezer and stored in cold storage. The fresh cuttlefish skin had 85.98% moisture, 10.70% protein and 1.35% lipid content. The frozen storage study is under progress.

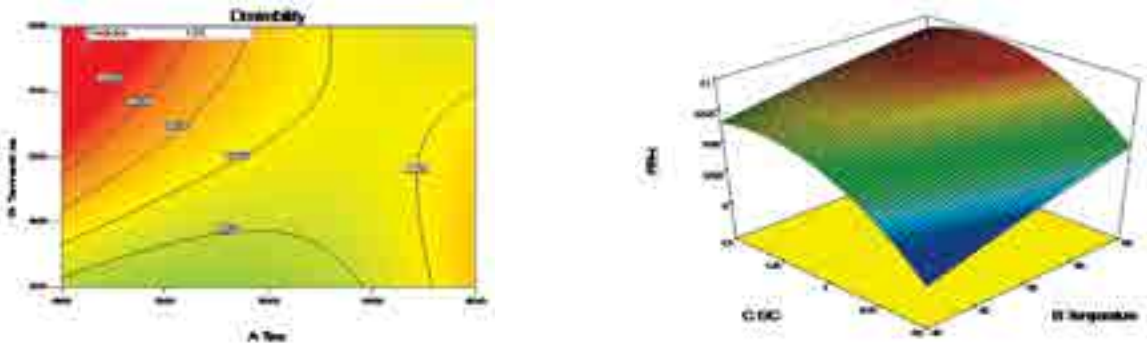
Preparation of papain-derived hydrolysate

Preparation of skin gelatin hydrolysates using different enzymes

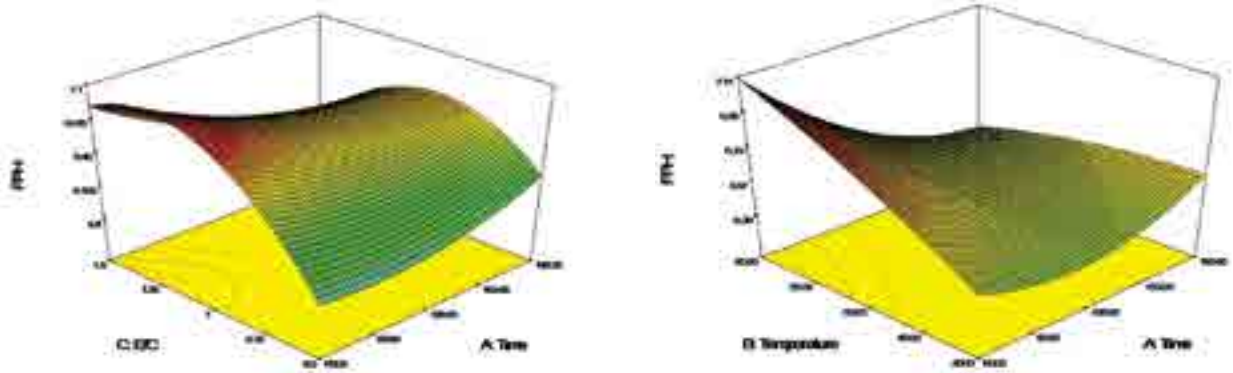
Protein profile of Nile tilapia skin gelatin and its hydrolysate indicated the presence of high molecular weight (HMW) polypeptides in gelatin whereas, no visible bands were found in the hydrolysate.

Extraction of fish protein from fish waste using acid/alkali treatment

Optimized the alkali-assisted extraction of fish protein hydrolysate by response surface methodology (RSM) from tilapia head waste. The combined effects of three independent variables, namely time (60, 120 and 180 min.), temperature (40, 50 and 60 °C) and enzyme concentration (0.5, 1 and 1.5 g/100g of head waste) on responses to yield was examined by Box-Behnken Design. Based on the models derived by RSM, optimized conditions for the maximum yield of 6.6 g/100 g of head waste (dry basis) from tilapia head waste. The proximate analysis of protein hydrolysate from tilapia head waste showed 36.37±0.06% of protein, 5.09±0.005% of fat, 3.29±0.01% of moisture and 6.26±0.03% ash. The quality parameters such as TVB-N, TMA and TBA were within the limits. The colour analysis showed the L* value of 89.36±0.04. The antioxidant activity of protein hydrolysate was evaluated using different assays such as DPPH, FRAP and metal chelating activity. The antioxidant activities were found to be increased with an increasing concentration of FPH.



Desirability score of ingredients



Response surface plots of fish protein hydrolysate

Formulation of health mix added with fish protein hydrolysate

Quality characteristics of health mix incorporated with protein hydrolysate were evaluated. Based on RSM, 12 different ingredient combinations were prepared and subjected to sensory analysis to derive the best combination of basic mix. Enhancement in protein content, antioxidant and functional properties were observed by addition of protein hydrolysate in the optimized basic mix. Sensory studies indicated highest acceptability for health mix containing 2.5% protein hydrolysate.

Stability characteristics of fish protein hydrolysate at different storage conditions

Stability characteristics of spray dried tuna protein hydrolysate packed in plastic containers and stored at ambient temperature (28 °C) and chill storage conditions (4 °C) were analyzed up to six months. With storage, there was a gradual increase in the oxidative indices and the changes were more prominent under ambient conditions.

Preparation and quality evaluation of fermented silage from prawn shell extract

Quality evaluation of fermented foliar spray developed from prawn shell extract was carried out. The proximate composition and changes in nitrogenous compounds were estimated during a period of 30 days. The product was found to be stable for the past four months.

Fermented silage from prawn shell extract

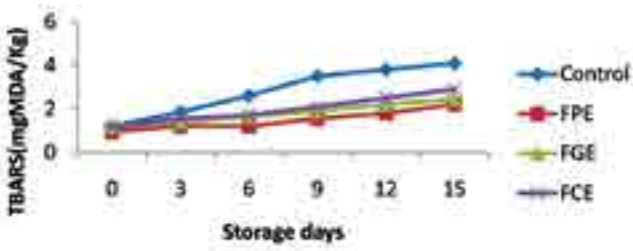
Bioensilage of fish waste using sugarcane waste

Bioensilaging of fish waste using sugarcane waste

Protocol for biosilaging of fish waste using sugarcane waste was optimized. The pH of the biomass could be reduced to the range of 4 but was slow compared to the conventionally processed silage mass. Moreover, fungal infection was often observed during the initial phase of ensilaging. This could be overcome by externally adding lactic acid on the first day of silaging.

Use of natural antioxidant for fish oil

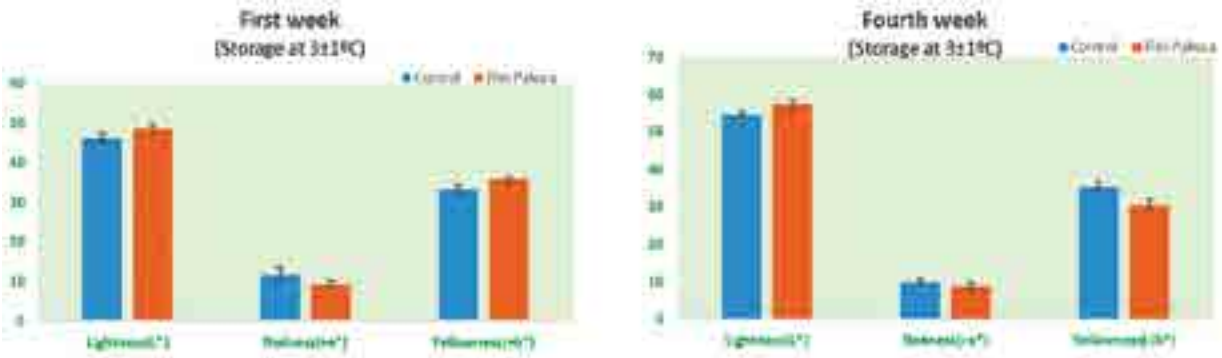
Antioxidants activities of extracts from green tea, green coffee, ginger, citrus and pomegranate were determined and applied in fish oil emulsion. It was observed that fish oil emulsion prepared with pomegranate extract had lower peroxide value (2.12meq.O_2/kg to 6.5meq.O_2/kg) and thiobarbituric acid value (0.95 mg of MDA/kg to 2.2mg of MDA/kg) when compared to other sources.



TABA of different treatments

Development of protein-enriched snack product

Vegetable-fish pakora was developed with different levels of tilapia meat incorporation and acceptance studies were carried out. The shelf life of vegetable-fish pakora was studied under chilled condition (2 °C±1 °C) with 60% vacuum. The product retains high sensory attributes up to 14 days of storage period.



Colour analysis of veg pakora (control) and fish incorporated veg pakora (Tilapia)

Preservative coating formulations from secondary raw material

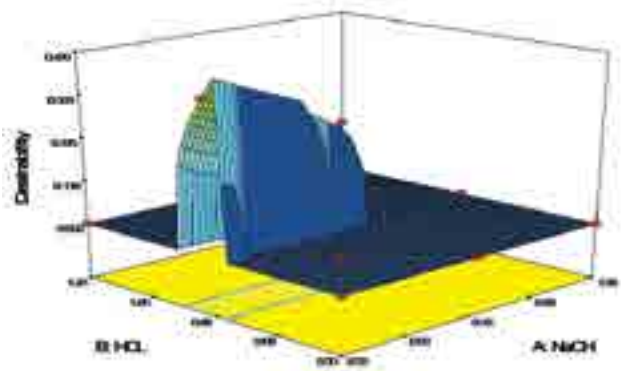
Preservative coating formula was prepared with tilapia head waste along with chitosan and ginger. The results indicate that ginger (1%), tilapia hydrolysate and chitosan possess antibacterial activity against the selected eight bacterial strains used in the study. However, ginger (0.5%) and cuttlefish skin hydrolysates (1% and 2%) did not express antibacterial activity.

MIC and MBC of different formulations

Bacterial strains	MIC (ul/ml)			MBC (ul/ml)	
	Chitosan (1%)	Ginger (1%)	Chitosan + TPH (1%)	Chitosan (1%)	Chitosan + TPH (1%)
V. parahaemolyticus	7.8	31.5	7.8	7.8	7.8
E. coli	250	-	250	500	250
L. monocytogenes	62.5	1000	125	125	125
S. aureus	62.5	500	62.5	62.5	62.5
E. faecalis	125	-	125	125	125
V. cholerae	125	62.5	125	125	125
S. paratyphi	250	500	250	-	250
P. aeruginosa	62.5	-	62.5	500	62.5

Design and analysis of experimental data

A modified method of chitin production was formulated by reducing the NaOH content. D optimal response surface design was formulated for optimizing the NaOH and HCl content. Quadratic model was fitted to the quality parameters of chitin *viz*: yield, ash and moisture content. The optimum combination was found to be 0.50 NaOH and 0.83 HCl with a desirability score 0.49. Two stage response surface design has been formulated for the modified method of chitin production. The study is progressing.



Desirability score of process parameters

Efficacy evaluation of chitosan for waste water treatment

Jar Test was conducted to evaluate the coagulant efficiency of chitosan of three different DA- 90%, 92% and 96% in flake form. Surimi wash water (pH-6.5) was treated with chitosan at 1% level. The wash water was stirred at 200 rpm for 3 min. followed by 30 min. at 80 rpm. The mixture was allowed to settle for 30 min. and supernatants analyzed for turbidity, TDS, colour and total N. All the experimental runs were carried out by controlling the room temperature at 25 °C. Chitosan with 96% DA resulted in removal of 41% turbidity, 57% colour, and 33% TDS. While for total N, 90% DA chitosan exhibited 50% removal efficiency. Effect of chitosan dosage on coagulant efficiency of fish wash water was analyzed at 0.5, 1 and 2% level. Chitosan with DA 96% was selected for the study based on previous studies. The fish wash water (pH 6.5) was stirred at 200 rpm for 3 min. followed by 30 min. at 80 rpm. After words the agitation was stopped and the mixture was allowed to settle for 30 min. Among the different dosage, 0.5% level is found to be effective in reducing TDS, COD, turbidity (12%) and colour (10%). In the case of TDS, and COD the percentage of reduction was found to be very low (<10%).

Preparation of benzyl derivatives of chitosan

The protocol for the preparation of benzoyl chitosan was optimized with respect to the substitution reagent benzyl chloride. The concentration of benzyl chloride required for varying degree of solubilization was standardized. The titration curve clearly indicated two distinct zones of derivative formation, with lower and higher solubility values. The formation of derivative was confirmed by FTIR spectra. The derivative was characterized for viscosity, salt formation, and UV spectra. An inverse relationship with the degree of substitution and viscosity was observed. The viscosity of the derivative was found to be lesser than native chitosan, and was dependent on the temperature and duration of ultrasonication. The maximum yield of the derivative with respect to chitosan was 120%.

Extraction and characterization of chitosan oligosaccharides

Chitosan oligosaccharide (COS) (chitin derivates) was prepared from 75.41% deacetylated chitosan. Partial hydrolysis was carried out using concentrated HCl at 72 °C for 30 min. After hydrolysis, the sample was neutralized with NaOH. The precipitated oligomers were washed with methanol. The final product was dried in vacuum drier and the sample was analyzed further for characterization. The Degree of Deacetylation of COS was determined by using FTIR spectra. The quantification of COS was carried out using D glucosamine. The yield was 8.2-9.0%. The prepared COS was characterized using FTIR and reducing sugar. The antimicrobial effect of COS was tested against *E. coli* and *Staphylococcus* and the inhibitory effect was studied.

Application of chitosan derived materials to control pathogenic and spoilage bacteria in food

Antimicrobial activity of ZnO-NP-COS was checked by the well diffusion assay under different concentrations and time against *Salmonella* and MRSA. It was found that 1% ZnO-NP-COS at pH 5 had maximum inhibition. The antibiogram of ZnO-NP-COS was conducted under different pH and tested for MRSA and *Salmonell*a. MRSA showed better zone of inhibition.

Development of commercial protocols for fish bone oil

The oil extracted from Dolphinfish was encapsulated using maltodextrin and chitosan and the quality characteristics were evaluated. The encapsulates were characterized based on encapsulation efficiency, optical microscopy, DSC, viscosity and FTIR profile. The powder showed EE of 65.89% and solubility of 18.7%. Oxidation parameters such as PV and TBA values indicated 0.75 mg.Kg and 0.29 mg malonaldehydes/kg, respectively.

Fish bone oil **Fish bone oil encapsulates**

Profiling of fish market waste

A pilot study was carried out on ensilaging market waste by collecting the entire waste generated in the selected fish markets in a day. The entire waste generated in a particular day from these markets were collected and quantitative and qualitative profiling was carried out. The quantity of waste varied from 22 kg to 120 kg. It revealed Moisture – 60-72%, Protein – 13-24%, Fat – 2-7%, Ash – 10-18%, pH – 7.1-8.3% and NPN – 800-1100 mg%.

Astaxatnin from shrimp head waste and development of astaxanthin-fortified milk powder

Astaxanthin was extracted from shrimp head waste and characterized for antioxidant, antibacterial and UV protective effects. Further, astaxanthin-fortified milk powder was prepared by spray drying technique.

Astaxanthin from shrimp head waste and astaxanthin-fortified milk powder

Quality characteristics of health mix incorporated with protein hydrolysate

A study was carried out to evaluate the quality characteristics of health mix incorporated with protein hydrolysate. For this, optimized protein hydrolysate from red meat of yellow fin tuna (*Thunnus albacares*) was used. The basic mix (BM) consisted of malted barley, malted wheat, milk powder, sugar and flavor. BM was added with tuna protein hydrolysate (TPH) @ 2.5, 5, 7.5 and 10% levels referred to as $BM_{2.5}$, BM_5, $BM_{7.5}$ and BM_{10}. BM without added protein hydrolysate was used as control. Nutritional, functional, antioxidant, physical and sensory properties of the samples were assessed. Incorporation of protein hydrolysate in the BM

Health mix from fish protein hydrolysate

improved its nutritional, functional as well as antioxidant properties. Sensory studies indicated highest acceptability for basic mix with 2.5% protein hydrolysate.

Stability characteristics of fish protein hydrolysate at different storage conditions

A study on the stability characteristics of fish protein hydrolysate optimized and derived separately for functional properties *viz.*, functional tuna protein hydrolysate (FTPH) and antioxidative properties *viz.*, antioxidant tuna protein hydrolysate (ATPH), from the red meat of yellowfin tuna using papain, was carried out. Spray dried tuna protein hydrolysates were packed in air tight plastic containers and stored at ambient (28 °C) and chill storage (4 °C) conditions for up to six months. Initial characteristics of the hydrolysate samples as well as its storage stability was analyzed for physico-chemical parameters. With storage there was a gradual increase in the oxidative indices and the changes were more prominent under ambient conditions.

Antimicrobial activity of zinc oxide incorporated in water soluble chitosan oligosaccharides

Chitosan oligosaccharide (COS) dissolved in 1% acetic acid had better antimicrobial activity. Hence, in the present study instead of acetic acid, water was used to dissolve COS and analyzed the antimicrobial effect of COS in water medium. Zinc oxide nano particle (ZnO-NP)-incorporated COS, i.e., 2% of ZnO-NP in 2% COS dissolved in water was prepared. After addition of ZnO the pH of the substance reached 6.3 and tested for the antibacterial activity. The same substance, the pH was reduced up to 5.0 using absolute acetic acid and the antibiogram was carried out against *Salmonella* and MRSA. A 2% COS (dissolved in water) was kept as control. There was no antibacterial activity for COS dissolved water (COS – control; ph -5). But, nano particle incorporated COS i.e., ZnO-NP-COS (pH - 6.3) exhibited medium antimicrobial activity. ZnO-NP-COS (pH – 5.0) exhibited very large zone of inhibition as given below.

Antibacterial activity of chitosan oligosaccharide

Antibiogram identification	Chitosan oligosaccharide (COS)	*Salmonella* (mm)	MRSA (mm)
Control	COS in water pH - 5.0	0	0
1	ZnO-NP-COS in water pH - 6.3	14	9
2	ZnO-NP-COS in water and adjusted pH - 5.0	21	20

Screening of natural antioxidant from plant and fruit sources and optimization of antioxidant and emulsifier concentration for producing stable nano fish oil emulsion

Antioxidant activities of extracts of green tea, green coffee, ginger, citrus and pomegranate were determined. Antioxidant assays revealed that green tea, green coffee, ginger, citrus and pomegranate extracts have the DPPH radical-scavenging activity of 80.99%, 85.45%, 89.72%, 86.25%, 88.65%, respectively. Based on the antioxidant activity and emulsion stability, ginger, citrus and pomegranate extracts were selected and four different formulations of fish oil emulsions were prepared. Fish oil, extract and emulsifier were added at 3%, 1%, 0.5%, concentration. Fish oil emulsion prepared without extract was kept as control. Oxidative stability of fish oil emulsion was determined up to 15 days by measuring peroxide value and thiobarbituric acid values. Results showed that fish oil emulsion prepared with pomegranate extract had lower peroxide value (2.12meq.O_2/kg to 6.5meq.O_2/kg) and thiobarbituric acid value (0.95 mg of MDA/kg to 2.2mg of MDA/kg) than ginger extract (PV- 2.62 meq.O_2/kg to 10.89 meq.O_2/kg; TBA- 1.19 mg of MDA/kg to 2.46 mg of MDA/kg), citrus extract (PV- 2.92 meq.O_2/kg to 12.60 meq.O_2/kg; TBA - 1.14 mg of MDA/kg to 2.90 mg of MDA/kg) and control (PV- 2.92 meq.O_2/kg to 20.73 meq.O_2/kg; TBA- 1.19 mg of MDA/kg to 4.09 mg of MDA/kg) during storage.

Interventions in processing and preservation of commercial and unconventional fishery resources

Preparation and characterization of proteolytic derivatives from *Ambassis* sp.

The hydrolysate solution prepared from *Ambassis* sp. was divided into four equal portions, of which one portion was directly subjected to spray drying (APH) and the other three portions were mixed with malto-dextrin (M-APH), pectin (P-APH) and gum acacia (GA-APH) and subjected to spray drying for encapsulating the hydrolysates. The protein content in the *Ambassis* hydrolysate was 86%, whereas the protein hydrolysate

encapsulates *viz*. P-APH, GA-APH and M-APH had the protein value of 61.44, 60.12 and 59.50, respectively. The whiteness value of FPH preparations were in the order of M-APH, APH, GA-FPH and P-APH. The viscosity of 1% FPH was observed and encapsulates solution was measured at 100 rpm and the values were in the range of 1.31-1.71 cP.

***Ambassis* sp. and protein hydrolysates from *Ambassis* sp.**

Shelf life extension of pufferfish storage under chilled conditions

The pufferfish (*Lagocephalus* sp.) muscle contains 80.76% moisture, 16.14% protein, 0.99% ash and 0.17% fat and it can be categorized under 'low oil-high protein' fish. The predominant fatty acids in pufferfish muscle were DHA and palmitic acid. The effects of freeze-chill technology and noni (*Morinda citrifolia*) fruit extract on the shelf life of pufferfish in chilled storage were studied. Freeze chilling resulted in softer texture of the sample whereas conventional chilling and dip treatment with noni fruit extract prior to chilling provided better texture. The noni extract can control the lipid oxidation during chill storage. Freeze chilled sample and noni-treated chilled samples had an extension of two days of shelf life in chilled condition.

Nutritional profiling of *Ariomma indicum* and *Platycephalus indicus*

Proximate, mineral, and amino acid profiling of *P. indicus* (Average length 42 cm and weight 540 g) and *A. indicum* (average length 15.2 cm and weight 54 g) was carried out. Analysis of proximate composition showed 17.9% protein and 3.48% fat in *A. indicum* indicating that this fish is rich in protein and fat. Mineral profiling was done by ICPMS which indicated the abundance of macro minerals *viz*. sodium, potassium, calcium and magnesium as 117.3, 122.0, 22.29 and 12.98 ppm, respectively. Moisture, protein, fat and ash content of *P. indicus* was 76.46, 20.77, 1.328 and 1.14%, respectively. Among the macro elements, sodium and calcium was found in lower levels (27.73 and 7.5 ppm, respectively) while potassium and magnesium were the most abundant (152 and 19.96 ppm, respectively). Amino acid profiling indicated comparable protein quality of *A. indicum* and *P. indicus*. The content of EAAs such as Alanine, Valine, Leucine, Phenyl alanine and Histidine were higher in *A. indicum* whereas the EAAs such as Methionine, Tyrosine, Isoleucine and Lysine was higher in *P. indicus*.

Ariomma indicum

Platycephalus indicus

Evaluation of *Ariomma indicum* protein gel quality and suitability for value added products

Surimi gel was prepared from unwashed and single washed mince (1: 4 w/v for 5 min.) of *A. indicum* and evaluated its gel strength and hardness values. Washing has improved the strength of surimi gel from 1.85 kgmm to 2.14 kgmm. The hardness value was also increased after washing (32.62 N to 54.71 N). Water holding capacity of the gel was comparatively poor and washing has increased WHC from 55.89% to 64.18%. Whiteness of raw mince was 49.83 and that of unwashed and single washed surimi gel was 62.31 and 66.43, respectively. Protein solubility in different ionic strength solution was tested and expressed as the index of ionic bond, hydrogen bond and hydrophobic interactions. Washing has decreased the index of ionic bond (15.25 to 8.65 mg/ml) and hydrophobic interactions (10.43 to 3.91 mg/ml) while the index of hydrogen bond was increased (2.98 to 4.71 mg/ml). Suitability of *A. indicum* mince for developing battered and breaded products was assessed and the products including fish ball, nuggets and cutlets showed good sensory acceptability. However, the binding capacity of mince was not excellent.

Mince-based products from *A. indicum*

Optimization of process parameters for prawn pulp-incorporated fish sausage

D-optimal design was formulated to optimize the combination of fish mince and prawn pulp for the development of prawn pulp incorporated fish sausage. Quadratic and cubic models were developed for

the quality response variables *viz*: TPA, WHC, colour values and sensory score. These models were used to predict the response variables. The optimum combination was found to be 83.4% fish mince and 3.3% prawn pulp; and the corresponding desirability score was 0.99.

Effect of incorporation of dietary fibre in fishery products

Heat-induced gels prepared from threadfin bream (*Nemipterus japonicus*) containing one of the three types of dietary fibres (wheat fibre, oats fibre or psyllium fibre) was evaluated with respect to the functional properties. Dietary fibre was incorporated at 2% level to the fish mince. Among the dietary fibres oat fibre was found to be the best option as it did not affect the textural properties when compared to the control where as psyllium fibre had a negative effect on the textural properties of the fish gels. Sensory evaluation of the samples indicated that addition of dietary fibre did not affect the flavour of the fish gels.

Post harvest and processing characteristics of *Pangasius silasi*

Pangasius silasi is a new species reported from River Krishna which supports the local fishery. Samples were procured from Nagarjuna Sagar Reservoir of Andhra Pradesh to study the post harvest and processing characteristics. Studied the chilled storage characteristics of fillets. The fillets were white in colour and the deposition of fat was significantly less when compared to the farmed *Pangasius hypophthalmus*. Initially the total aerobic plate count (TPC) for gills, intestine, skin, and fillets were $1.7x10^6$ cfu/g, $2.2x10^7$ cfu/g, $3.8x10^5$ cfu/g and $7.4x10^3$ cfu/g, respectively. *E. coli* was present in intestine and gills and absent in skin and fillets. Initially faecal Streptococci were present in only intestine while the gills, skin and fillets were free from faecal Streptococci. *Staphylococcus* was absent in all four samples initially. The fresh fillets stored under chilled condition had a shelf life of 19 days.

Fish protein hydrolysates from solefish

Protein hydrolysates were prepared from the mince of tongue solefish (*Cynoglossus arel*) using alcalase and nutrase enzymes and the properties were compared. Alcalase and nutrase yielded 8.46% and 7.33% hydrolysates from raw material (mince). Proximate composition indicates 87.4 and 89.6% protein in FPH produced by nutrase and alcalase, respectively. Degree of hydrolysis was more for nutrase catalyzed FPH (58.5%) than that by alcalase (49%). Antioxidant activities of (DPPH scavenging, metal chelating and metal reducing power) of FPH produced by nutrase were higher than that of FPH produced by alcalase.

Fish protein hydrolysate from solefish

Preparation and evaluation of gelatin hydrolysate from skin and bone of solefish

Skin gelatin hydrolysate from solefish

Gelatin hydrolysate was prepared from skin and scale of solefish by continuous extraction and hydrolysis using alcalase enzyme. Yield of skin GH (16.42%) was significantly higher to that of scale GH (8.44%). Average peptide chain length of skin GH and scale GH was 4.23 and 5.28, respectively. Functional properties like emulsion activity index, emulsion stability index and foaming properties of scale GH was superior to that of skin GH. Antioxidant properties of skin GH and scale GH was comparable.

Nutritional composition and bioactive properties of jellyfish

Jellyfish belong to Phylum Cnidaria had 96% moisture, 2.19% protein, 2.10% ash and 0.02% fat. Amino acid content of jellyfish sample were analyzed in which glycine and alanine contributed the highest and proline contributed the least. Two species of jellyfish, *Crambionella sthulmanni* and *Cyanea purpurea* available in the Cochin coast were collected and evaluated for antioxidant properties. *C. sthulmanni* was found to have better antioxidant property when compared to *C. purpurea*. The extract from this jellyfish can be used as a better antioxidant source. In all the analysis both the jellyfish body and body fluid exhibited similar values.

Assessing the benefit-risk ratio of consuming RTE tuna products

Yellowfin tuna packed in TFS cans and retortable pouches and processed using different heating mediums were evaluated for benefit-risk ratio. Higher process time and better retention of nutrients particularly glutamic acid, aspartic acid and DHA content was observed for yellowfin tuna in retortable pouches processed

in water immersion retort. Histamine and heavy metals mainly mercury, lead and cadmium were below the acceptable levels indicating a low risk of consuming RTE yellowfin in TFS cans and retortable pouches.

High pressure processing of sea crab

Trials on the effect of high pressure processing on the shucking of sea crab (*Portunus pelagicus*) meat was undertaken. HPP at 300 MPa for 5 min. is the most suitable pressure for shucking of meat with retention of sensory qualities. To further investigate the exact pressure, temperature and holding time for processing, the optimum conditions were arrived with an RSM-based experimental design.

Shucked meat from boiled, raw and HPP treated crab

Processing Doi maach - An ethnic preparation in retort pouches

Doi maach: An indigenous rohu in dahi curry

Doi maach is an indigenous rohu (*Labeo rohita*) curry very popular in the Bengal region of India. The present study was carried out to identify the heat penetration characteristics of Doi maach. The marinated and fried rohu fish steaks in dahi gravy were packed in transparent retort pouches and processed in a steam retort at 121.1°C up to a sterilization value (F_0) value of 9.46. The ready to eat (RTE) product thus prepared was highly accepted by sensory panellists. The product was found to be commercially sterile.

Prevention of melanosis in shrimps using beetroot and muringa leaf extract

A study was carried out on melanosis prevention efficiency of beetroot (TB) and muringa (*Moringa oleracea*) leaf (TM) extracts in whiteleg shrimp (*Litopenaeus vannamei*) and Indian white shrimp (*Fenneropeneus indicus*) during ice storage. Melanosis score of control reached maximum value of 10 on 8th day of storage. TB reached a maximum melanosis score of 3 on Day 10 and TM reached a maximum melanosis score of 5.7 on Day 10. Beetroot extract was found effective in preventing melanosis compared to muringa leaf extract.

Development of processing protocols for the quality enhancement of cured fishery products

The effect of optimized combination of spice mixture on the quality characteristics of dried Malabar tongue sole (*Cynoglossus* sp.) was carried out. Fresh sole fishes were salt dip treated and subjected to drying in mechanical driers having an average chamber temperature of 55 °C. Prior to drying one lot was marinated with spice mix @ 3% and other was kept as control. Dried samples were subjected to fortnightly sampling for biochemical, microbial and sensory parameters. Study revealed good shelf stability for both samples and the quality was observed to be comparatively superior for spiced samples throughout the storage period.

Quality characteristics of mackerel stored under normal and slurry ice

A comparative evaluation of the quality characteristics of mackerel (*Rastrelliger kanagurta*) stored under normal and slurry ice was carried out. Sampling was done periodically for assessing quality characteristics *viz*., physical, chemical, sensory and microbiological indices. The TBA and PV values indicated a higher oxidation rate for slurry iced samples compared to normal iced ones throughout the storage period. Though both samples were within the microbiological limit during storage, based on sensory analysis normal iced samples were rejected on 10th day of storage. However slurry iced samples were sensorily acceptable in terms of appearance, texture and taste but as the salt content exceeded 2% on Day 13, it was rejected based on this criteria.

Mackerel in normal ice and slurry ice

Quality characteristics of spice dried Malabar tongue sole

The effect of optimized combination of spice mixture on the quality characteristics of dried Malabar tongue sole (*Cynoglossus* sp.) was carried out. Fresh solefish were salt dip treated and subjected to drying in a

mechanical dryer having an average chamber temperature of 55 °C. Prior to drying, one lot was marinated with spice mix @ 3% and other was used as control. Further the dried samples were packed in sealed plastic bags and stored at ambient conditions (28 °C) for a period of up to six months. Drying kinetics study indicated a drastic reduction in the moisture content from an initial value of 78% to about 26% in both lots during the initial 10 hours of drying. Study revealed good shelf stability for both samples and the quality was observed to be comparatively superior for spiced samples throughout the storage period.

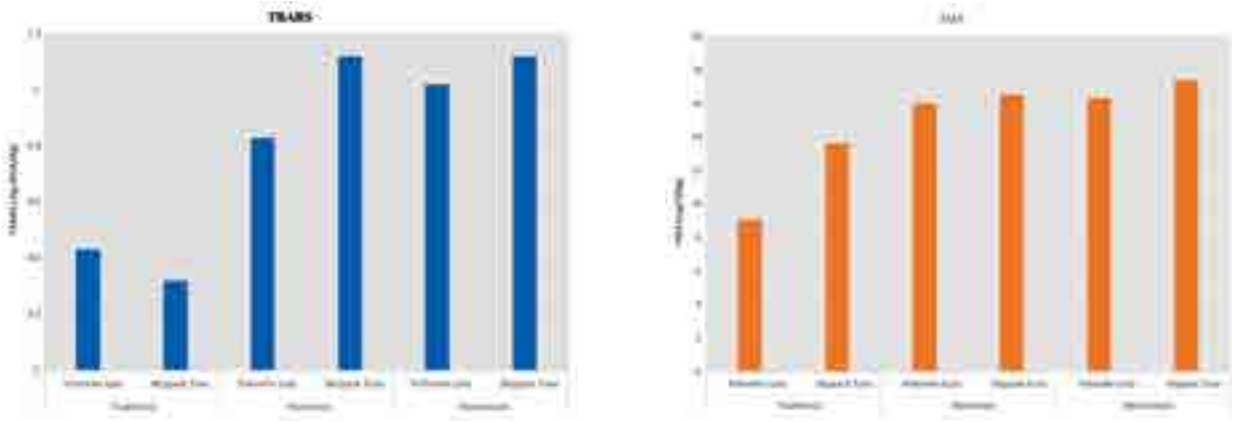
Solefish, (a) Control, (b) Spiced

Quality evaluation of selected lean fishes stored under conventional and slurry ice

An attempt was made to study the quality of Bombay duck stored under slurry ice. Bombay duck stored under conventional flake ice was used as control. Fresh fish had 88.92% moisture, 9.65% protein, 0.85% fat and 0.92% ash. Biochemical parameters such as pH, PV, TBA, TVB-N and TMA-N showed an increasing trend during storage. Peroxide value reached the acceptable level (20.15 meq.O_2/ Kg) on 13th day in control. However, fish stored under slurry ice had peroxide value of 19.25 meq.O_2/ Kg on 16th day. In both the samples TBA values were within the limit throughout the storage. Salt content varied from 0.15-0.28% in control. However, fish stored under slurry ice showed increasing trend (0.15- 2.2%) in salt content during storage. Microbial analysis showed a gradual increase in aerobic plate count (APC) during storage. Control reached acceptable limit of APC (5.09 $\log_{10}$) on 13th day. However, fish stored under slurry ice had APC of 4.95 $\log_{10}$ on 16th day. Based on the sensory and microbial analysis, fish stored in slurry ice had a shelf life up to 16 days than control (13 days).

Quality evaluation of tuna caught by different fishing methods

The biochemical quality and histamine formation in yellowfin tuna and skip jack tuna caught by different fishing methods including gillnetting and hook and line by long lining and trolling methods operated by traditional as well as mechanized fishing crafts from Visakhapatnam and Pudimadaka fishing village was analyzed. The quality difference between yellowfin tuna and skipjack tuna caught by long lining was evaluated. Proximate composition and biochemical analysis (lipid oxidation parameters - TBARS, PV and volatile amines - TVB-N, TMA), Histamine of yellowfin tuna and skipjack tuna are shown in the Figure below. TVBN, TMA, PV and TBARS are in the range of 13.25-20.83 mg/100g, 9.1-17.41 mg/100g, 9.035-15.04 mEqO2/kg and 0.32-1.12 MAD/kg, respectively.



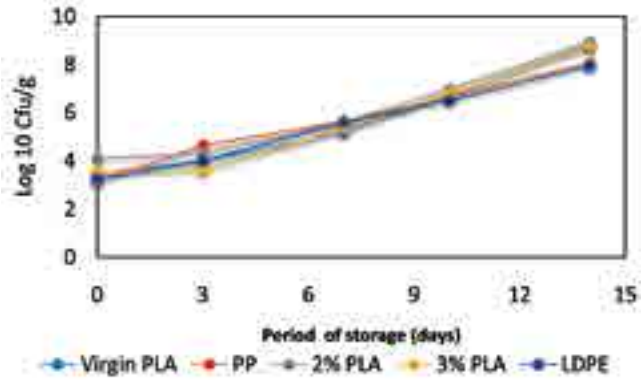
Proximate composition of yellowfin tuna and skipjack tuna

Biodegradable packaging materials for fish and fishery products

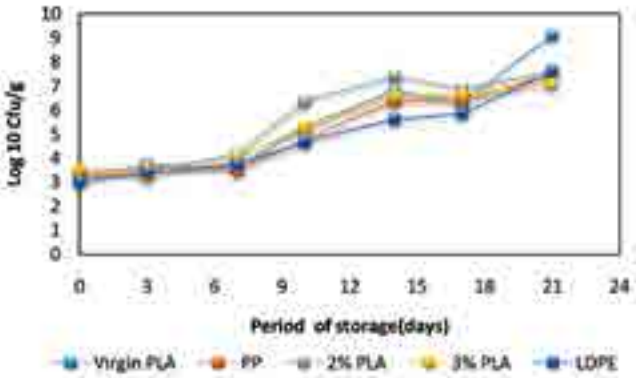
Evaluation of storage stability of fishery products packed in containers

PLA/nanocellulose films were developed by uniformly embedding 1%, 2% and 3%, nanocellulose in a polylactic acid matrix. The blends were prepared by compounding in a twin screw extruder and the mixture was then

blown using a monolayer blown film machine. The addition of nanocellulose significantly improved the tensile strength and heat sealing properties of the films. A storage study was conducted for determining the shelf life of whole cleaned gold spot mullet (*Liza parsia*) in virgin PLA, PLA/2% NC and PLA/3% NC films, low density polyethylene (LDPE) and polypropylene (PP) films in chilled condition. Biochemical analysis such as peroxide value, free fatty acid, total volatile base nitrogen and psychrotrophic and mesophilic bacteria count were determined. Two and 3% PLA/nanocellulose films exhibited superior properties than polymer-based films. Results indicated that PLA/nanocellulose films were found suitable for packaging of fish.



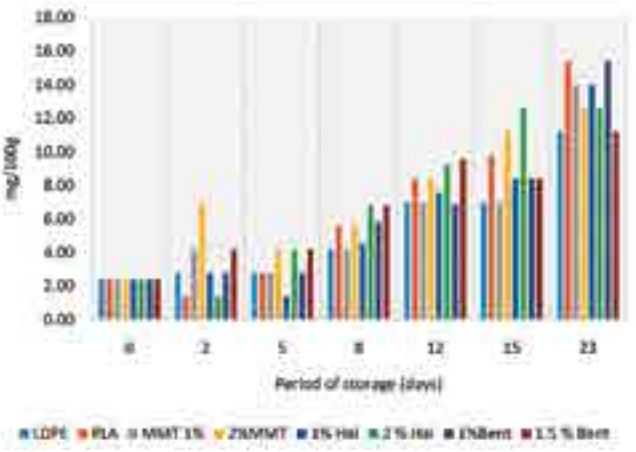
Changes in psychrotrophic bacteria count



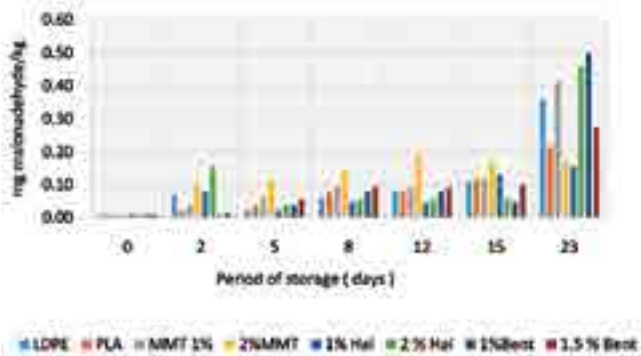
Changes in mesophilic bacteria count

Storage studies were conducted for determining the shelf life of cultured Nile tilapia steaks (*Oreochromis niloticus*) under iced storage. Eight different packages like LDPE, neat PLA, PLA and 1% MMT and, PLA and 2% MMT and, PLA, 1% halloysite and 2% PLA halloysite, PLA 1% Bentonite and PLA with 1.5% bentonite were used

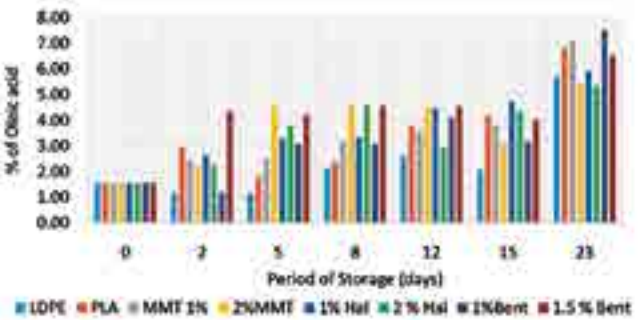
Tilapia steaks in different packagings



Changes in TVBN content



Changes in TBA content



Changes in FFA content

for the study. The initial quality of tilapia used in the study was very fresh, as indicated by low mesophilic and psychrotrophic counts (3 and 2.57 log cfu/g). On second day, variations in the microbial quality of tilapia packed in eight different packages was observed. The tilapia packed in PLA with 2% halloysite showed least mesophilic and psychrotrophic count (2.8 and 2.32 log cfu/g) and followed by PLA with 1% halloysite, PLA with 1% bentonite and, PLA with 2% MMT and, PLA with 1.5% bentonite, respectively. Similiar trend was followed up to 13th day of storage. Enterobacteriacea and *Brochohtrix* count was observed from 8th day of storage. The specific spoilage bacteria such as *Pseudomonas* and H_2S forming bacteria were not found upto 13th day of storage.

Palm sheath containers for chilled fish

Application of palm sheath containers for chilled packaging was undertaken. The palm sheath trays (25 x 17 x 3 cm) were evaluated for physical, mechanical and thermal properties with respect to packaging of fish and fishery products. The physical and mechanical properties of palm sheath trays were comparable to five-ply paper boards. Storage studies of milk-fish (*Chanos chanos*) in palm sheath trays in chilled condition indicated that the trays had a similar shelf life for fish packed in polystyrene trays. Hence the trays were found suitable for short term preservation (chilled) of fish.

Palm sheath trays wrapped in stretch film

Palm sheath trays wrapped in shrink film

Shelf life extension of tilapia fillet using sodium alginate film containing green tea extract

Total phenolic content of green tea extract was 57.81 mgEq of galic acid/g and DPPH scavenging radical activity was 75.19% (at 1 mg/ml). Alginate film coating solution was prepared following the standard protocol and 1% (v/v) green tea extract was incorporated in the solution. The developed film was used for wrapping tilapia steaks. Treatment includes C: tilapia fillet packed in a polythene cover as control; AF: Tilapia fillet wrap with sodium alginate film and GTF: Tilapia fillet wrap with green tea extract incorporated sodium alginate film. Sodium alginate film added with green tea extract exhibited better ability to inhibit the formation of volatile bases (TVB-N) and lipid oxidation products (PV and TBARS). Initial PV was 2.75 meq O_2/kg and reached 10.54, 10.31 and 5.04 meq O_2 for C, AF and GTF, respectively on 21 days of storage period. APC of all samples showed a steady increase and reached 5.5 log cfu/g, 5.45 log cfu/g and 4.76 log cfu/g for C, AF and GTF, respectively, on 21 day. GTF also gave better sensory acceptability as compared to C and AF. Considering the fact that green tea is a food and could enhance the shelf life of fish, when incorporated into sodium alginate films, it can be used for developing safe and active packaging materials.

Sodium alginate film | **Green tea extract-incorporated sodium alginate film** | **Control steaks** | **Tilapia steak wrap with sodium alginate film** | **Tilapia steak wrap with green tea extract incorporated film**

Preparation of seaweed extract-based biodegradable films

Three different biodegradable films from seaweed extracts were prepared and characterized for its chemical and mechanical properties.

Preparation of biodegradable active films from poly lactic acid

Biodegradable active films were prepared from poly lactic acid (PLA-5%) by solvent casting method incorporating ginger essential oil (GO – 1 to 2%) to study its effect on antimicrobial, structural, mechanical and barrier properties of PLA film. The preliminary determination of antimicrobial activity of the films was

PLA, PLA+1% GO, and PLA+2% GO films

Seerfish used in the study

Seerfish packed in PLA and PLA+GO film

done by disc diffusion method using Mueller-Hinton Agar (MHA) plates. The PLA films without essential oil displayed no antimicrobial activity against the studied microorganisms. PLA+1% GO and PLA+2% GO films showed inhibition zones of 20±0.46 mm and 31±0.14 mm against *Staphylococcus aureus* and 7±0.61 mm and 12±0.42 mm against *E. coli*. The PLA+GO composite films were more flexible than the native PLA films. Further, the efficiency of the film in maintaining the keeping quality by reducing the microbial load of the seerfish (*Scomberomorus guttatus*) steak stored at 4 °C was evaluated. The PLA+GO films were effective in delaying the generation of volatile bases (TMA-N and TVB-N) and controlling lipid oxidation as indicated by a lower TBA value, compared to PLA films. The microbial counts of fish steaks packed with PLA+GO films were considerably lower than the fish steak samples packed in PLA film alone and the microbial shelf life was extended by six days, when fish steaks were packed in PLA+2% GO composite films.

Effect of PLA-based active packaging system on the shelf life of fish stored at chilled condition

Indian mackerel stored in PLA and PLA+CLEO films with and without oxygen scavengers

An experiment was undertaken to determine the efficacy of dual functional active packaging system combining PLA-based antimicrobial film and O_2 absorber in extending the shelf life of Indian mackerel (*Rastrelliger kanagurta*) fish steaks stored at 2 °C. Essential oil was extracted from curry leaf (*Murraya koenigii*) by hydro-distillation. Curry leaf essential oil, at 0.5% (v/v), was incorporated into poly lactic acid (PLA) to develop active antimicrobial film. Fresh gillnet caught Indian mackerel in the form of steaks were used in the study. O_2 absorber reduced the count of aerobic *Pseudomonas* and the antimicrobial film was effective against gram positive organisms like lactic acid bacteria (LAB) and *Brochothrix thermosphacta*. The dual functional pouch of antimicrobial film with O_2 absorber extended the microbial and sensory shelf life of fish steaks up to 12 days compared to six days for control sample.

Production and characterization of gelatin-based biodegradable films

Gelatin films prepared at different drying temperatures

Gelatin was extracted from the skin of unicorn leather jacket (*Alterus monoceros)*. Bleaching was carried out in fish skin prior to gelatin extraction to improve the colour and transparency of the films. Increasing the concentration of bleaching agent reduced the protein content and viscosity of the gelatin. The FTIR Spectra of gelatin from leather jacket skin treated with bleaching agent at different concentration including control showed a major peak at amide I region. The gelatin films were prepared with different concentration of gelatin (1-3%) and water vapour permeability of film reduced with the increasing concentration of bleaching agent. Gelatin films prepared with 1% chitosan showed improved mechanical and physical properties compared to control gelatin film.

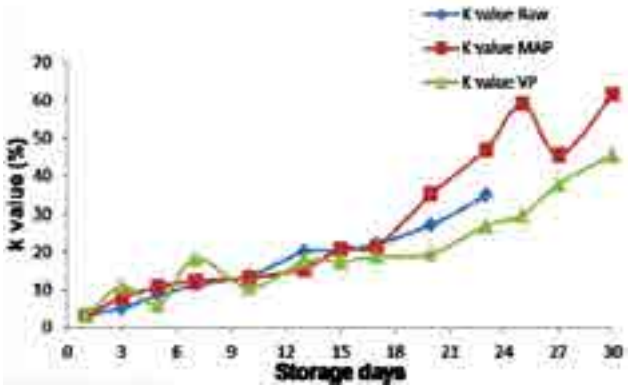
Development of processing protocols for emerging farmed fishery resources

Microbial profiling of cage environment

The microbial hazard profiling of captivity environment was carried out. The presence of faecal indicator bacteria was confirmed in both harvested fish as well as in the water samples indicating the extent of pollution in the culture environment and cautions the requirement of efficient farm management protocols in captive rearing.

Post-mortem biochemical and textural characteristics of Nile tilapia with reference to farming practices

The cage-reared Nile tilapia (*Orechromis niloticus*) showed higher overall acceptability compared to pond-reared counterpart, in terms of colour, flavor, and appearance. Bleeding of Nile tilapia prior to storage improved colour and functional properties of proteins. Bleeding reduced modori activity at 55 °C and enhanced gel setting at 40 °C. Among the sensory attributes, the colour of the vent was found to be a good indicator of freshness of the fish. The reddish colour of the vent gradually fainted into brownish colour with the progress of storage period. The storage quality of tilapia showed variation with respect to harvest size. The larger sized fishes showed comparatively longer shelf life than smaller sized fishes.



Changes in k-value of Nile tilapia during chilled storage

Colour change observed in Nile tilapia on Day 14 and Day 20 of chilled storage

Shelf life assessment of pompano stored in modified icing system

Cage-reared silver pompano

Shelf life assessment of pompano (*Trachinotus blochii*) stored at three different conditions: iced, ice-water and fish (1:4) ice-water and salt (3.5%) and fish (1:1:4) was carried out. Biochemical and microbiological analysis showed that the fish in iced condition has a shelf life of 22 days and fish stored in ice-water was acceptable upto 26th day. The fish stored in ice water and salt showed better shelf life of 29 days. *Pseudomonas* was found to be the dominant spoilage bacteria during ice-storage.

Ice storage characteristics of red snapper using different packaging systems

Farmed red snapper were packed in air, VP and MAP (40% CO_2 and 60% N_2). The air packed fish was rejected on 23rd day of ice storage while VP and MAP were acceptable till 30 days.

Improving the gelation behaviour of Nile tilapia surimi by nano-sized fish scale slurry

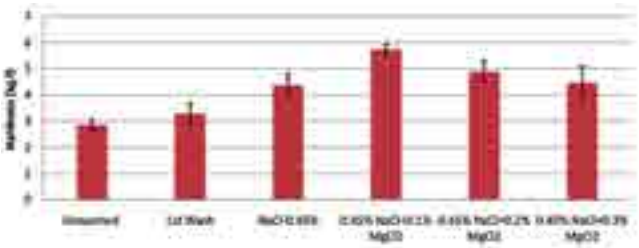
The activity of endogenous transglutaminase (TGase) can be improved by the addition of Ca divalent ions. Fish scale contains significant proportion of calcium phosphate. Hence, gelation properties of Nile tilapia mince as affected by addition of fish scale slurry containing nano-sized scale particles as calcium source, at different levels (0%, 0.25%, 0.5%, 1%, 2%, and 4%) were evaluated. The gelation behaviour of the mince was monitored through DSC and TPA analysis.

Thermally processed RTE products from Nile tilapia and red snapper

Retort processed ready to eat (RTE) Malabar style curry was prepared using fried and non-fried tilapia and the thermal process characteristics along with sensory and microbiological parameters were studied. The heating and cooling lag factors for fried tilapia curry were markedly different from non-fried tilapia curry. The Ball's process time for fried tilapia curry (58 min.) was found to be higher compared to non-fried tilapia curry (44 min.). Cage-cultured red snapper was thermally processed in brine and oil medium up to F value of 10-11. Red snapper processed in oil medium (sunflower) had higher lipid content (22.6%) than the fish processed in brine medium (6.7%). TBA value of processed fish in both brine and oil medium was 0.105 and 0.108%, respectively. The product was found to be commercially sterile. Sensorily, red snapper in oil medium was preferred over brine medium, by the panellists.

Optimization of water washing process and gelation parameters of Nile tilapia surimi

The effect of addition of salts (NaCl, KCl, $CaCl_2$ and $MgCl_2$) at 2% level in washing water on physico-chemical, functional and textural properties of surimi from Nile tilapia was investigated. The addition of salts improved the dewatering process as indicated by the reduction in moisture content and increase in protein. Magnesium chloride had profound effect on dewatering of tilapia surimi. Further, the use of magnesium chloride along with sodium chloride (0.45%) in the range of 0.1-0.2% in wash water yielded surimi with better textural properties.



Changes in hardness value of Nile tilapia surimi as a function of salt concentration

Development of functional mince from Nile tilapia and its quality evaluation

Fish mince from Nile tilapia was incorporated with fish oil at 1.0% level. Further, to improve the oxidative stability of fish mince, orange essential oil and pomegranate essential oil were added at 0.5% level. Biochemical analysis showed an increasing trend in pH, PV and TBA during storage. Initial pH of 6.51 increased to 6.91 during storage. The overall results indicated a shelf life up to 16 days, for functional mince, whereas control mince was rejected on 10th day.

Deodourised protein powder from Nile tilapia

Deodourised protein powder was developed from Nile tilapia for incorporation in low moisture products. The mince was initially washed with citric acid, solubilized by pH shift method and spray dried. The powder properties were improved by adding maltodextrin at 5% weight of protein during homogenization. The spray dried powder having a moisture content of 6.3% and water activity of 0.5 was analyzed for its powder characteristics. Initial microbial count was less than 10^4 CFU/100 g. The powder with maltodextrin indicated lower water activity, and better sensory acceptability.

Development of fish protein bars from Nile tilapia

Nutritional bars incorporated with fish protein in powder form, to enhance the protein content was developed. The maximum concentration of protein that could be supplemented from the treated protein powder was 12% without any sensory rejection. The bars incorporated with dried protein powder had a moisture and a_w values below 10 and 0.6, respectively. The developed bars had a shelf life of two months under normal room conditions.

Nutritional bars from Nile tilapia

Fish meat bars from Nile tilapia

Development of fish meat bars from Nile tilapia

Fish meat bars were prepared using Nile tilapia mince. The ingredients were standardized based on sensory acceptability. The developed bars were analyzed under chilled storage (2-3 °C) and frozen conditions (-18 °C) in two different packaging materials like metalized polyester (MPE) and polyester polyethylene (PPE) films under vacuum. The product had a gel strength of 212 g.cm, hardness (30 N) and elasticity which was measured as springiness (4.4 mm) value. The biochemical quality parameters indicated slow release of total volatile base compounds and low oxidation indices values in the product.

Development of extruded products from partially hydrolyzed fish flour

Functional extruded product was prepared by incorporating partially hydrolyzed fish flour from Nile tilapia with acceptable sensory and textural properties. Incorporation of hydrolyzed flour at 20% level showed better texture profile and sensory scores compared to other combinations. Washing the mince prior to hydrolysis improved appearance of the product with more appealing once it is given a masala coating.

10%, 20% and 30% hydrolyzed flour-incorporated extruded products

CIFT-Instamix: Instant fish cutlet mix powder

An instant mix for cutlet using fish flour was developed. Initially, the composition of the ingredients was standardized for fish cutlet using dehydrated tilapia mince. The fried cutlets showed satisfactory rehydration capacity with good textural and sensory acceptability. The breaking force and compressibility values of fried cutlet were at par with wet mince-based conventional cutlets.

CIFT-Instamix: Instant fish cutlet mix powder

CIFT-Instamix: Instant marinating mix

A series of shelf-stable instant marinating mixture in different flavours, which can be stored at room temperature was developed. Individual pouch contains separate tenderising, marinating and garnishing mixtures.

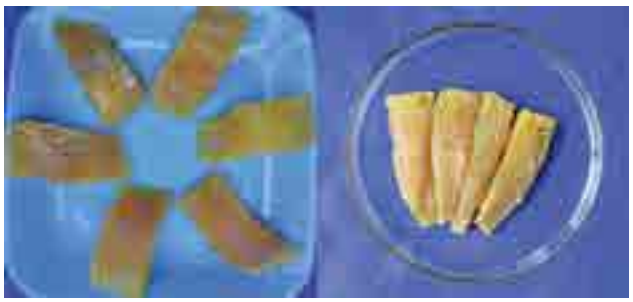
CIFT-Instamix: Instant marinating mix

Dehydrated spongy fish fingers from Nile tilapia

Tilapia mince was modified by mixing with salt, binders (guar gum and tapioca starch) and spices, cut into finger shape and dehydrated to form spongy fingers. Yield of dried fingers from the mince was 25%. The moisture content was in the range of 10-15%. The product retained its finger shape and was well accepted by the sensory panelists.

Microwave dried and breaded and battered fingers

Low moisture ready to cook gravad fillets and steaks from Nile tilapia



Ready to cook gravad fillets and steaks from Nile tilapia

Tilapia loins were prepared with salt:sugar mixture (1:1 and 1:2) and marinated over a period of 1-4 days at refrigerated temperature. About 10-13% reduction in moisture was achieved by gravading; the moisture content reduced with increasing concentration of sugar in the mix. Gravading with more sugar was found to be more acceptable than that with less sugar. Gravads packed under vacuum and air remained acceptable until the period of testing (31 days).

Texture modified products from tilapia mince (Smoke flavoured chips)

Smoke flavoured chips from tilapia mince

The yield of chips from washed mince was 15%. The effect of different starch sources (corn and cassava starch at 5% and 10% levels) on the physical and sensory properties of smoke flavoured chips were evaluated. Higher L, a and b values were found with starch added samples compared to control. Rehydration rate (RR) of the samples were studied up to 2 hrs and the RR of control was found to be lowest and that of chips with 5% corn was the highest. Addition of both starches at 10% level decreased the rehydration capacity compared to that of 5% starch added chips. Linear expansion of the chips after frying was evaluated. Chips with 10% cassava starch had the lowest linear expansion (29.78%) followed by 5% cassava starch and control. 5% corn starch added samples had the highest expansion (74.95%). Total phenolic content of the liquid smoke was found to be 74.16µg GAEQ/mg of the smoke concentrate and IC_{50} value of DPPH radical scavenging activity was found to be 42 µg/ml.

Fermented flavoured chilled Nile tilapia fillets

Control fillets, 2.5% fermented fish extract fillets and 5% fermented fish extract fillets

Fermented fish extract was prepared and characterized. Lactic acid (0.5%) was mixed in the extract to add preservative effect. The extract was used for developing fermented fish flavoured farmed tilapia fillets at two different concentrations of flavour extract (T1:2.5% and T2:5%). Shelf life of the fermented fish flavoured farmed tilapia fillets was studied under chilled condition. The product retained its flavour very well under chilled condition and keeps well up to two weeks from the date of preparation. TPA showed a gradual reduction of hardness in all the samples as expected due to protein degradation. Water activity was found to be higher in control samples than in treated samples during the storage period. The nitrogenous volatile compounds were found within the acceptable limits during the storage period.

Comparison of muscle composition of mud crab from different sources

The comparison of muscle composition of mud crab (*Scylla olivacea*) from different sources was carried out. The protein content ranged from 14.18% to 19.32%. The fat content ranged from 0.24% to 0.98% with significant difference between male and female crabs. The glycogen varied from 6.0% to 19.6%. The body meat of wild male crab had the highest phospholipid content while the claw meat had the lowest content. The carotenoid content was highest in claw meat in all the samples studied. The wild variants were found to be more acceptable than the cultured crabs.

Effect of microwave blanching on enzymatic activity of crab muscle

The autolytic enzymatic activity of crab meat was studied at 35 °C, 45 °C, 55 °C, 65 °C, 75 °C and 85 °C in a thermostatically controlled water bath. Further, fresh crabs were subjected to microwaves for 10 s, 20 s, 30 s, 40 s, 50 s, 60 s, 70 s to optimize the blanching process so as to achieve minimum autolytic activity. The autolytic activity was found to be high at 55 °C for mud crab meat. The exposure for 50 s showed a greater reduction of peptide content which increased substantially at 60 s of exposure. Hence, an exposure period of 60 s was optimized for blanching mud crab using microwave oven.

Development of live transportation protocol using food grade anaesthetics for Nile tilapia

A series of independent trials were conducted on live transportation of Nile tilapia. A study was carried out to assess the dosage requirement for anaesthetizing Nile tilapia during live transportation. An effective dosage of 100 ppm clove oil is required for larger fishes of 500 g size, whereas smaller fishes required a lower dose of 25 ppm or less. A concentration of 50 ppm can be effective for anaesthetizing and short term transportation (< 4 hours) of bigger Nile tilapia (≥ 500 g).

Post-mortem biochemical quality of anaesthetized Nile tilapia

The biochemical quality of live Nile tilapia (<200 g) treated with clove oil was studied. Skin of the fish got slightly bleached in control while it was darkened in treated ones. Hardness values decreased with storage, the anaesthetized samples presented firmer texture compared to unanaesthetized samples. The FFA content of control and lower dose treated samples (5 ppm and 10 ppm) showed slightly higher values indicating the higher extent of stress in these samples compared to the fish anaesthetized using 25 ppm clove oil. The sensory analysis of the samples did not indicate any prominent variations between the samples with respect to the taste, texture or colour.

Transportation of live farmed fishes under reduced oxygen tension and low temperature

Aeration and water temperature was found to have vital roles in the survival rate of fishes during live transportation. Hence, development of live transportation protocol using low temperature holding systems for Nile tilapia was attempted. Under unaerated conditions, the mortality starts at 3 hrs at room temperature and 8 hrs at low temperature. Low temperature had significant influence on the survival of fishes and showed 100% survival at stocking density of 1:1 (Fish:water) for 24 hrs at 20 °C. The results revealed that, stocking of tilapia at low temperature with continues aeration had a strong influence on survival rate of live tilapia.

Low cost live fish transportation container for Nile tilapia

A prototype of transportation container was designed integrating a battery operated (6-8 h) refrigeration set up to provide the required low temperature of <20 °C in the container), 12V Peltier Module Thermoelectric Cooler (6 amps) for the water cooling purpose, a battery operated aeration system to provide dissolved oxygen in the container during transportation and CO_2, O_2 scavengers and filters to regulate the container. The Peltier Module Thermoelectric Cooler took 30 minutes to bring down the temperature of air in the insulated box of 5 L capacity to <15 °C, whereas 1 h was required to reduce the temperature of water.

Live transportation container

Development of active and intelligent packaging system for fish and shellfishes

Trials with various active and intelligent packaging systems

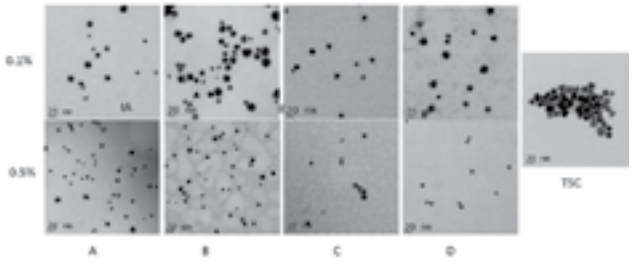
Smaller mesh size iron (120 mesh size) effectively reduced the head space oxygen level compared to higher mesh size iron (200 mesh size). Rate of oxygen reduction on 1st day compared to initial day ranged from 11.15 to 11.18 for the combinations containing 200 mesh iron powder compared to 2.8 - 3.11 for 120 mesh iron powder indicating the effectiveness of 200 mesh iron powder. Commercial oxygen scavenger reduced the oxygen level rapidly compared to indigenously developed scavengers. Air packed mackerel were acceptable up to ~8-9 days compared to 13, 16 and 16 days for active packed sachets containing iron powder and ascorbic acid (3:1), iron powder, ascorbic acid and sodium hydrogen carbonate (3:1:1), and commercial oxygen scavenger, respectively. Air packed tuna

Yellowfin tuna chunks packed under control air, vacuum, commercial and indigenous oxygen scavenger

chunks were acceptable up to ~5-6 days compared to 10-11 days for vacuum packed, commercial and indigenous oxygen scavengers.

Optimization of conditions for synthesizing gold nano particles

Conditions for synthesizing gold nano particles using chemical (trisodium citrate) and natural reducing agents like different degree of deacetylation (83-85%) chitosan, carrageenan, cuttlefish skin protein hydrolysate (CSPH), cheese fruit extract, clam shuck water are optimized. Optimized condition for the gold nano particles synthesis is heating at 95 °C at 500 rpm for 15 min. TEM images revealed that the synthesized AuNPs had different shape (round, hexagonal, triangle, square, rhomboid etc.) and size. Higher concentration of chitosan resulted in the synthesis of smaller but uniform sized AuNPs. Gold nano particles prepared using TCS resulted in aggregated nano particles resembling grape bunches.



TEM image of gold nano particles prepared using chitosan of different DDA (A-D) and TSC

Gold nano particles prepared using TSC and different concentration of chitosan

Distinguishing fresh and frozen packed products

Gold nano particles prepared were studied for their ability to distinguish fresh and frozen stored packed products. UV-visible spectrum for AuNPs prepared using trisodium citrate (TSC) and lower concentration of chitosan (0.1 and 0.2% for all the four different DDA) showed a distinctly different broader spectrum with reduced peak intensity. Peak shifting towards right was also observed. The ruby red colour of the AuNPs changed to slightly greyish upon exposure to frozen condition for TSC and lower concentration of chitosan (0.1%) indicating its application as smart packaging to distinguish packed fresh and frozen fish.

Visible colour change of fresh and frozen AuNPs prepared using TSC and different concentration of chitosan

Development of Time-Temperature-Indicator

Gold nano particles synthesized were evaluated for their ability to distinguish temperature abuse in frozen storage conditions. In this surface functionalized AuNPs using low concentration of chitosan was evaluated. The AuNP solution was exposed to -18 °C and abused at different temperatures (10, 37, 45 and 55 °C) and its properties were evaluated. Samples abused at higher temperature (37, 45 and 55 °C) indicated a colour change in the AuNPs solution. AuNPs exposed at 37 °C turned from its initial ruby red colour to dark greyish colour by 30 h and colourless by 48 h.

Gold nano particles showing colour change upon temperature abuse from frozen storage condition

Antimicrobial effect of silver nano particles

Antimicrobial activity of AgNPs against pathogens on MHA plates

Conditions for the synthesis of silver nano particles (AgNPs) using different reducing agents *viz.*, TSC, ascorbic acid, ethylene glycol with and without cetyl trimethyl ammonium bromide (CTAB) and high and low molecular weight chitosan. Antimicrobial activity of silver nano particles were evaluated for *L. monocytogenes*, *S. flexineri*, *P. aeruginosa*, *Y. enterocolitica*, *V. parahaemolyticus*, *V. cholerae*, *V. alginolyticus*, *A. hydrophila* and *S. aureus* on Muller Hinton agar (MHA) plates. Highest zone of inhibition was observed for AgNPs prepared using a combination of TSC and CTAB against *L. monocytogenes*. For *P. aeruginosa* and *Y. enterocolitica*, AgNPs prepared using high molecular weight chitosan exhibited maximum antimicrobial properties whereas for *V. cholerae*, AgNP prepared using low molecular weight chitosan was observed better. Among all the different reducing agents, AgNP prepared using combination of trisodium citrate and CTAB was found effective against all the pathogens studied.

Cobalt nano-composite for thermochromic sensor

Cobalt based nano-composite were synthesized for application as thermochromic sensor. Cobalt acetate and alkaline polyol mixture were mixed with AgCl as seed solution and it was allowed to react at 170 °C for synthesizing cobalt nanorods. The nano-composite was exposed to different temperatures (-18 °C, 0 °C, 4 °C and room temperature) to assess its ability to use as Time-Temperature Indicator. Upon exposure to room temperature and 0 °C, the bright magenta colour of the CoNPs changed to slight pink colour.

170 °C Room temperature 0 °C

Cobolt nano-composite in different temperatures

Development of Time-Temperature-Indicating button using *Lactobacillus* spp.

Time-Temperature-Indicating button prepared using bacterial culture was evaluated for its ability to distinguish temperature abuse. In this, *Lactobacillus* spp. from dairy source and fish source was used to assess the freshness condition of the fish being packed for transportation or storage. If the indicating button is pink it indicates fresh condition and yellow colour indicates spoilage of fish. In this study, various fishes like mackerel, tuna, grouper and croaker (Dhoma) were packed and stored under various temperatures (-18, -2, 4, 10, 22 °C and RT) and colour change was observed with the storage period. Fishe stored under room temperature turned to yellow within a day indicating its spoilage.

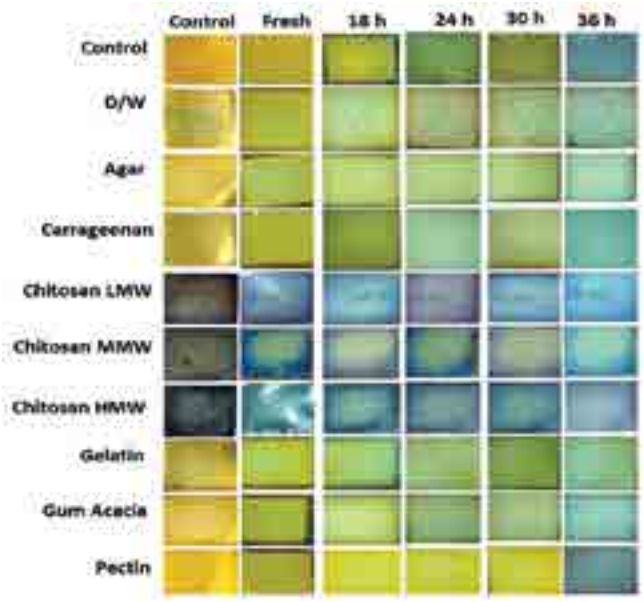
Visible time-temperature-indicating buttons for spoilage indication

Development of freshness indicator for packed fishery products

Ten pH sensitive dyes were evaluated for developing freshness indicators. The indicators of known concentration were mixed with functional solution and impregnated onto the filter paper disc. Indian mackerel (*Rastrelliger kanagurta*), Indian white shrimp (*Fenneropeneaus indicus*) and squid (*Loligo duaceuli*) were used in the study. Among the 10 different dyes, functionalized bromocresol purple correlated well with the biochemical and microbial changes.

Biopolymer coating for freshness indicator

The effect of eight different biopolymers (Agar, carrageenan, chitosan LMW, chitosan MMW, chitosan HMW, gelatin, gum acacia and pectin) on the performance of bromocresol-based freshness indicator was studied at room temperature. The bromocresol-impregnated disc was dipped in different polymer solution separately, and dried before using as indicator. Yellowfin tuna meat was packed in an HDPE tray and sealed with films attached with indicators. The changes in colour of paper indicator was monitored in accelerated storage condition. Among the biopolymers, colour change of pectin, gum acacia-coated indicator strip correlated well with the spoilage of fish.

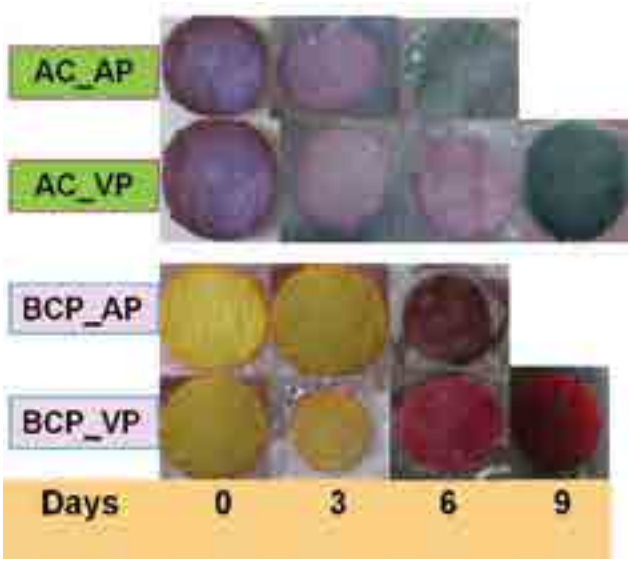


Visible colour change of functionalized bromocresol purple impregnated strip with and without biopolymer coating

The compatibility of biopolymer like pectin and gum acacia as a coating agent on the freshness indicator developed to prevent the migration of pH sensitive dye was evaluated in iced condition. The steaks prepared from skipjack tuna was used as model system. The tested biopolymers were found to be compatible and identical to the uncoated freshness indicator. A strong correlation was found between the colour changes in indicators, TVB-N and total plate count.

Freshness indicator using anthocyanin from red kidney beans

Studies were conducted to develop pH-sensitive freshness indicator using natural compounds. Anthocyanin extracted from red kidney bean (*Phaseolus vulgaris*) seed coat was used to assess the efficiency for using as freshness indicator for air and vaccum packed ginger prawn (*Metapenaeus kutchensis*) and it was compared with chemical-based freshness indicator. During the storage under iced condition, biochemical, microbial and sensory quality was monitored. Over the period of storage, colour of the freshness indicating dyes changed distinctly from slightly pinkish purple to bluish green, revealing its efficiency for freshness prediction and the colour change correlated well with the quality attributes of shrimp. For bromocresol purple-based chemical freshness indicator, the colour changed from yellow to red with the spoilage of fish.



Visible colour change of anthocyanin (AC) impregnated discs for ginger prawn packed under air (AP) and vacuum (VP)

Paper and film-based freshness indicators

Paper and chitosan film-based indicators were developed to assess the freshness of packed fish using natural compounds *viz.*, red cabbage, turmeric and beetroot extracts during storage. The films/paper strips act as visual colourimetric sensors inside fish package, changing colour with the rate of spoilage. The Indian oil sardine were acceptable up to 8th day. The red cabbage film turned from purple to green, turmeric film turned from yellow to orange and the beetroot film turned from orange to yellow and correlated very well with the sensory scores. The study reveals that the smart films can be effectively used as visual fish freshness detectors.

Novel approaches for value addition and safety assessment of fishery resources of east coast

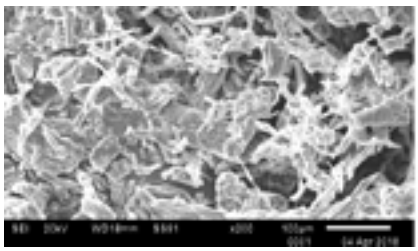
Microwave vacuum drying of mackerel: Physico-chemical qualities and lipid oxidation status

Indian mackerel was dried by microwave vacuum drying (MVD) and its physico-chemical quality was compared to mackerel dried by hot air drying (HAD). Antioxidant effects of thyme (TMO) and clove leaf essential oils (CLO) during storage were also evaluated. Brine salted mackerel was dried in hot air oven (50-55 °C) and microwave vacuum dryer (600 W and 600 Hg mm). For essential oil treatment, mackerel was dipped in 0.75% TMO and CLO for 5 min. Moisture content of MVD and HAD samples was reduced to 30-32% in 1.2 h and 12 h, respectively. Rehydration ability and water absorption index of MVD samples were significantly ($p<0.05$) higher to that of HAD samples. Significantly higher hardness and chewiness values were observed for HAD samples. Colour and appearance of uncooked MVD sample was superior to that of HAD samples. As per the results of PV and TBARS, TMO exhibited better antioxidant effect compared to CLO.

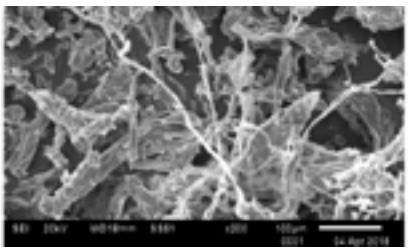
Microwave vacuum dried and hot air oven dried mackerel

Comparison of physico-chemical qualities of squid shreds dried by different methods

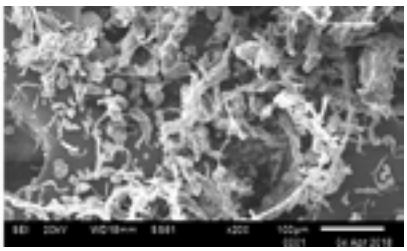
Dried products from squid shreds (Sun drying - SD, hot air drying - HAD and dried by microwave vacuum drying - MVD) were studied for their physico-chemical properties. Drying was faster in MVD (2.4 h) followed by SD (10 h) and HAD (13 h). Proximate composition indicated lower moisture in squid dried by MVD (10.05%) compared to other drying methods (11-12.4%). Protein content of dried squid varied from 42 to 48%. Rehydration properties (water absorption index, rehydration rate etc.) of the squid shreds dried by MVD were superior to those of other products. Lightness of MVD samples was higher than that of SD and HAD samples. Analysis by scanning electron microscopy of the muscle fibre indicated a spongy and regular arrangement in MVD samples and higher extent of protein denaturation in SD samples.



Microwave vacuum dried squid shreds



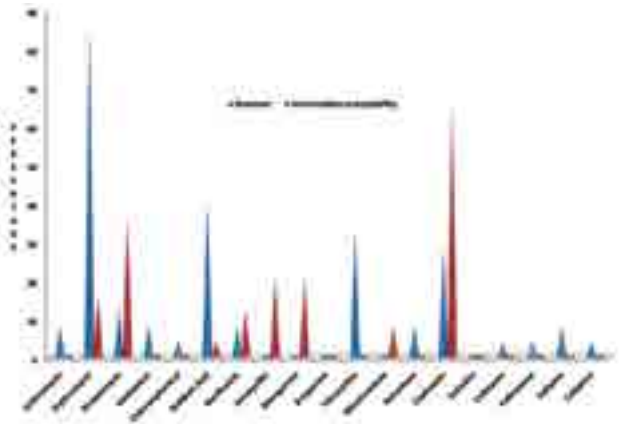
Hot air dried squid shreds



Sun dried squid shreds

Screening of bacteria isolated from fish and fishery environment for antimicrobial resistance

Twenty five isolates of *E. coli* isolated from fish were tested for their susceptibility to 24 antibiotics. The *E. coli* isolated exhibited resistance towards 13 antibiotics namely azithromycin, erythromycin, streptomycin, gentamicin, chloramphenicol, norfloxacin, tetracycline, aztreonam, cephazolin, cefotaxim, ceftriaxone, cefixime and cefepime. Maximum resistance was observed towards erythromycin (84%) followed by nalidix acid (40%), tetracycline (32%) and cephazolin (28%). Erythromycin (0%) and cephazolin (8%) were found to be least effective on *E. coli* isolated from fish. On the other hand, ertapenem (100%), cefotaxim (96%), ceftriaxone (96%) and cefepime (96%) were found to be more effective on *E. coli* isolated from fish. 20% of the *E. coli* isolated from fish showed intermediate susceptibility to the carabepenem and meropenem.



Antimicrobial resistance of different antibiotics

Bacteriophages for destroying antibiotic resistant bacteria

Bacteriophages were isolated from sewage water samples collected from Visakhapatnam Sewage Treatment Plant and sea water from Visakhapatnam fishing harbour. The samples collected from Visakhapatnam sewage treatment plant showed the occurrence of relatively higher number of bacteriophages (9440 pfu/100ml) on phage susceptible *E. coli* host strain. Twenty two bacteriophages were isolated and used for lysis of antibiotic resistant *E. coli*. Bacteriophages ϕ7, ϕ10 and ϕ11 showed clear lytic activity against the *E. coli* isolates E3 and E11 which were resistant to cephazolin, erythromycin, nalidixic acid and tetracycline. Phage treatment using enriched ϕ7 and *E. coli* isolate No. 11 yielded larger number of plaques almost destroying the complete bacterial lawn indicating that ϕ7 is a promising candidate for the control of *E. coli* resistant to important antibiotics such as cepahlopsorin, tetracycline and erythromycin.

Isolation of bacteriophages using phage susceptible *E. coli* host strain

Lysis of antibiotic resistant *E. coli* by bacteriophage

Post-mortem changes in colour and texture parameters of farmed *Litopenaeus vannamei*

Hardness 1 and Hardness 2 values showed a rapid decrease within the first three hours of storage at ambient temperature. Positive a* value was observed between 6 h and 12 h of storage. On the other hand, ice-stored *L. vannamei* (<4 ºC) showed a* value of -2.38 and b* value of 4.76 after 24 hours of storage. The a* value of fresh shrimp was -2.49. The results show that *L. vannamei* with a* value above -1.1 is an indication of loss of freshness.

Back pack model of CIFT-Fish bag

A back pack model of the CIFT-Fish bag was designed to aid the retail fish vendors for easy carrying and transportation of chilled fish products. The back pack model of fish bag is made up of three layers *viz*., an outer water proof covering, a middle insulation layer and an inner plastic lining. The insulation layer is basically a multi-layered unit composed of two foam sheets with a plastic coated iron mesh in the middle. The fish bag had a height of 20" (50.8 cm), diameter of 17" (43 cm), weight of empty fish bag is 1.18 Kg and the volume of fish bag is 50 litres. It can easily hold 10 kg of iced-fish/fishery products. Field trials of fish bag by a fish retailer (M/s Tirumala Aqua Food Products, Visakhapatnam) indicated that the back pack model bag is convenient and it maintained fish products in chilled condition for six hours with no flies, no off-odour and no dust contamination.

Back pack model fish bag

Seafood flavour peptides

The seafood flavour peptides from *Solenocera* sp. (Deep sea shrimp) was prepared by enzymatic hydrolysis using digestive enzyme such as pepsin and trypsin and the properties of peptides dried by spray drying and microwave vacuum drying was compared. Yield, protein and degree of hydrolysis of seafood flavour peptides are in the range of 12.16-12.75%; 83.13-83.56% and 22.19-22.5%, respectively. Results indicated higher antioxidant properties of

Microwave vacuum dried peptide

Spray dried peptide

microwave vacuum dried flavour (DPPH and reducing power) than spray dried flavour, whereas, seafood flavour peptides dried with spray drier had better emulsion properties as compared to flavour dried in microwave vacuum drier. Spray dried flavour was white in colour which was indicated by whiteness value (L*) 94.86 and microwave vacuum dried flavour was yellow in colour (b* value 37.18). Molecular weight profiling of extracted flavour was characterized by SDS PAGE and found that peptides had molecular weight 26000 Da and between 16500 and <6000 Da.

Residue contaminants from domestic markets

The study was carried out to determine the concentrations of formaldehyde in selected fish samples from different fish markets of Vashi, Navi Mumbai. Freshwater samples *viz.*, tilapia, rohu, pangasius and scampi (freshwater prawn) had formaldehyde content of 4.92 ± 0.06 mg/kg, 5.05 ± 0.03 mg/kg, 4.85 ± 0.05 mg/kg and 5.31 ± 0.11 mg/kg, respectively. Rohu and tilapia were found to have a formaldehyde content of 4.67 ± 0.05 mg/kg and 4.77 ± 0.02 mg/kg, respectively. However shrimp had a higher formaldehyde content of 8.82 ± 0.04 mg/kg. Hence the present study revealed that the level of formaldehyde in the fish samples collected were below the tolerable levels for humans indicating it to be naturally occurring and hence safe for human consumption.

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

Cellulose from dried water hyacinth fiber

Developed procedure for the preparation of cellulose from dried water hyacinth fiber in which an additional step of de-waxing was carried out before the sodium chlorite treatment to improve the cellulose yield. The yield of cellulose was found to increase from 38% (without de-waxing) to 54%. A procedure for the preparation of thin fiber layer from water hyacinth stalks was developed with de-waxing treatment. Also a thin hydrophobic layer was developed from water hyacinth stalks without de-waxing step. The efficacy of water soluble chitosan as absorbent polymer for moisture soaking was evaluated. It was determined that 1.0 g of water soluble chitosan was sufficient to absorb and hold 20 ml of distilled water for a period of 10 days in chilled environment.

Stalks, dried stalks, fiber and cellulose from water hyacinth

Specific technological problems and mitigation measures in fish and fishery products of Maharashtra region

Quality evaluation of fish meal samples

Quality evaluation of the fish meal samples procured from M/s Omega Fish Meal and Oil Pvt. Ltd., Ratnagiri was carried out. The fish meal samples were periodically analyzed for physical, biochemical, functional and microbiological indices under ambient conditions. There was no significant change in the microbiological quality of the samples during storage. Aerobic plate count of the samples during eight months of storage was 5.3 $\log_{10}$ and 5.2 $\log_{10}$ for A and B, respectively. Storage study of the sample is proposed for two years and is currently under progress.

E-beam irradiation for shelf life extension of headless vannamei

E-beam irradiation has the potential to prolong the shelf life of fishery products without affecting the edible quality and nutritional value. An attempt was made to study the effects of 5-MeV E-beam (0, 2.5, 5, 7.5 kGy) irradiation and vacuum packaging on extension of shelf life of headless vannamei (*Litopenaeus vannamei*) stored at 4 °C. Biochemical parameters analyzed included proximate composition, pH, TVB-N, TMA-N, PV and TBA. pH values showed an increasing trend (6.85 to 7.45) during storage. NPN values showed a significant increase (536 mg% to 641.2 mg%) during storage. Similarly, peroxide values showed an increasing trend during storage. However, TBA values did not show any significant increase during storage. Changes in texture and sensory characteristics of vannamei

during storage were also evaluated. Colour analysis showed significant increase in b* values (10.19 to 12.36) during storage. Microbiological parameters including TPC, Psychrophiles, *Pseudomonas* and Lactobacilli were also determined. Results indicated that control and 2.5 kGy treated vannamei had a shelf life up to 12th day and 14th day, respectively. Off-flavor was noticed in 5.0kGy, 7.5kGy treated sample from19th day and they were rejected on 28th day.

Effect of vacuum packaging and E-beam irradiation on the quality and shelf life of peeled vannamei during chilled storage

Attempts were made to study the effects of vacuum packaging and 5-MeV E-beam (0, 2.5, 5.0, 7.5 kGy) irradiation for extending the shelf life of peeled vannamei (*Litopenaeus vannamei*) stored at 2 °C. Biochemical parameters including proximate composition, pH, TVB-N, TMA-N, PV and TBA were analyzed. pH showed an increasing trend from 6.35 to 6.89 during storage. NPN values did not change significantly during storage. Fresh peeled vannamei had PV, FFA, TVB-N values of 1.7 meq.O_2/kg, 10.96% of oleic acid, 18.2 mg%, respectively. Control sample crossed the acceptable limit of TVB-N values (52.45 mg%) on 10th day. However, 2.5 kGy, 5.0kGy, 7.5 kGy treated samples reached the maximum acceptability level on 13th day (39.2 mg%), 18th day (40.6 mg%) and 23rd day (41.5mg%), respectively. Changes in texture, colour and sensory characteristics of peeled vannamei were also determined during storage. Microbiological parameters evaluated included TPC, Psychrophiles, *Pseudomonas* and Lactobacilli. Results indicated that control, 2.5 kGy and 5.0 kGy treated peeled vannamei had a shelf life of 10 days, 13 days and 18 days, respectively. It was observed that off-flavour was noticed in 7.5kGy treated sample from18thday onwards and it was rejected on 23rd day.

Electron Beam Accelerator used in the experiment

Use of 96 Well Plate Method to assess the efficacy of electron beam to eliminate various food-borne pathogens

Studies were carried out to standardize the level of Electron Beam Irradiation for complete elimination of different bacteria using sterile 96 well culture plates. It is inferred that 1 kGy completely destroyed more than 2×10^7 number of *E. coli*; 2×10^6 number of MRSA; 5×10^5 number of *Salmonella*, *V. cholerae* and *S. aureus*; and 1×10^4 number of *P. aeruginosa* and *B. cereus*. Similarly, 2 kGy could completely destroy 4×10^6 number of *Salmonella, P. aeruginosa* and *L. monocytogenes* and 6.7×10^4 number of *B. cereus*. Hence, based on the study it is concluded that 96 well cell culture plate method of analysis is an easy and rapid method to understand the efficacy of EBI against food pathogenic bacteria. The degree of susceptibility of bacteria to EBI is as follows: *E. coli* < MRSA < *V. cholerae* < *S. aureus* < *Salmonella* < *P. aeruginosa* < *B. cereus* < *L. monocytogenes*.

Antibacterial activity of chitosan with various metal oxides

The study was carried out to find other suitable nano materials to enhance the antimicrobial activity of chitosan. Alumina (Al_2O_3), titanium oxide (TiO_2), ferrous oxide (Fe_2O_3) and copper oxide (CuO) nano particles were tested for the study and found that among the selected nano particles only CuO showed better antibacterial activity after incorporation with chitosan. To derive an optimum proportion of CuO-NP with chitosan for better antibacterial activity, CuO-NP at different concentration i.e, 0.2%, 0.4% and 1% was incorporated into chitosan and the antibiogram was carried out with *S. aureus* and *E. coli*. It was observed that 1% CuO-NP in 1% chitosan had better antimicrobial activity than other proportions. Characterizing the copper oxide nano particles by UV-Visible spectrophotometer indicated the appearance of a strong band at 260 nm for cuprous oxide nano particles (Cu_2O) and weak band at 650 nm for cupric oxide nano particles (CuO).

Zone of inhibition against *B. cereus* for CuO-NP and ZnO-NP

Wide zone of inhibition was observed for the 1% CuO-NP-CH

Biochemical parameters of Modified Atmospheric Pressure (MAP) packed chill stored headless vannamei shrimp and seerfish steaks

Chill storage studies of MAP (60% CO_2 and 40% N_2) packed headless vannamei shrimp and seerfish steaks from the industry were evaluated. Parameters *viz.*, proximate composition, pH, moisture, TMA, TVBN, PV and TBARS were evaluated. pH of the samples indicated a slight increasing trend while moisture content remained constant during the storage period. TBARS and PV were observed to increase during storage. PV of vannamei reached the acceptability limit towards 15 days of storage while it was lower for seerfish during the study period. TMA and TVBN also increased during study, but were within the acceptability limit.

Fortified pasta from Bombay duck

Fish pasta was formulated from Bombay duck (*Harpodon nehereus*) by cold extrusion method. Wheat and refined wheat flour (1:1) were the basic ingredients and fish mince was added at different levels *viz.*, 5, 10, 20 and 30% for pasta preparation. Pasta with no added fish mince was used as control. Influence of the ingredients on the physical, cooking and sensory properties of the pasta was studied. Textural and sensory properties of pasta revealed a fish mince level of 5% as desirable and mouth feel of the product was affected beyond this concentration. Storage stability study of Bombay duck pasta (5%) stored at ambient conditions revealed a shelf stability of up to six months.

Fortified pasta from Bombay duck

Nutrient profiling of commercially important fish species of Maharashtra region

A study was carried out to comprehend the nutritional status of commercially important fish along Maharashtra region *viz.*, Bombay duck (*Harpodon nehereus*), Indian mackerel (*Rastrelliger kanagurta*), jawla (*Acetus indicus*), silver pomfret (*Pampus argenteus*), Chinese pomfret (*Pampus chinensis*), black pomfret (*Parastromatus niger*), eastern little tuna (*Euthynnus affinis*), yellowfin tuna (*Thunnus albacares*), spotted seerfish (*Scomberomorous guttatus*), barred seefish (*Scomberomorous commerson*), golden anchovy (*Coilia dussumeiri*), pabda catfish (*Ompak pabda*) and ribbonfish (*Trichiurus lepturus*) were studied. Proximate composition, fatty acid, amino acid and mineral profiling of the samples were determined.

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

- All India Network project on Fish health
- Preparation of pictorial guidelines based on freshness ratings for the species of fishes exported to European Union

Most significant achievements

- Validation of cold fill and hold process in acidified fish and prawn pickle for 5 log reduction of vegetative bacterial pathogens such as *Salmonella enterica*, *Listeria monocytogenes* and *Escherichia coli* O157:H7 as required in Code of Federal Regulations (21 CFR 114) was carried out.
- The recovery of food-borne pathogens comprising of *L. monocytogenes* and *S. enteritidis* using 3-tube methods revealed that PCR detection is better in comparison to conventional plating method.
- Geo-referenced data on Cephalopods (n=36) were collected to identify hotspots of cadmium in coastal fishing grounds.
- The Cd bio-accumulation in various tissues (muscle, digestive glands and tentacles) were estimated and highest concentration (8.79±0.1 ppm) was observed in muscle of *Uroteuthis singhlensis*.
- Studies on matrix-based differential recovery of food-borne pathogens indicated 65%, 54% and 60% recovery from raw fish, shrimp and squid samples, respectively.
- Monitoring study of food-borne pathogens in 30 fish and shellfish species sampled from Thevara market and Cochin Fisheries Harbor indicated mesophilic bacterial load of 5.38-8.11 log CFU/g.
- Samples (15 Nos.) of raw, salted and dried, and dried Leather Jacket (*Scomberoides* spp.) from Navabandar Region of Gujarat showed higher yeast and mold count ($1.2x10^3$ CFU/g) in salted and dried samples. No pathogenic bacteria were detected.
- Use of 60:40 ratio of CO_2 and N_2 in modified atmosphere packaging of *Scomberomorus commerson* (Seerfish) steaks extended the shelf life by 8-9, 5-6 and 2-3 days, compared to air packed LDPE, laminated pouches.
- In 6.81% of salted and dried fishery products (n=40), the water activity was above the FSSAI prescribed limit of 6.81% and salt content was less than 12% in 26.67% of samples.
- Fermented fishery products sourced from Tripura were free from all major food-borne pathogens, but arsenic was detected at trace levels (1.0-1.9 ppm) in 'Puthi shidal' and 0.8-1.2 ppm in 'Phasa shidal'.
- Hygiene status of three fishing harbours and one aquaculture farm revealed the presence of hygiene indicator bacteria to a varying degree and water available for use as major source of contamination.

- Analysis of 26 samples procured from Kerala, Karnataka and Gujarat revealed none of the samples as positive for ciguatoxin.
- Paper strip-based rapid detection kits for checking ammonia and formaldehyde adulteration in fish was developed with LoD of 350 mg/Kg
- In fish pickles from various locations, pH was in the range of 4.00-4.30, a_w was 0.866-0.931 (for solid pieces alone), acidity was 0.99-1.26% and salt content was 4.03-8.60%.
- Genetic similarity of *V. parahaemolyticus* by RAPD-PCR showed three distinct groups with a total of eight distinct RAPD pattern at 80% similarity level.
- A total of 132 samples screened for heavy metals showed the presence of arsenic (BDL-16.2 ppm), cadmium (BDL-1.41 ppm) and lead (BDL-0.209 ppm).
- Changes in microbiological quality of high pressure treated mullet at 400 MPa for 5 min. holding time during chilled storage showed aerobic plate count of 5.62 log CFU/g which remained less than the prescribed limit even after 32 days of chilled storage.
- Pictorial guidelines were prepared for 16 species of fish that included farmed freshwater fish, farmed brackishwater shrimp, wild marine shrimp, cuttlefish and marine fish.

Chief findings

Institute projects

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

Determination of growth and survival of pathogens

A challenge study was designed for cold fill and hold process validation of acidified fish and prawn pickle as required under USFDA Code of Federal Regulations (21 CFR 114). After acidification with 2% acetic acid and 0.033% sodium benzoate, the fish and shrimp pickle requires a holding time of minimum 116 h and 104 h. MPN-PCR was found to be a rapid and reliable method that could facilitate the enumeration of *L. monocytogenes* and *S. enteritidis* in fish pickle.

Studies on matrix-based differential recovery of food-borne pathogens indicated 65%, 54% and 60% recovery from raw fish, shrimp and squid samples, respectively. Recontamination potential (estimated in terms of mean recovery) was found to be higher from cooked samples in comparison to raw matrices. Raw fish samples pre-treated with *Bacillus subtilis* was found to have 1.2 log lower recontamination with *Escherichia coli*.

Monitoring study of food-borne pathogens in fish and shellfish species sampled from local markets indicated mesophilic bacterial load of 5.38-8.11 log CFU/g. Significantly higher *E. coli* load than the prescribed limit of 20 cfu/g was observed in squid (1996 CFU/g) and *Epinephelus malabaricus* (39810 CFU/g) indicated fecal contamination of samples at fishing harbor and markets. Evaluation of *Shigella* in all these samples by targeting *ihaP* gene revealed absence of the pathogen in the fisheries environments.

Vibrio parahaemolyticus isolates obtained from seafood samples were characterized for their antibacterial resistance. Out of 22 antibiotics tested, five isolates of *V. parahemolyticus* were sensitive towards amoxyclav and three isolates were sensitive towards ampicillin. Around 41% of the isolates were resistant to all the 22 antibiotics tested.

Progressive reduction of *Listeria monocytogenes* during successive processing steps in freezing, cold smoking and pickling of mackerel was modelled. In samples artificially contaminated with *L. monocytogenes*, 56.92% reduction in original inoculum level was recorded 30 days after blast freezing and cold storage at -18 ^{o}C. Similarly a cumulative reduction of 67% and 98% was observed in cold smoking and pickling process, respectively.

Data on cadmium load in Cephalopods

Geo-referenced data on Cephalopods (n=36) were collected to identify hot spots of cadmium in coastal fishing grounds and bio-accumulation in various tissues (muscle, digestive glands and tentacles) were estimated and

compared. In *Uroteuthis singhlensis*, highest concentration of Cd (8.79±0.1 ppm) was observed in muscle. Tentacles of *Amphioctopus membranaceous* (13.68±0.33 ppm) and digestive glands of *Octopus vulgaris* (59.46±0.76 ppm) accumulated highest concentration of Cd.

Quality of fresh/dried fishery products of Gujarat region

Raw fish (7 Nos.), salted and dried (4 Nos.) and dried (4 Nos.) samples were studied. Salted and dried Leather Jacket (*Scomberoides* spp.) showed higher yeast and mold count ($1.2x10^3$ CFU/g). No pathogenic bacteria were detected.

Optimization of gas combination for modified atmosphere packed fishes

Effect of single and multi-layered packaging material and effect of modified atmosphere packaging on the shelf life of seerfish (*Scomberomorus commerson*) steaks was studied. For this, seerfish steaks were packed in control LDPE and polyester-polyethylene pouches. Significant reduction in TBA values and TVBN content was observed for MAP samples compared to control samples. Histamine formation was least for MAP-1 followed by MAP-2, laminated pouch and LDPE pouch samples. Based upon sensory evaluation, samples were acceptable up to ~11-12, ~13-14, 17 and ~19-20 days for samples packed in LDPE, laminated pouches, MAP-2 and MAP-1, respectively. Use of 60:40 ratio of CO_2 and N_2 extended the shelf life of seerfish by 8-9, 5-6 and 2-3 days compared to air packed LDPE, laminated pouches and 40:60 ratio of CO_2 and N_2, respectively.

Biological and chemical hazards associated with fermented fishery products

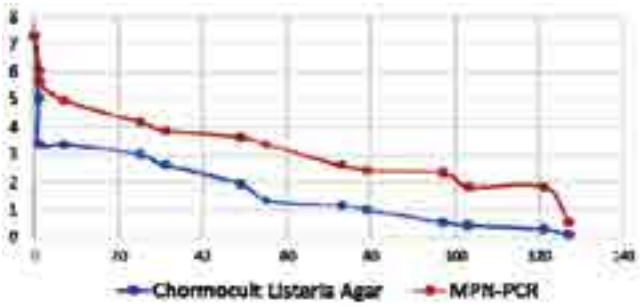
Fermented fish samples from North-east India were analyzed for the presence of pathogenic bacteria (*Salmonella*, *Listeria monocytogenes*, *Vibrio cholerae*, *Staphylococcus aureus* and *E. coli*) and heavy metals (As, Cd, Hg and Pb). None of the sample were found positive for bacterial pathogens. But spoilage bacteria *Pseudomonas* count was calculated to be 2.07 log cfu/g in 'Puthi shidal' and 1.96 log cfu/g in 'Phasa shidal'. Among heavy metals, arsenic (As) was detected in the range of 1.0 - 1.9 ppm in 'Puthi shidal', 0.8 - 1.2 ppm in 'Phasa shidal' and upto 2.5 ppm in 'Lona ilish'.

Quality and safety of cured fishes and fermented products

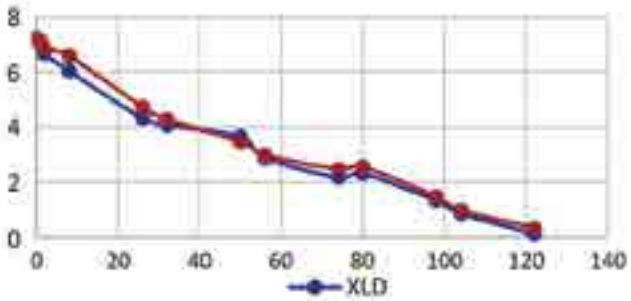
In 6.81% of salted and dried fishery products (n=40), the water activity was above the FSSAI prescribed limit and salt content was less than 12% in 26.67% of samples. TVBN content ranged from 84 and 273 mg/100g and TMA from 28 to 210 mg/100g. Content of heavy metals were found to be within the prescribed limits (Hg: <20 ppb; As: BDL-0.57 ppm, Cd: BDL-0.054 ppm and Pb: BDL-0.053 ppm).

Comparative isolation of *Listeria monocytogenes* and *Salmonella* sp. from fish pickle

The recovery of food-borne pathogens comprising of *L. monocytogenes* and *S. enteritidis* using 3-tube methods showed that PCR detection is better when compared to conventional plating method.



Recovery pattern of *Listeria monocytogenes*



Recovery pattern of *Salmonella*

Monitoring of ciguatoxin in coral reef fishes

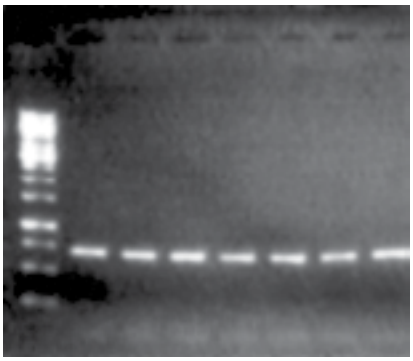
Twenty six samples of different fish and fishery products procured from Kerala, Karnataka and Gujarat were tested for the presence of ciguatoxin using mouse bioassay. None of the samples were found positive for this significant biotoxin. Occurrence data on Indian Ocean ciguatoxin was included as a conference document in CCCF meeting held at Brazil.

Molecular techniques for typing of pathogenic *V. parahaemolyticus*

Comparison of different molecular techniques (RFLP, RAPD and PFGE) used for the typing of pathogenic *V. parahaemolyticus* isolates with characteristics of pandemic clones in seafood were carried out. Seafood and environmental samples may harbor strains of *V. parahaemolyticus* which may not fit into the classical definition of pandemic clones, but possess characteristics of pandemic clones and also are genetically closely related to pandemic clones.

Evaluation of efficiency of full-length and mini-length DNA barcoding for authentication of differently processed fish products

DNA extraction was carried out from fresh, frozen and canned tuna samples. PCR conditions were optimized for amplification of *Col* gene (650 bp). Mini-length DNA barcoding primers were designed.



Gel electrophoresis image showing *Col* gene amplification with 650 bp amplicons

Effect of high pressure on shelf life extension of flathead mullet

Changes in microbiological quality of high pressure treated mullet (*Mugil cephalus*) (200 MPa and 400 MPa; 5 min. holding time) were evaluated during chilled storage. Aerobic plate count of 400 MPa treated fish (5.62 log CFU/g) remained less than the prescribed limit even after 32 days of chilled storage. Enterobacteriaceae, Coliform and histamine forming bacteria remained absent throughout the storage period.

Screening and characterization of shrimp allergens

Identified and confirmed the allergic protein component of Flower tail shrimp (*Metapenaeus dobsonii*) by Western Blotting Technique. Sera from 12 shrimp allergic persons was used for confirming the allergic protein component. Western Blot with individual sera of patients showed that IgE antibodies positively reacted with Tropomyosin band of 37 KDa. Gel filtration profile of crude cooked extract showed IgE reactivity by tropomyosin in the second fraction by ELISA technique.

Food safety hazards in Ready to Eat and Ready to Cook fishery products

Safety of Ready-To-Eat (RTE) products available in commercial retail outlets (fish, squid, prawn pickles and prawn chutney powder; n=29) and Ready-To-Cook (RTC) products (battered and breaded products; frozen fish fingers, fish popcorn, fish pakodas, fish fingers, fish cutlets, seafood spring rolls, fish samosa, imitation products like crab sticks, and crab claw; n=29) were evaluated. In fish pickles, pH was in the range of 4.00-4.30, a_w was 0.866-0.931 (for solid pieces alone), acidity was 0.99-1.26% and salt content was 4.03-8.60%. Analyzed parameters complied with the Indian standards for fish pickle – IS 14515:1998 and the currently notified FSSAI draft standard for fish pickles. In RTE samples APC ranged from 1.8 to 7.2 log CFU/g. Coliforms were detected in 33.3% of the samples. Coagulase positive *S. aureus* was detected 12.5% of the samples which ranged from 2 to 2.3 log CFU/g. Enterobacteriaceae was found in all samples and ranged from 1 to 4.07 log CFU/g. Other pathogens such as *Salmonella*, *L. monocytogenes*, *E. coli* O157, *V. parahemolyticus* and *V. cholerae* were not detected in any of the samples.

Ready to Eat and Ready to Cook fishery products evaluated

In RTC samples APC ranged from 2 to 5.07 log CFU/g and 12.5% of the samples showed above 5 log CFU/g. For RTC products, TMA in imitation products was found to be in the range of 1.4 mg% to 2.8 mg%; and for all products, TVBN was found to be 1.42 mg%-6.72 mg% and TBA in the range of 0.12 to 0.81 mg MDA/Kg, falling under the acceptable limit of the analyzed parameters. Sodium benzoate (E 211), a permitted Class II preservative, was found to be in the range of 0.005-0.04% which falls within the recommended level of preservative as per FSSAI regulations of fish and fish products, including Molluscs, Crustaceans and Echinoderms, pickled and/or in brine.

Developing a rapid detection kit for formaldehyde contamination in seafood

Rapid detection of ammonia adulteration

A paper strip-based rapid detection kit was developed for ammonia adulteration in fish, a combination of reagents was incorporated into filter paper with different pore size, and tested for colour development with different concentration of standards. The time taken for colour development was also improved with modifications in combination of reagents used. A standard chart was developed based on spiked study in fish samples.

Experiments were conducted with fish samples stored in the made up of 1% and 3% ammonia solution. Both whole fish and fish meat developed a blue colour on the test strip for both the treatments indicating ammonia contamination in the meat. The shelf life of the test strips was evaluated by observing the changes in response and response time during the analysis.

During filed trials, about 53 samples (28 species) from different markets of Ernakulam, Thiruvananthapuram and Kasargod districts were analyzed and all the samples were found free from ammonia contamination.

Ammonia detection kit Standard chart **Modified chart**

A rapid detection kit for formaldehyde in seafood

A rapid detection kit was developed for checking the formaldehyde adulteration in seafood. The kit consist of simple paper strips, reagent bottle and a solution. The paper strip react with the content of formaldehyde in the tissue/skin of adulterated fish. Adding one drop of reagent solution into the swabbed paper strip can result colour development within a minute (maximum of two minutes). The combination of chemicals incorporated into the filter paper was optimized based on reaction time, colour development, specificity and sensitivity to the matrix.

A colour chart is prepared for different concentrations ranging from 5 to 100 ppm (5, 10, 20, 50 and 100). Absence of formaldehyde in fish results slight yellowish colouration with a green tinge indicating safe fish free from adulteration. For adulterated one it can result a clear green colouration at lower level to dark bluish colouration at higher levels.

Rapid detection kit for formaldehyde adulteration

Validation of the rapid kit

The kit is statistically validated by 'full factorial experimental design with two factors namely concentration and contact time of treatment' with 32 combinations. The concentrations used were 0, 2, 4 and 6 ppm and the contact time of dip treatment were 6 and 15 minutes. The resulted colour change of the paper strip was noted as Response 1 (R1) and the result of instrumental method (Effective concentration in homogenized

meat including skin) as Response 2 (R2). For fixing the lower limit of detection of kit, a single factorial experimental design was used by keeping the time constant at 6 minutes. Lower limit of detection of kit is fixed as 4 ppm.

Detection capability studies of the paper strip

Ice storage studies of formaldehyde treated fish were carried out and checked for colour change at different intervals. Two dip treatments of formaldehyde solution at 100 ppm and 1% level was carried out in samples of Indian mackerel in duplicate. Treated samples were iced in a tray and kept in room temperature. Ice along with melt water is changed on hourly basis and checked for colour development using the strip. Detectable colour change was observed during storage in hourly intervals and after 24 hours of storage.

Three dip treatments of formaldehyde solution at 10 ppm, 1000 ppm and 1% level were carried out in samples of Indian mackerel. Treated samples were iced in separate insulated containers and stored in chill room. Samples were checked for colour change on daily basis. Colour development was prominent and clear in case of samples treated at higher concentrations of 1000 ppm and 1% till the end of storage. In the case of sample treated at 10 ppm concentration, a fainted green colouration was observed on 4th day of storage.

Market study using CIFTest kit

Fish were collected from different markets such as Palluruthi, Chambakkara, Vykom, Kanjangad, Kasargod and Palayam and cold store of one fresh fish outlet at Kochi. A total of 67 samples were collected and 13 were screened positive (19.4% of total samples).

Base line data of background levels of formaldehyde in commercially important species

Estimated the formation of free formaldehyde level during ice storage of eight different species of fish and shellfish.

Shri Radha Mohan Singh, Union Minister of Agriculture and Farmers Welfare, released the "Rapid detection Kits (CIFtest) to detect adulteration of formaldehyde and ammonia in fresh fish" developed by the Institute on 30th January, 2018 at New Delhi.

A demonstration of rapid detection kits for adulterants in fresh fish was given to Kerala Fisheries Minister Smt. J. Mercykutty Amma at Palayam market, Thiruvananthapuram on 14th February, 2018. The demonstration was followed by a press conference by the Minister.

Smt. E.R. Priya demonstrating the kit before Shri Radha Mohan Singh

Release of the kit

Demonstration of the kit before Smt. J. Mercykutty Amma

Microbiology, Fermentation and Biotechnology

Research projects handled

Institute projects

- Molecular heterogeneity and bioprospecting of aquatic and fish bacteria for novel molecules and genes
- Occurrence, distribution and molecular characteristics of emerging and re-emerging pathogens in seafood and its environment
- Assessing environmental aspects of fish, fishery products and effects of chemical hazards

Externally funded projects

- Genetic diversity of *Clostridium botulinum* in seafoods and development of Lateral Flow Immuno Assay (LFIA) for toxinotyping
- Evaluating cost and benefits of prophylactic health products and novel alternatives on small holder aquaculture farms in Asia and Africa
- National surveillance programme for aquatic animal diseases

Most significant achievements

- *Salmonella* was present in 3.3% of dry fish in Kochi region. *Salmonella* Typhimurium, *Salmonella* Urbana, *Salmonella* Paratyphi B and *Salmonella* Salamae were the serotypes of *Salmonella* found in seafood samples of Kochi.
- 1/2a, 3a and 1/2b,3b,7 were the serogroups of *Listeria monocytogenes* found in seafood samples of Kochi.
- *Vibrio harveyi* was found in 7.8% of hatchery and farm samples.
- t334, t311, t304, t3481 and t127 *spa* types of MRSA were found in landing centers and retail markets of Kottayam district.
- *Thiobacillus aquaesulis*, a potential sulfur oxidizing bacteria isolated from acquaculture farm was optimized for immobilization studies.
- Metagenomic analysis of aquaculture farm samples for ammonia oxidizing bacterial diversity revealed that Phylum Chloroflexi was the dominant Phylum followed by Proteobacteria.
- Nine tyrosinase producing Actinomycetes were isolated from aquatic environment.
- Three *Bacillus* spp., a potential quorum quenching *Bacillus* as an alternative to antibiotics to protect *Penaeus monodon* post-larvae from *Vibrio harveyi* infection is identified.
- O Serotyping of 58 pathogenic isolates *of V. parahaemolyticus* revealed that they belonged to Serotypes O1, O2, O3, O4, O5, O7, O10 and O12.
- *Cronobacter sakazakii* was isolated from 10 seafood and environment samples screened.
- *Staphylococcus warneri*, *S. haemolyticus*, *S. xylosus*, *S. simulans*, *S. auricularis* and *S. epidermidis* were the coagulase negative Staphylococci identified from seafood of Veraval, Gujarat.

- Draft genome sequence of two methicillin resistant Staphylococci (MRSA) isolate (ST 1 and ST 39) from salted dry fish from Gujarat was completed.
- Three samples were found to be positive for WSSV out of 48 shrimp samples tested.
- *E. coli* isolates from fish and fishery environment were screened for antimicrobial resistance and maximum resistance was observed for erythromycin (84%), nalidixic acid (40%), tetracycline (32%) and cephazolin (28%).

Chief findings

Institute projects

Molecular heterogeneity and bioprospecting of aquatic and fish bacteria for novel molecules and genes

Salmonella from dry fish

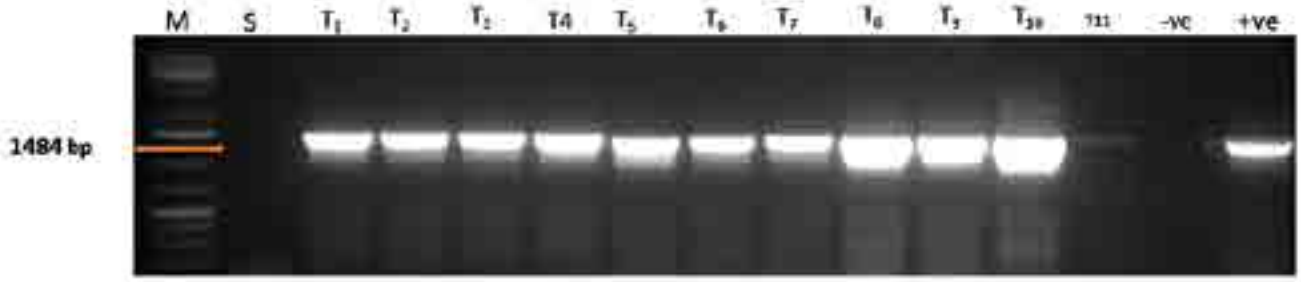
A total of 120 dry fish smples from local markets of Kochi were screened for *Salmonella* and the prevalence was found to be 3.3%. All the isolates showed multi-drug resistance (MDR) for the antibiotics tested and the common pattern of resistance was nitrofuran, cephalosporin and carbapenem class of antibiotics.

Serotyping of *Salmonella* from seafood

Serotyping of *Salmonella* isolated from seafood samples of Kochi area were identified as *Salmonella* Typhimurium, *Salmonella* Urbana, *Salmonella* Paratyphi B and *Salmonella* Salamae.

Characterization of *Listeria* isolated from fish and fishery environment

Characterization of virulence genes: Eleven isolates of *Listeria monocytogenes* were screened for the presence of eight virulence genes *inlA*, *inlC*, *inlJ*, *plcA*, *hlyA*, *actA*, *iap* and *prfA* in multiplex PCR. All the 11 isolates were positive for *InlA*, *inlC*, *inlJ*, *plcA*, hly*A*, *prfA* and *iap*, but two isolates were negative to *actA* gene.



M-Ladder (1 kb plus); S-Test Sample; T_1-T_{11} = Positive isolates; Negative = Negative control; Positive = ATCC 7644

PCR for *Listeria monocytogenes* virulence gene *plcA*

Characterization for serogroups: The serogroup of *L. monocytogenes* (1/2a, 1/2b, 1/2c and 4b) was determined by multiplex PCR targeting four genes *imo*737, *imo118*, *ORF2819* and *ORF2110*. Among the 11 isolates nine isolates belonged to 1/2a, 3a and two isolates to 1/2b and 3b.

Characterization for antibiotic resistance: Antimicrobial susceptibility testing of all the 11 isolates with 23 antibiotics revealed that all the isolates were resistant to ampicillin, erythromycin, penicillin, clindamycin, tetracycline and sensitive towards oxacillin, gentamicin, co-trimoxazole, ofloxacin, chloramphenicol and methicillin. The highest percentage of resistance was shown towards clarithromycin (91.66%) followed by azithromycin (58.33%) and rifampicin (33.33%).

Studies on MRSA from landing centres and retail markets

Methicillin resistant *Staphylococcus aureus* (MRSA) was identified from (9/49) samples from two landing centers (Vaikom and Chempu) as well as two retail fish markets (Poothotta and Ettumanoor) samples collected at Kottayam district. *spa* types identified in the study were t334, t311, t304, t3481 and t127.

Pathogenic *Vibrio harveyi* from aquatic environment

Vibrio harveyi was found in 7.8% of 54 hatchery and farm samples screened. Eleven isolates were confirmed biochemically and molecularly using PCR targeting *tox* gene specific for *Vibrio harveyi*.

Bio-prospecting of aquatic bacteria for production of biocatalysts: Quorum quenching bacteria as an alternative to antibiotics to protect *Penaeus monodon* post-larvae from *Vibrio harveyi* infection

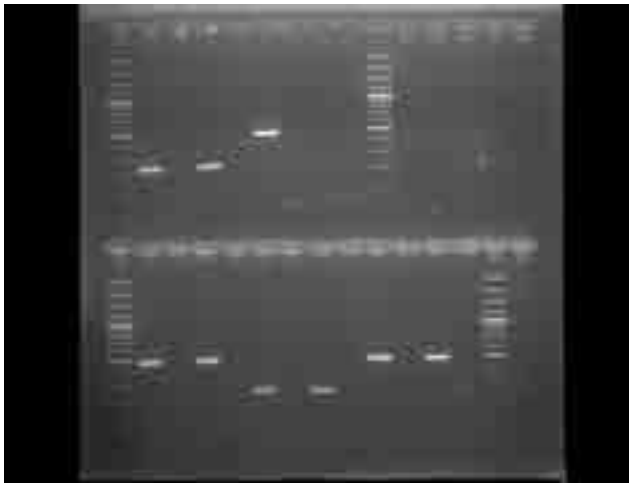
Fifty six *Bacillus* spp. isolated from aquaculture ponds/mangrove soil were screened for quorum quenching activity. Seventeen isolates showed potential quorum quenching activity, out of which three showing highest activity were identified as *B. subtilis*, *B. lentus* and *B. firmus*. Inhibition of hemolytic activity and suppression of protease, lipase, phospholipase, caseinase, biofilm formation and gelatinase in *V. harveyi* VH201 was confirmed in the three strains. The three isolates were able to survive at a wide range of temperatures, pH, and NaCl levels. Molecularly the expression of virulence genes such as metalloprotease, serine protease and haemolysin was confirmed by PCR analysis. *In vivo* experiment in *P. monodon* post-larvae fed with the three isolates of *Bacillus* spp. was able to protect the post-larvae from a mortality up to 91%. These *Bacillus* spp. are an alternative to antibiotics in shrimp hatcheries for controlling the luminescent Vibriosis.

***Bacillus* sp. showing quorum quenching activity in LB agar with AHL molecule**

Genetic relationship of pathogenic *Vibrio parahaemolyticus*

The O Serotyping of the 58 pathogenic *V. parahaemolyticus* using multiplex PCR revealed that isolates belonged to the Serotypes O1, O2, O3, O4, O5, O7, O10 and O12. The isolates that were clustered together with the reference clinical isolate were positive for *tdh* gene indicating genetic relatedness between these isolates. All the 58 isolates were GS-PCR negative.

Genetic diversity of *V. parahaemolyticus* from seafood



Genetic relatedness of *Vibrio parahaemolyticus*

The study of genetic relatedness among the isolated strains of *V. parahaemolyticus* using ERIC PCR revealed extensive diversity among the isolates. The minimum similarity among the pathogenic isolates was found to be 44.8% and at this similarity coefficient the isolates were distributed into 14 clusters. The distribution of the O Serotypes in the ERIC clusters revealed that there is no correlation between genetic relatedness and Serotype relatedness. The analysis of PFGE macro-restriction profiles grouped the isolates into 15 clusters with minimum similarity of 57.4%. Pathogenic isolates of *V. parahaemolyticus* from different geographical locations were found to cluster together in the dendrogram, representing the spread of these pathogenic isolates.

Screening for plastic-degrading bacteria

Soil and water samples collected from soil dumping sites of Willingdon Island and Kakkanad were incubated in minimal media for two months with HDPE, LDPE, PP, PVC and PP film. Twenty one out of 134 samples were found to reduce the weight of the plastic. There was a weight loss of 43% for PVC while the maximum weight reduction was 39% for PET. HDPE, LDPE and PP had weight reduction of less than 20%.

Anti-chikungunya activity of Actinomycetes

The culture supernatant from four out of 105 isolates of Actinomycetes from marine environment with anti-chikungunya activity were fractionated on silica gel and further purified by HPLC. One HPLC fraction from one of the isolates gave 90% activity at 0.01 ug/ml concentration. This fraction will be further characterized

to determine the active principle present. A lead compound with anti-chikungunya activity was identified from marine Actinomycetes. Further characterization of the compound is in progress.

Antibacterial activity of nano particle-incorporated biocellulose discs

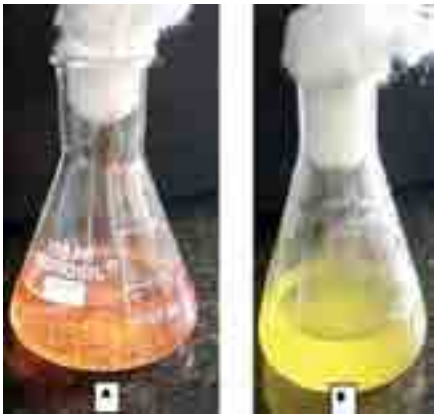
Bacterial cellulose, a highly pure cellulose produced by bacteria, possesses large surface area and excellent loading capacity. The MIC of nano ZnO, TiO_2 and chitosan were determined and these concentrations were used for incorporation into biocellulose discs. The antibacterial activity was determined by disc diffusion test.

Primary screening of Actinobacteria for antimicrobial activity by agar plug method

Out of 100 Actinomycetes isolates screened primarily for antibacterial activity by agar plug method, 10 isolates with good activity against pathogens *viz.*; *Candida albicans*, *E. coli*, MRSA, *Bacillus* sp., *K. pneumoniae* and *P. aeruoginosa* were selected for further study. Antibacterial activity of partially purified extracellular crude extracts of 10 isolates were determined by agar well diffusion method. One strain with maximum activity against MRSA was selected for further study.

Characterization of sulphur oxidizing bacteria

Ninety six distinct morphological isolates of sulphur oxidizing bacteria (SOB) were isolated from freshwater fish aquaculture farms using six isolation media and checked for maximum sulphate ion production. The SOB identified was *Thiobacillus aquaesulis*. Four sulphur oxidizing bacterial isolates were immobilized on to 3% alginate beads. Sulphur oxidation potential and optimization of growth condition revealed that maximum amount of sulphate ion was produced in mannitol as carbon source, ammonium sulphate as nitrogen source, at pH 6, temperature 25˚C and shaking at 150 rpm.

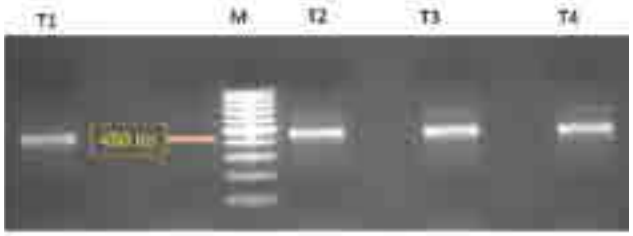


Growth of sulphur oxidizing bacteria in *T. aquaesulis* broth (B) after 4-5 days compared to control (A)

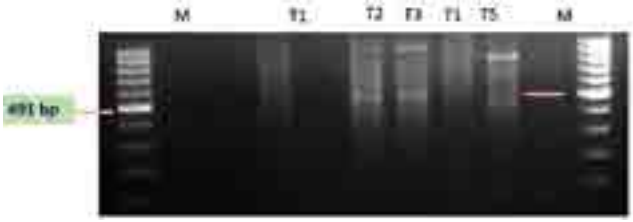
Diversity of ammonia oxidizing bacteria from aquaculture farms

Ammonia oxidizing bacteria (AOB) were screened from 20 aquaculture farms of Alappuzha, Kottayam and Ernakulum districts of Kerala. Among the 24 colonies picked from a single farm tested to reduce 0.5 ppm of ammonia. Majority of them were identified as *Pseudomonas* spp., *Bacillus* spp., *Aeromonas* spp. and *Acaligens* spp.

Sediment samples were collected from aquaculture farms to determine AOB diversity using Illumina Miseq platform. One metagenome sample (SRF7) showed 37532 OTUs from 442320 reads. The study identified nine major Phyla and Phylum *Chloroflexi* as dominant Phylum followed by Proteobacteria. In this sample, OTU belonging to LCP-6 played a vital role for ammonia oxidation and is about 19.35% followed by Desulfobacca with 10.03%.



V3-V4 amplification of metagenomic DNA



***amoA* gene amplification of metagenomic DNA**

Bioinformatic analysis of 16s rDNA gene sequences

Twenty seven genomic sequences of bacteria were analyzed for local alignment using existing NCBI bioinformatics tools and the respective matching bacterium were identified. Major genus of bacteria as per the database generated are *Streptomyces* sp., *Clostridium* sp., *Aeromonas* sp., *Vibrio* sp. and *Bacillus* sp.

Actinomycetes in mangrove ecosystem

Nineteen morphologically distinct Actinomycetes from mangrove ecosystem were checked for tyrosinase, asparaginase, protease, amylase, cellulase and lipase activity. Out of which, 14, 20, 12, 14 were asparaginase,

protease, lipase, cellulase producers, respectively. One isolate showed extracellular tyrosinase production.

Tyrosinase activity shown by the brown colouration of media

Lipase activity of Actinomycetes on lipid media

PUFA producing bacteria from fish and aquatic environment

PUFA producers were isolated from intestines of oily fish of salt water and brackish water habitats. A total of 24 cultures isolated from sardine fish were shortlisted as potential PUFA producer, to be confirmed by GCMS.

Screening bacteriophages against pathogens

Live clams and crabs, water from brackish and sea samples were screened for the presence of lytic phages against various pathogens *viz.*, Methicillin resistant *S. aureus*, *Aeromonas* sp., *Vibrio harveyi*, *V. parahaemolyticus* and *Edwardsiella tarda*. Plaques presumptive for phages against *E. tarda* was observed from live clam sample.

Microbial diversity of fermented fish products

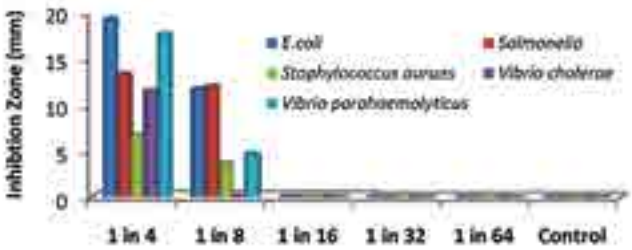
Microbial diversity of fermented fish products from the north east region of India was determined. Total aerobic count ranged from 1.92×10^2 to 2.16×10^4 CFU, Total anaerobic count ranged from 1.16×10^3 to 1.64×10^4 CFU, Lactobacilli count ranged from 5.5×10^2 to 7.8×10^3 CFU, yeast and molds count ranged from 1.84×10^2 to 7.8×10^2 CFU. None of the samples were positive for Enterobacteriaceae and *E. coli*.

Isolation of Actinomycetes from the Navi Mumbai creek region

Mud samples were collected from the mangrove sea shore region of Vashi, Navi Mumbai, Maharashtra for isolation of Actinomycetes. All the samples were subjected to various pre-treatment and inoculated in ISP 2 and 3 Media. Colonies appeared one week post-inoculation. Most of the colonies were light pink, light green and light yellow in colour with swarming in nature. All the colonies were again purified in the ISP 3 Media and stored in chill condition for further antimicrobial activity. These colonies were grown in ISP broth and incubated for five days for complete growth. Then the broth samples were centrifuged and screened for antibacterial activity against various pathogens *viz. Salmonella, E. coli*, MRSA, *L. monocytogenes, V. cholerae, V. parahaemolyticus* and *B. cereus*. Even though most of the colonies exhibited a mild antimicrobial activity against MRSA bacteria, only four isolates exhibited strong antibacterial activity against MRSA with the inhibition zone of 9 to 13 mm.

Thyme oil as inhibitor of pathogenic bacteria

The minimum inhibitory concentration of thyme oil to inhibit pathogenic bacteria was studied. Thyme oil at 1:4 and 1:8 concentrations produced inhibitory zone against *Salmonella, Vibrio cholerae*, *V. parahaemolyticus*, *E. coli* and *S. aureus*. The mean zone diameters at 1:4 concentration was 19.3±13.6 mm, 17.7±2.5 mm, 13.3±2.1 mm, 11.5 mm and 6.7±2.5 mm for *E. coli*, *V. parahaemolyticus*, *Salmonella*, *V. cholerae* and *S. aureus*, respectively.



MIC of thyme oil for different bacteria

Effect of salinity on growth of probiotic bacteria

A commercially available probiotic (label claim: 10^9 CFU/g; contains heterotrophic bacteria) was used for the study. Seven different bacteria, based on colony morphology, were isolated from the probiotic powder (S1: Gram positive Cocci; S2 to S7: Gram positive Rods) and tested for their growth at different salt concentrations *viz.*, 0 ppt, 5 ppt, 10 ppt, 20 ppt, 30 ppt, 40 ppt and 50 ppt. The growth of each bacteria was measured (OD600) at 30 min. intervals for 10-12 hours. Majority bacterial isolates (86%) exhibited relatively good growth at water salinities between 0 ppt to 10 ppt. On the contrary, majority of the bacteria (71%) did not grow or exhibited weak growth at 40 ppt and 50 ppt salt concentration. However, S1 (Gram

positive Cocci) isolate grew well even at 20 ppt and S6 (Gram positive Rods) exhibited growth up to 30 ppt salt concentration. Only one isolate (S3) showed almost similar growth pattern over wide range of salinities ranging from 0 ppt to 50 ppt. The results indicate that commercial probiotics (containing different types of bacteria) when applied to ponds containing water at different salinities may perform differently owing to the difference in the growth rate of bacterial isolates at different salt concentrations.

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

Design of sampling plan for occurrence study

Designed and developed the sampling frame for collection of microbial survey data and samples from different channels *viz*. retail market, roadside market, landing centres and aquaculture farms from Ernakulam district based on the secondary data. Sampling units were allocated on monthly basis according to the frame. This sampling plan was implemented for a cross sectional study of the emerging and re-emerging pathogens in seafood. Samples included in the study were finfish, Crustaceans, Molluscs, dried fish, water and ice.

Quantitative estimation of hygiene indicators

Quantitative estimation of total viable bacteria, hygiene indicators and fecal indicators from different fish, fishery products and aquatic environment were conducted on 106 samples. The TPC count ranged from 5 x 10^5 to 5.1 x 10^8 (finfish), 1.8 x 10^6 to 4.6 x 10^8 (Crustaceans), 6.0 x 10^6 to 4.1 x 10^8 (Molluscs), 1.7 x 10^6 to 2.8 x 10^8 (dry fishes), 1.2 x 10^5 to 5.3 x 10^7 (water), 1.7 x 10^5 to 2.7 x 10^7 (ice), and 4 x 10^4 to 7.7 x 10^7 (sediment).

Isolation of *Arcobacter* spp. from fish and fishery environment

A total of 94 samples were screened for the presence of *Arcobacter* spp. Molecular identification of the enriched broth using species-specific 16S rDNA primers for *Arcobacter* spp. revealed eight samples as positive for *Arcobacter* spp.

Isolation of *Cronobacter sakazakii* from fish and fishery environment

Cronobacter sakazakii (18 Nos.) was isolated from 10 samples screened in the study. The cultures were confirmed biochemically and molecularly by Polymerase Chain Reaction (PCR) targeting *crno* gene specific for *C. sakazakii*.

Cronobacter sakazakii on Enthobacter Sakazakii agar media

Isolation of *Plesiomonas shigelloides* from fish and fishery environment

Total 106 samples were screened for *Plesiomonas shigelloides* and 127 suspected isolates were not identified as *P. shigelloides*. Competing flora for *P. shigelloides* were identified as *E. coli*, *Citrobacter*, *Salmonella*, *Klebsiella*, *Vibrio*, *Corynebacterium* and *Bacillus alcalophilus*.

Isolation of *Vibrio mimicus* from fish and aquatic environment

Total 106 seafood samples were screened for *Vibrio mimicus*. Five isolates were confirmed as *V. mimicus* out of 93 tested biochemically and molecularly targeting hemolysin gene.

Colony character of _V. mimicus_ on TCBS agar

Incidence of *Photobacterium damselae* in fish and aquatic environment

Total 106 seafood samples were screened for *Photobacterium damselae*. Analysis of 77 suspected isolates revealed that the isolates that were showing similar biochemical characteristics of *P. damselae* when subjected to PCR turned out to be negative for the organism.

Screening for *Vibrio vulnificus*

A total of 83 samples were screened for *Vibrio vulnificus*. Out of 126 presumptive isolate studied with biochemical testing no isolate was found positive for *V. vulnificus*.

Occurrence of *Campylobacter* spp. in seafood and its environment

A total of 105 samples were screened for *Campylobacter* spp. Eighty isolates were tested for the presence of 16S rRNA Campylobacter gene and *Campylobacter* spp. was not detected in the samples tested.

Haemolytic activity of pathogenic bacteria on various blood agar

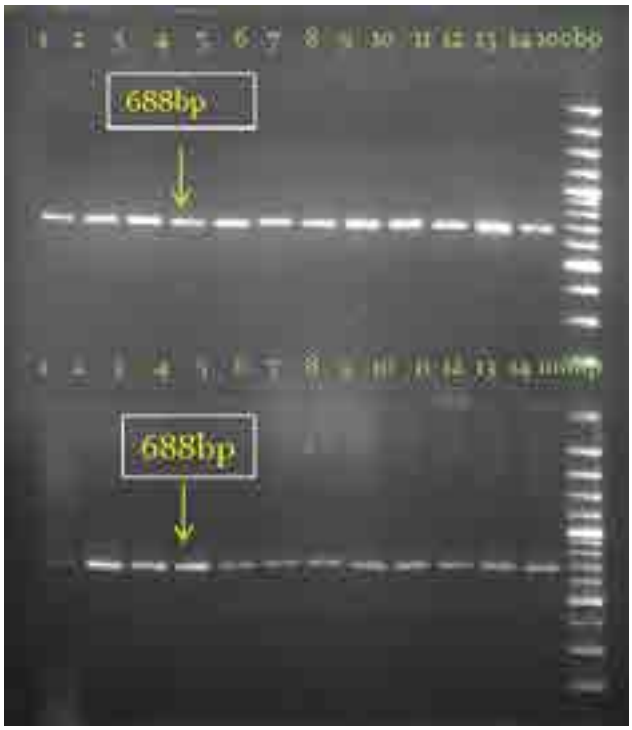
Haemolytic activity of fish pathogens (*Edwardsiella tarda*, *Aeromonas hydrophila*, *Enterobacter cloacae* and *Pseudomonas aeruginosa*) and human pathogens (*Escherichia coli*, *Staphylococcus aureus*, *Vibrio cholerae* and *Salmonella* Paratyphii) on sheep, human and fish blood were studied. ß-haemolytic activity was observed for all pathogens on human, sheep and fish blood agar plates but *E. cloacae* did not showed hemolytic activity on fish blood. The antimicrobial property of fish blood was observed for fish pathogens (*Pseudomonas aeruginosa*, *Edwardsiella tarda* and *Aeromonas hydrophila*).

Blood agar plates from Haemolymph of *Litopenaeus vannamei* and *Scylla serrate* showed haemolysis by aquatic as well as public health pathogens *viz.*, *Edwardsiella tarda*, *Aeromonas hydrophila*, *Enterobacter cloacae*, *Pseudomonas aeruginosa*, *Escherichia coli*, *Staphylococcus aureus*, *Vibrio cholerae* and *Salmonella* Paratyphii.

Four haemolytic *V. parahaemolyticus* bacterial strains were isolated from the haemolymph of shrimp *Litopenaeus vannamei* and confirmed the presence of *ToxR* gene by PCR detection. Though the four isolates were found to be haemolytic on human blood, neither of the strains were positive for *TDH* and *TRH* genes, suggesting some unknown factors responsible for the haemolysis.

Screening for Extended Spectrum Beta Lactamases

A total of 34 samples from the landing centres and retail fish market in and around Kochi were collected and screened for Extended Spectrum Beta Lactamases (ESBL) producing *E. coli*. Twenty seven samples were found positive for ESBL production (79.41%) and the typical ESBL colonies were screened for antibiotic sensitivity test to five antimicrobial agents of Third Generation Cephalosporins for further confirmation. More than 50% of the samples were positive on multiplex PCR for *blaCTXM* Group1 with 688 bp and only four samples were positive for TEM-type beta-lactamases.



PCR amplification of *blaCTXM* Group genes for ESBL *E. coli*

Assessing environmental aspects of fish, fishery products and effects of chemical hazards

Epidemiology of bacterial pathogens in fish and fishery products

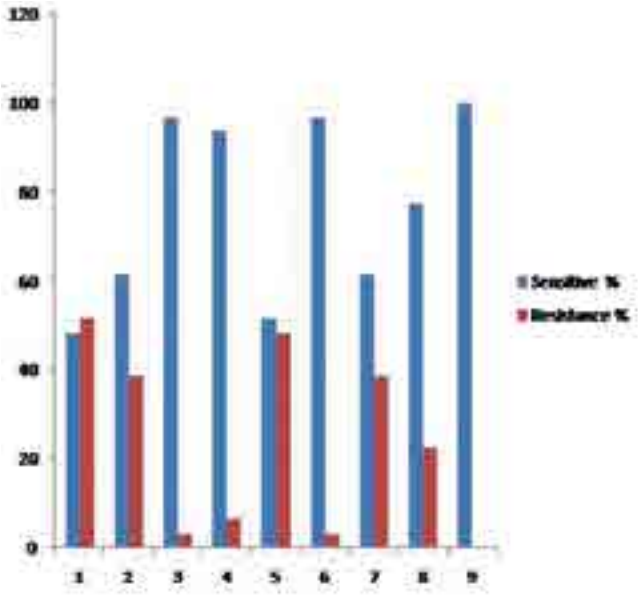
A total of 45 fish samples from the market, fish processing industries, dry fishes and fish handlers (22) from Veraval, Gujarat were screened for the epidemiological survey of bacterial pathogens. The samples contained mainly Coagulase Positive (CPS) (156) and Coagulase Negative Staphylococci (CoNS) (95) and *E. coli* (130). The CoNS isolates identified at species level by Oxoid Identification System (12S) with Microbact 2009 were mainly dominated by *S. warneri*, *S. haemolyticus*, *S. xylosus*, *S. simulans*, *S. auricularis* and *S. epidermidis*.

Screening for nasal carriers of Staphylococci in fishery workers

Nasal swab was collected from three dry fish factory workers (n=62), of which 129 numbers of Staphylococci 62 and 52 were Coagulase Positive (CPS) and Coagulase Negative Staphylococci (CoNS), respectively from these nasal swabs. 9.68% and 18.52% of CPS and CoNS MRS were found in the nasal swab from the dry fish workers.

Minimum Inhibitory Concentration on coagulase negative Staphylococci (CoNS) from seafood

Thirty one multi-drug resistant (MDR) CoNS were assessed for MIC level of resistance to nine important commercially available antimicrobial agents. All the isolates (100%) were sensitive to vancomycin (≤4 mcg/ml). These findings clearly indicate the presence of higher number MDR CoNS isolates.



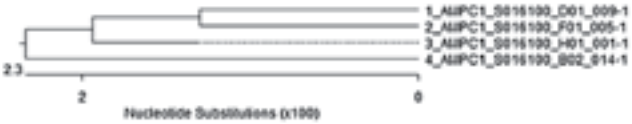
Resistance in MIC for CoNS strains

Incidence of multi-drug resistant seafood-borne bacterial pathogens

A total of 20% of the CoNS were found positive for Methicillin Resistant Staphylococci and 26% of them were MDR to antibiotics. 12% of the CPS was found to be MDR and MRSA. 18% of the *E. coli* isolates were MDR and 5% of them were Extended Spectrum Beta Lactamases producers (ESBL).

Antibiotic resistance pattern of ESBL producing *E. coli* isolates

ESBL producing *E. coli* isolates (n=5) were tested for their antibiotic resistance using 24 number of antimicrobial disks. All the isolates showed resistance to ceftriaxone and cefoperazone. Four isolates showed resistance to cefuroxime and amoxyclav and three isolates showed resistance to ceftizoxime and ampicillin. The phylogenetic analysis based on these *CTX-M* and *ampC* genes revealed the possibility of contamination from different sources since it is falling on two distinct clade.



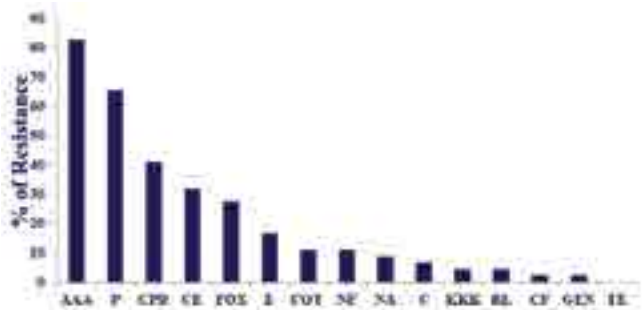
Phylogenetic analysis of *blaCTXM* gene of ESBL *E. coli*

Whole genome sequence analysis

A draft genome sequence of two methicillin resistant Staphylococci (MRSA) isolate (ST 1 and ST 39) from salted dry fish from Gujarat was completed. The two isolates have significant differences in the protein coding genes.

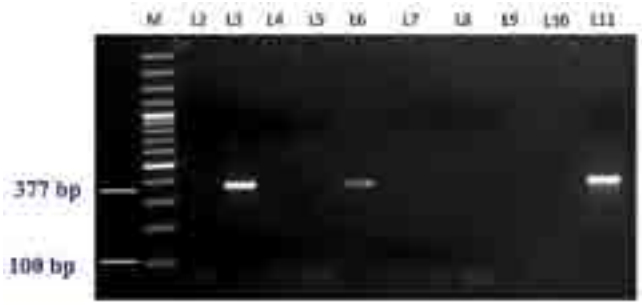
Antibiotic resistance pattern in aquaculture farms of Kerala

A study was undertaken to compare antibiotic resistance in heterotrophic bacteria isolated from farm fed with residual (SRF) and professional (SPF) fed finfish. One hundred and two bacterial isolates belonging to



AAA: ampicillin; P: pencillin G; CPD: cedpodoxime; CE: cefoxtin; Fox 30: cefotaxine; E: erythromycin; COT: sulphamethaxazole-trimethoprim; NF: nitrofurantoin; NA: nalidixic acid; C: chloramphenicol; KKK: kanamycin; RL: sulfamethaxazole; CF: ciprofloxacin; GEN: gentamycin; TE: tetracycline

Antibiotic resistance pattern of heterotrophic aquatic bacteria



A 377 bp amplified product of *blaZ* gene detected in *Planococcus* spp. (L_3) and *Staphylococcus* spp. isolate (L_6) using $blaZ_1$, $blaZ_2$ primers M: 100 bp marker; $L_{2,4,5,7,8,9}$: negative to *blaZ* gene; L_{10}: negative control; L_{11}: positive control

PCR amplification of *blaZ* gene

10 genera were isolated from sediment and water samples of aquaculture farms. The bacteria identified were *Planococcus* sp., *Acinetobacter* sp., *Vibrio* spp., *Micrococcus* spp., *Arthrobacter* spp., *Bacillus* sp., *Lactobacillus* spp., *Staphylococcus* spp. and Enterobacteriacae. The results showed highest resistance towards ampicillin (82.1%) followed by pencillin (65.20%) in SPF, while the lowest resistance was observed for gentamicin (0%). All the isolates from SRF showed resistance to tetracyclines. The multiple antibiotic resistant (MAR) index of the isolates tested ranged between 0.0769 to 0.615. Isolates showing resistance to Beta-lactams were amplified using PCR targeting *blaZ* gene and 377 bp was observed on 2% agarose gel.

Cadmium and lead content in cuttlefish, squid and octopus

Samples of squid, cuttlefish and octopus collected from Okha and Veraval landing centers were analyzed for lead and cadmium. Lead was found below the detectable level in Veraval and Okha samples, whereas cadmium was detected in all the samples except in squid collected from Okha, but the concentration was within the permissible limit of 1.00 ppm for Cephalopods.

Effect of different sodium salts on squid rings shelf life under refrigerated storage

Loligo duvauceli rings were treated with sodium salts *viz.*, sodium citrate, sodium acetate and sodium chloride and packed in EVOH pouches and held at refrigerated storage (6±1 °C). Higher antimicrobial activity was showed in sodium acetate treated samples followed by sodium citrate and sodium salts. However, the tenderness and cooking yield was more in sodium citrate compared to other sodium salts. The shelf life of squid rings increased 3-4 days compared to the untreated sample.

Effect of corn starch-based biocomposite edible coating containing fumaric acid on microbial shelf life of silver pomfret

Silver pomfret (*Pampus argenteus*) was coated with corn starch containing fumaric acid prior to storage at 4 °C. The pH value of the fresh fish sample was 5.09. During storage, values of pH and formation of volatile bases in the fumaric acid-treated samples were lower than that of the control and samples coated with corn starch alone. The TBA concentration was 0.24 mg MDA/kg in the beginning, which crossed the value of 1 mg MDA/kg on 6th and 9th day in control and corn starch-coated fish samples, respectively. The initial total viable count was 3.5 log cfu/g, indicating the sustainable quality of the fish sample. Total viable count and psychrotrophic bacterial count of control sample exceeded the permissible limit on 6th day. Treating fish with fumaric acid helped to reduce total viable count, psychrotrophic count and *Pseudomonas* count of the samples. Dip treatment by antibacterial fumaric acid caused a 2 log reduction in the total psychrotrophic bacteria count and extended the shelf life of silver pomfret by three days during chilled storage. Based on the organoleptic properties and total viable bacterial count, control sample was rejected on 6th day, CS on 9th day and FA and CSFA on 12th day. The results of the study suggest that fumaric acid is an effective agent to increase the microbial safety and shelf life of fish.

Microbial quality and safety of dried mahi-mahi coated with sodium alginate containing gallic acid

Mahi-mahi (*Coryphaena hippurus*) procured from Veraval fish market had a moisture content of 75.15±0.5%, crude protein content of 19.64±0.32%, lipid content of 2.12±0.10% and ash content of 1.48±0.01%. The fish were then dry salted at 4% (w/w) and kept overnight at room temperature, washed and divided into three groups. The first group of salted fishes without coating was kept as control (C) and the second group was coated with 5% sodium alginate, before drying (SA). The third group of salted fish was soaked in 5% sodium alginate solution containing 2% gallic acid for 10 min., before drying in the dryer (SAG). The moisture content reduced to 30±2% in control (C) sample after drying the fish for 8 h in three days in ICAR-CIFT solar dryer. All the three batches were stored at room temperature for four weeks. The microbiological (Total mesophilic bacteria count, Total Coliforms, yeast and mold) bio-chemical (pH, TVB-N and TBA) and sensory qualities of the fish were evaluated immediately after drying (0th day) and after 1st, 2nd, 3rd and 4th week of storage. TVB-N values of C, SA and SAG dried fish samples were 40.4±2.2, 38.6±3.1 and 35.4±2.7 mg%, respectively, while TBA values were 3.2±0.06, 2.9±0.04 and 2.4±0.05 mg malonaldehyde/

Dried mahi-mahi un-coated (C) and pre-coated with sodium alginate (SA) without/with gallic acid (SAG)

kg of sample. Yeast and mold were not detected in any of the dried samples. During storage, formation of volatile bases and lipid oxidation was significantly higher in uncoated sample, compared to the coated fishes. After four weeks of storage, there was a 1.5 log reduction in the total mesophilic count of dried fish sample coated with sodium alginate and gallic acid, compared to control. The results indicate that gallic acid treatment has the potential to improve the microbial quality of dried fish.

Antimicrobial effect of sodium salts on refrigerated Cephalopods

The antimicrobial effect of three different sodium salts namely sodium citrate, sodium acetate and sodium chloride on squid (*Loligo duvauceli*) rings were studied. The samples treated with sodium acetate showed higher antimicrobial activity followed by sodium citrate and sodium chloride in refrigerated storage condition. However, the tenderness and cooking yield was more in sodium citrate compared to other sodium salts.

Biochemistry and Nutrition

Research projects handled

Institute projects

- Marine biomolecules – Characterization and utilization for neutraceutical, biomedical and industrial applications
- Seaweeds of Indian coast as source of bioactive compounds for developing nutraceuticals/ functional foods

Externally funded projects

- Nutrient profiling and evaluation of fish as a dietary component
- Biomodulation of marine biopolymers for the preparation of biomaterials of healthcare importance

Most significant achievements

- Thaimine and pyridoxine-loaded vannilic acid-grafted chitosan was developed.
- Squalene powder developed had oxidative stability of four months.
- Pectin-based multiple emulsion was developed as a potential delivery system for squalene and anthocyanin.
- Fish oil rich in squalene supplementation effects the mRNA and protein expression of enzymes of lipid metabolism.
- Omega-3 and Omega-6 fatty acids extracted from sardine using super critical fluid extraction gave better yield and quality of fatty acids when compared to conventional extraction methods.
- Fucoxanthin and lipid from brown seaweed (*Sargassum* sp.) was extracted by super critical fluid extraction method.
- Chitosan nano particles were prepared by ionic gelation method for the entrapment of anthocyanin as an effective strategy to enhance their *in vivo* bio-availability and *in vitro* stability. Oral supplementation of anthocyanin-loaded nano particles were found to have hypolipidemic effect in high fat-alcohol fed experimental rats and also protected gastric mucosa against HCl-ethanol induced damage.
- A marine biopolymer, carrageenan was extracted from the red seaweed *Kappaphycus alvarezii*, by hot alkaline water treatment and characterized by FTIR Spectroscopy.
- Characterized and evaluated seaweed waste as a suitable feed ingredient in fish feed industry.
- Bioactive collagen peptides were prepared through enzymatic digestion of acid soluble fraction of skin collagen from hammerhead shark (*Sphyrnae mokkaran*) followed by subsequent column chromatographic fractionation with 94% radical scavenging activity.
- A pain relieving balm with squalene as an active component was developed. *Cissus quadrangularis* extract was added as an additional component which has healing property in bone ailments.
- A skin moisturizing lotion was developed with collagen, chitosan and alginate as main ingredients.

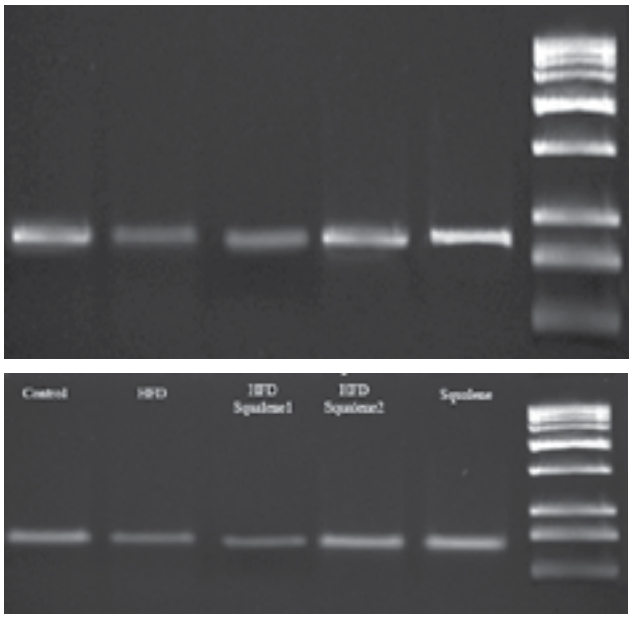
Chief findings

Institute projects

Marine biomolecules - Characterization and utilization for neutraceutical, biomedical and industrial applications

Extraction, characterization and elucidation of mechanisms of action of marine biomolecules: Elucidation of squalene action mechanism

Squalene consumption has been associated with several health benefits like hypolipidemic effect. Experiments were designed to delineate the mechanisms of the hypolipidemic effect through two approaches such as mRNA expression, and proteomics. RNA expression studies namely Acetyl Co A Carboxylase (ACC) A and B, Fatty Acid Synthase (FAS) and Steroyl Co A Desaturase-1 (SCD-1) were carried out for determining the level of expression of four genes in liver of Wistar strain rats in response to feeding of five different diets namely groundnut oil (control), high fat diet (40%), high fat diet and squalene at 10% and 20% and squalene alone. The findings demonstrated that the levels of mRNA for ACC and FAS increased and that of SCD-1 and HMG CoA reductase decreased in groups of rats fed with high fat diet supplemented with squalene which indicates its health benefits.



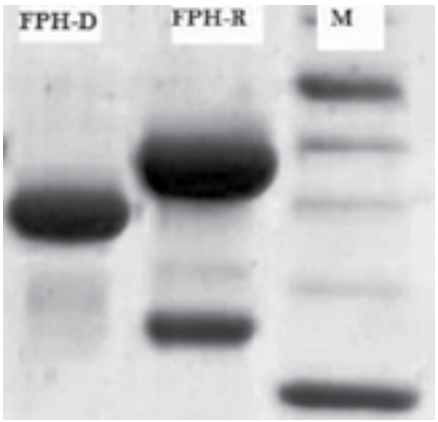
ACC and HMG CoA Reductase mRNA expression in liver of control and experimental rats

Fish protein isolation from *L. rohita* by iso-electric solubilization and precipitation

Iso-electric solubilization and precipitation method was used for extraction of protein from rohu (*Labeo rohita*). The protein isolate could be considered as Type 1 protein concentrate for dietary supplement. The protein isolate was white and showed good emulsifying property. Solubility was determined in different pH values. This process has huge potential in functional protein isolate development from fisheries waste or low value fish. The results of the study are as follows: Extraction yield – 15%, Protein – 83%, Fat – 0.48%, L* value – 64.59, Amino acid profile – Essential/non-essential amino acids, Emulsion stability – 39.7%, and Solubility – 1.25 to 15 mg/mL.

Development of protein hydrolysate from fish processing discards and fish roe

Fish protein hydrolysates were prepared from saebass fish byproducts, processing discards (FPH-D) and fish roe (FPH-R). Protein in FPH samples of discards was 39.64%±.026 and in roe the value was 72.4%±0.01. The maximum degree of hydrolysis (DH) after 6 h was about 30% in discards and 28% in roe. Electrophoresis revealed that the peptide fragments obtained for FPH-R were of lower molecular weight. Amino acid analysis of the hydrolysates showed the presence of essential amino acids in significant levels. Significant antioxidant activity as determined by DPPH, ABTS and metal scavenging assays was revealed in the hydrolysates with higher activity for FPH-R. Functional properties of the FPHs compared with those of egg albumin and soy protein concentrate showed that protein solubility and fat absorption properties of FPH are better.



FPH-D: FPH from seabass discards; FPH-R: FPH from seabass roe; M: Marker

Electrophoretic pattern of fish protein hydrolysates

Yield of Omega-3 and Omega-6 fatty acids obtained from supercritical fluid extraction and conventional method

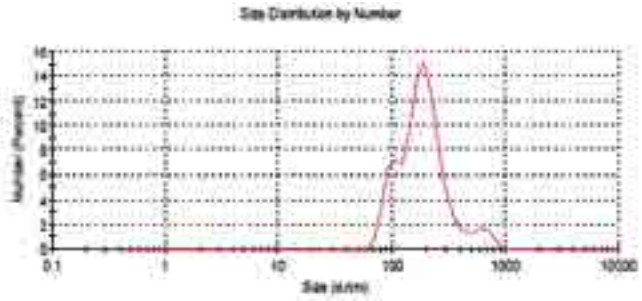
Omega-3 and Omega-6 fatty acids were extracted from lyophilized Indian oil sardine using supercritical fluid extraction (SFE). Extraction

condition for best total oil yield was 50 °C, 350 bar and 180 minutes. Best results on yield of Omega-3 and Omega-6 fatty acids was obtained at extraction condition of 40 °C, 100 bar and 112.5 minutes. Maximum yield of omega-3 fatty acids (16.85%) was obtained using SFE as against 9% using the conventional method.

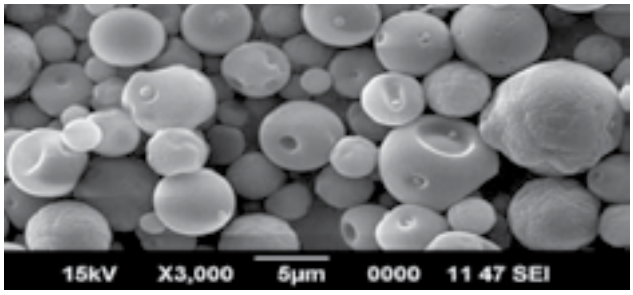
Super critical fluid extraction unit

Microencapsulation of squalene using chitosan-whey protein isolate complex and its evaluation

Based on emulsion characterization, a combination of 10% whey protein isolate and chitosan at pH 5.5 was used to microencapsulate squalene. Yield and encapsulation efficiency obtained were maximum at an inlet temperature of 170 °C and feed rpm of 16 which were used for the bulk production and spray drying. Initial peroxide value was 1.33 meq/O_2/Kg of oil and after 4th week, it increased to 3.43 meq/O_2/Kg of oil. A functional food-'cake' was prepared by incorporating encaspulated squalene. Nutrient profiling and sensory, texture and colour evaluation were similar to a product prepared using free squalene. Oxidative stability was better in the functional food with microencapsulated squalene (peroxide value: 2.5 meq O_2/kg oil) compared to the product prepared using free squalene (peroxide value: 4.6 meq O_2/kg oil).



Particle size of squalene-loaded microcapsule



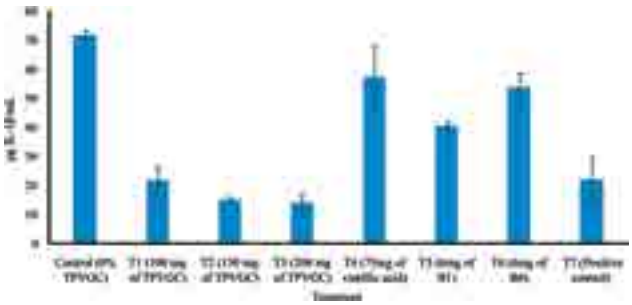
SEM microstructures of the encapsulated squalene micro particles

Anthocyanin-rich squalene-based multiple emulsion for functional food applications

Two plant materials, dried black currants (*Vitis vinifera*) and dried cranberries (*Vaccinium macrocarpon*) were used for extraction of anthocyanin-rich fractions. Black currants extracted with acidified alcohol showed maximum antioxidant capacity. For the preparation of a stable anthocyanin containing water-in-oil-in water (W1/O/W2), emulsion treatments were prepared using multiple emulsification process. The three treatments were prepared by varying the inner aqueous phase (W1) and keeping the outer two layers constant.

Influence of thiamine and pyridoxine-loaded vanillic acid grafted chitosan microspheres on pro- and anti-inflammatory activity in experimental rat model

A study was conducted to evaluate the anti-inflammatory effect of thiamine and pyridoxine-loaded vanillic acid grafted chitosan microparticles (TPVGC) in male Wistar strain albino rats. Expression of pro-inflammatory interleukin was higher in the control group compared to the treatment and standard group. Similarly, expression of anti-inflammatory indictor was higher in the treatment group fed with graded level of TPVGC. Metabolic responses assessed showed significant ($p<0.05$) difference between the control and treatment group, the control fed without TPVGC recorded higher activity when compared to the treatment group fed with graded level of TPVGC which indicates that dietary supplementation of thiamine and pyridoxine-loaded vanillic acid-grafted chitosan has good anti-inflammatory effect.



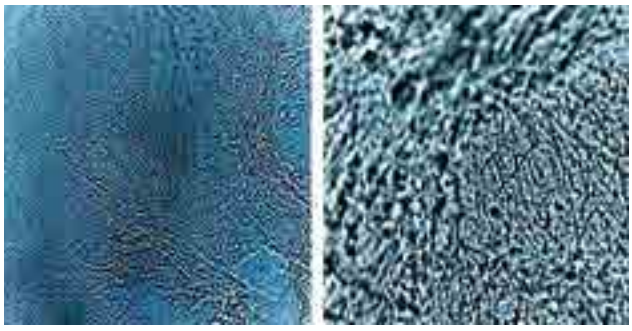
Effect of dietary supplementation of TPVGC on Interleukin 1β (IL-1β) as pro-inflammatory indictor in the serum of experimental rat model

Collagen-based composite scaffolds

Fish collagen-based composite scaffolds using a combination of fish collagen and collagen-alginate-chitosan (CAC) alone were developed. A combination of collagen and alginate was found to crosslink with each other forming a gel. The physico-chemical characterization of the scaffold and bio-compatibility evaluation are in progress.

Preliminary assessment of the elastic nature of collagen-based scaffold by stretching shows its potential to be used for applications such as vascular tissue regeneration. Microscopic analysis of the microstructure of the developed scaffold shows fibrillar nature which is similar to the native extracellular matrix.

Collagen-based composite scaffolds using a combination of fish collagen (a & b) and collagen-alginate-chitosan (c & d)



Microscopic images of collagen-based scaffolds showing fibrous nature

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

Supercritical fluid extraction of two seaweeds

The efficiency of various solvents, *viz*, supercritical carbon dioxide and conventional solvents such as water, absolute ethanol, 60% ethanol and 40% ethanol, in extracting bioactive compounds from two brown seaweeds (*Sargassum wightii* and *Turbinaria conoides*) was compared. The conditions followed for supercritical carbon dioxide extraction were 25 Mbar pressure, 28 g/min. CO_2 flow, 6% ethanol at temperature of 60 °C for 1 h duration and for conventional method, the sample to solvent ratio was maintained at 1:10 and extraction was performed for 72 h. The bioactivities of the seaweed extracts were compared in terms of protein content, total phenolics, total flavonoid, total antioxidant activity, DPPH and FRAP assay. Among the various solvents used, supercritical carbon dioxide was found to be more effective in obtaining seaweed extracts with highest total phenolic, flavonoid, antioxidant and radical scavenging activity.

Characterization and evaluation of seaweed waste as a suitable feed ingredient in fish feed industry

Sargassum biomass obtained after super critical extraction was used for the study. Seaweed waste (33%) was incorporated to formulate fish feed with 34 to 37% crude protein. Stability of fish feed prepared by incorporation of seaweed waste was assessed.

Testing the stability of pelleted feed prepared using single screw pelletizer

Evaluation of functional properties of protein extract of *Sargassum wightii* and *Turbinaria conoides*

Water Holding Capacity (WHC) and oil holding capacity (OHC) were determined for proteins extracted from *T. conoides*, *S. wightii* and *N. japonicus*. In case of *T. conoides*, WHC was 33.53 ± 1.3g water/g and OHC was 7.64± 0.11g oil/g. WHC and OHC of *S. wightii* were 34.28 ± 0.63g water/g and 11.46 ±0.83 g oil/g, respectively. WHC for *N. japonicas* was 28.57 ± 0.33 g water/g and OHC was

14.24±0.38 g oil/g. WHC and OHC of the protein extract generated from *T. conoides* and *S. wightii* along with its foaming and emulsifying properties suggest that it could be suitable for use in the formulation of a wide variety of food products such as sausages, breads, and cakes as well as soups and salad dressings. Moreover all the functional properties of the seaweed extracts are comparable with those of fish protein.

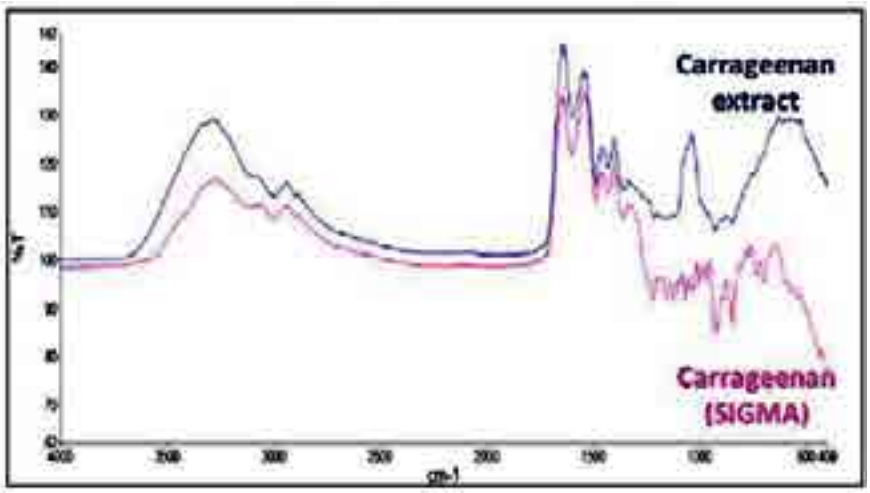
Organochlorine pesticide residues in seaweeds from Mandapam coast

S. wighti, *T. connoides*, *P. gymnocephalus*, *L. variegata*, *S. marginatum* and *U. lactuca* were analyzed for α-BHC, ß-BHC, γ- BHC, heptachlor, aldrin, heptachlor epoxide, p,p′-DDE dieldrin, o, p′DDD, endrin, pp′DDD, o, p′ DDT and p, p′ DDT. Most of the pesticides were not detected and a few that were detected were within permissible limits prescribed by FAO.

Carrageenan from *Kappaphycus alvarezii*

Marine biopolymer, carrageenan was extracted from the red seaweed, by hot alkaline water treatment and characterized by FTIR Spectroscopy. The peak observed at 3,385 cm^{-1} is characteristic of the O-H stretching, absorption at 2,912 cm^{-1} is due to the inter-layer C-H stretching, absorption at 1,636 cm^{-1} for polymer bound water, absorption at 1,446 cm^{-1} for sulfate stretch, absorption at 1,238 cm^{-1} for ester sulfate group C = O, absorption at 1,048 cm^{-1} for glycosidic linkage, absorption at 924 cm^{-1} for 3,6-anhydro-D-galactose, and absorption at 847 cm^{-1} for C- O-S axial secondary sulfate on C-4 of galactose.

Carrageenan from *K. alvarezii*



FTIR image of carrageenan extracted from *K. alvarezii* and standard carrageenan

Dried Ulva powder as an ingredient in pasta

Pasta was prepared with dried Ulva (Green seaweed) powder as an ingredient at different levels (5-30%). Moisture content of pasta varied from 5.6 to 10% (Dry weight basis). Crude fiber content was higher in pasta with 30% Ulva powder. Sensory evaluation indicates that pasta with 5% and 10% dried Ulva powder had better sensory acceptability score.

Seaweed-incorporated biscuits

Sea grapes (*Caulerpa racemosa*) a nutritive seaweed-supplemented semi-sweet biscuits were prepared to enhance the health promoting attributes.To improve the textural attributes of seaweed biscuits, the flour was treated with sodium metabisulphite (SMB) and its effects on biscuit properties were observed. SMB treatment increased the sulfhydryl group concentration. Addition of seaweed in the flour increased the water and oil absorption capacity.

Antibacterial and antifungal ointment with seaweed-silver nano particles

Silver nano particles (Ag-NPs) were synthesized by $AgNO_3$ thermal shock reduction process in the presence of carrageenan. The zeta potential of AgNps indicated moderate to good stability.

Extraction of Ulvan polysaccharide from *Ulva lactuca* and formation and characterization

Ulvan polysaccharide was extracted from *U. lactuca* and yield, chemical composition, rheological and textural properties were determined. Yield of Ulvan was 17.6%. Protein-1.93%, ash and mineral-16.01%, sulphate-14.73%, and uronic acid-22.41% were observed. Minerals estimated were Calcium - 7.01 and Magnesium - 1.90, Sodium - 35.46, Zinc - 5.61 and Copper - 0.61 mg/100g. Cadmium and lead were not detected.

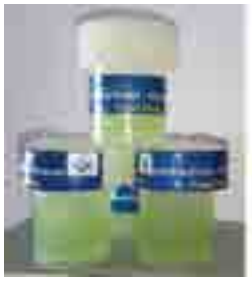
Ulvan hydrocolloids demonstrated a pseudo-plastic behaviour. Analysis of the gel forming green seaweed sulfated polysaccharide Ulvan revealed a spherical morphology (10-18 nm diameter) and more or less aggregated in aqueous solution. At pH 13 NaOH, Ulvan formed an open gel-like structure or a continuous film by fusion or coalescence of bead-like structures, while in acidic pH conditions, Ulvan appeared as dispersed beads. Low concentrations of sodium chloride, copper or boric acid induced the formation of aggregates. These results highlight the hydrophobic and aggregative behavior of Ulvan that are discussed in regard to the peculiar gel formation and the low intrinsic viscosity of the polysaccharide in aqueous solution.

Fatty acid profile of seaweeds collected from Okha

Five seaweeds were analyzed for its fatty acid composition. Seaweeds considered for analysis were *Valoniopsis* spp., *Caulerapa sertularioides, Boodlea composita*, *Padina tetrastromatica* and *Cystoseira indica*.

Synthesis of silver nano particles using seaweed extract for making antibacterial ointment

The silver nano particles Ag-Nps were synthesized by reducing the $AgNO_3$ using thermal shock in presence of carrageenan. The size and zeta potential of AgNps were evaluated and was found to be of moderate to good stability. Then 100 ul of solution containing known amount of AgNP was incorporated in 10 g W/O type ointment base and assessed for its antibacterial and antifungal activity.



AgNps-based ointment

Antibacterial and anti fungal activity of the ointment

Preparation of suture using seaweed extracts

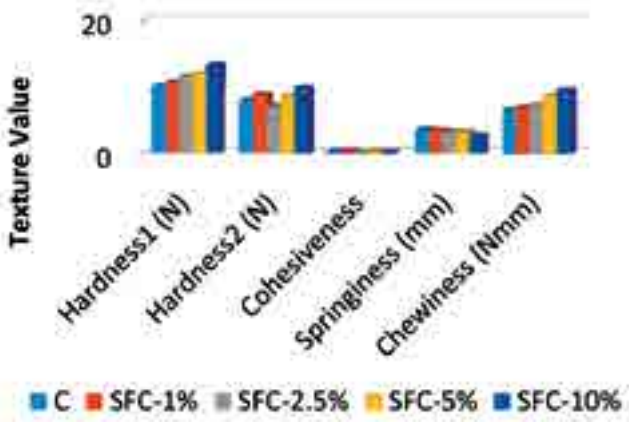
Absorbable suture was prepared using seaweed extract and its thermal properties were studied. Red seaweed extract was used as base material and glycerol was used as polymerizing agent. The thermal property was evaluated using TGA analysis, which shows optimal stability for the suture. Tensile strength was found to be moderate to good. Thermal analysis shows three major events of weight loss corresponding to evaporation of moisture, degradation of polysaccharide matrix and cross-linking agent.

Seaweed extract-based biodegradable suture

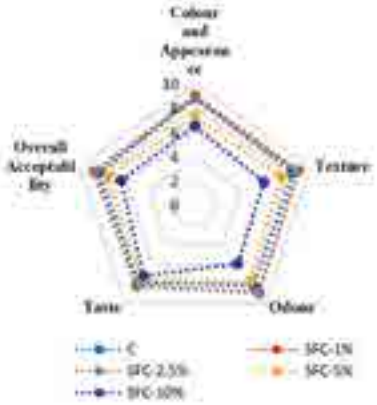
Effect of green seaweed powder on functional properties of fish cutlets

Dried green seaweed (*Ulva reticulata*) powder was incorporated in fish cutlets to investigate the water and oil holding capacity of fish products and also to improve the textural properties of fish products. Dried seaweed powder was added at 1, 2.5, 5 and 10% in fish cutlets. Samples were coded as C-control; SFC-1%, SFC-2.5%, SFC-5% and SFC-10% and cutlet prepared with 1%, 2.5%, 5% and 10% of dried Ulva seaweed powder, respectively. Moisture content of the cutlets increased with increasing concentration of dried seaweed

powder and highest moisture content was found in SFC-10% (60.54%). On the other hand, fat content was decreased with increased concentration of dried seaweed added cutlets. There was a significant decrease in fat content from 14.67% in control to 10.77% in SFC-10%. Results indicated that addition of seaweed powder increased the hardness and chewiness of the fish cutlets and reduced the springiness and cohesiveness. Up to 5% seaweed can be added without adversely affecting the sensory acceptability.



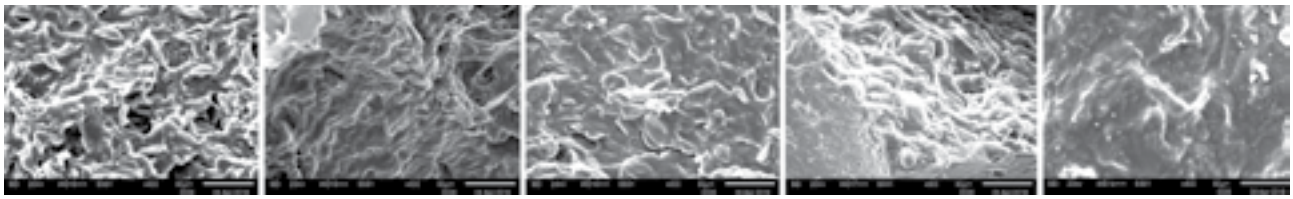
Textural properties of seawed-incorporated fish cutlets



Sensory evaluation of seawed-incorporated fish cutlets

Chemical, functional and structural evaluation of seaweed pasta

Pasta was prepared with dried *Ulva* powder as an ingredient at different concentration such as 2.5, 5, 10 and 15% and samples were coded as SWP-1, SWP-2, SWP-3 and SWP-4, respectively. Control was prepared from Samolina and egg white and coded as CP. Protein content of pasta varied from 10.05-13.84% and addition of dried Ulva powder increased the crude fibre content of pasta. Crude fibre content was higher in noodles with 15% Ulva powder (2.39%). Cooking time for pasta varied from 6.30 to 8 min. and cooked weight increased with increased seaweed concentration. However, cooking loss was highest in case of 10% and 15% seaweed-incorporated pasta as compared to other samples and control. Addition of 5% dried Ulva powder improved textural properties of pasta. Sensory evaluation indicates that pasta with 2.5% and 5% had better sensory acceptability. Pasta with 10% and 15% dried Ulva powder had mild seaweed flavour as assessed by panelist. Addition of seaweed in pasta disrupted the microstructural arrangement and porosity of network, producing a diffused and tightly packed matrix as compared to control samples.



Microstructure of control and seaweed-incorporated pasta at 500x, (A) CP, (B) SWP-1, (C) SWP-2, (D) SWP-3 and (E) SWP-4

Engineering

Research projects handled

Institute projects

- Quality improvement of Indian fishing fleet and engineering interventions in post harvest sector
- Design and development of tools and technologies for energy and water use optimization in fish processing industries

Externally funded project

- Feasibility study on coastal reservoir concept to impound Netravati river flood waters: A sustainable strategy for water resource development for Mangaluru and Bengaluru

Most significant achievements

- Modern, hygienic and refrigeration-enabled mobile fish vending kiosk was designed, developed and commercialized.
- Performance evaluation of the newly designed multi-purpose (fish drying, water heating and electricity) solar thermal conversion system with biomass heater backup was carried out.
- Redesigned the existing ICAR-CIFT solar-LPG hybrid dryer with notable innovations.
- Energy and cost efficient infrared dryer for fish was designed and developed.
- Performance evaluation of ICAR-CIFT hand-operated fish descaling machine was conducted to optimize operating conditions for various fishes.
- Developed Peltier-based 12 V battery-operated specimen collection and transport cooling device of 5 L capacity.

Chief findings

Institute projects

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

Quality Improvement of Indian fishing fleet: Standardization of boat building practices

An exhaustive study of steel boat construction industry of Kerala was conducted to analyze the prevailing practices of boat construction and its impact on the safety and performance in order to bring out guidelines and recommend good practices to boat builders. The data was collected from five builders from Kollam, ten builders from Kochi, and five from Kozikode coast. The study established specific design variations with respect to region and operator preferences which are highly influenced by operational ergonomics evolved and practiced over a time. On structural requirement, the scantling design was recommended. With respect to stability analysis, dimensional proportion should be critically considered for design. The study also reveals that material selection for boat construction is also an important aspect in boat building practices. Marine engines testing, validation and certification are being carried out by Engineering Division, ICAR-CIFT. Engine models of WD10C278-21 and WP6C185-21 from M/s Shandong Heavy Industry Pvt. Ltd., Maharashtra was tested and certified during the reporting period.

Design of a new bulk drying system for fishing industry

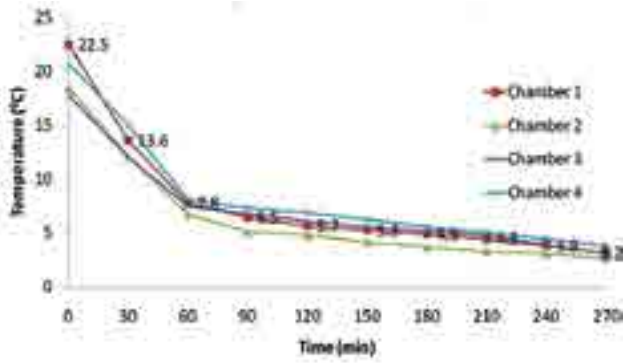
A new walk-in type bulk drying system design for fish drying was prepared to store the unutilized energy during day time in an innovative solid state thermal reservoir battery system combined with natural dehumidification and ventilation system. The design also features a streamlined induced air flow system. This design will use no power and only the internal air flow and external wind is used along with the incident solar radiation. The design is prepared for an area of 3000 sq.ft and will provide 4800 sq.ft of drying surface and will operate continuously even during off sunshine hours.

Engineering interventions in post harvest sector: Design development, performance evaluation and commercialization of mobile fish vending kiosk

Refrigeration-enabled mobile fish vending kiosk was designed and developed to improve unhygienic handling and selling practices prevailing in fish markets. Major components of the kiosk are chilled storage cum display facility, hand-operated descaling machine, fish dressing deck with wash basin, water tank, waste collection chamber and a working space. As part of commercialization of the technology, one unit of kiosk was launched by ICAR-CIFT at M/s Sha Cold Storage and Fish Centre at Pavankulangara Jn., Puthiyakavu, Tripunithra and another one at M/s Santhom Mart and Food Court, Mundamveli, Kochi (Details in Page No. 157).

Experiments were conducted in the kiosk under no-load and loaded-with fish conditions to know the temperature distribution in fish storage chambers. Average temperatures of 2-3 °C within 3.5 hours and 3-5 °C within 4.5 hours were recorded under no-load and loaded conditions, respectively.

Mobile fish vending kiosk



Temperature distribution in mobile fish vending kiosk under loading with threadfin bream

Design, development and performance evaluation of infrared fish dryer

An infrared dryer was designed and developed for efficient drying of high value fish and fishery products. The dryer was operated at no-load conditions to assess the temperature distribution pattern. Performance evaluation of the dryer was conducted using threadfin bream, sardine and shrimps. Drying time and energy requirement were significantly lesser than the conventional electrical dryers.

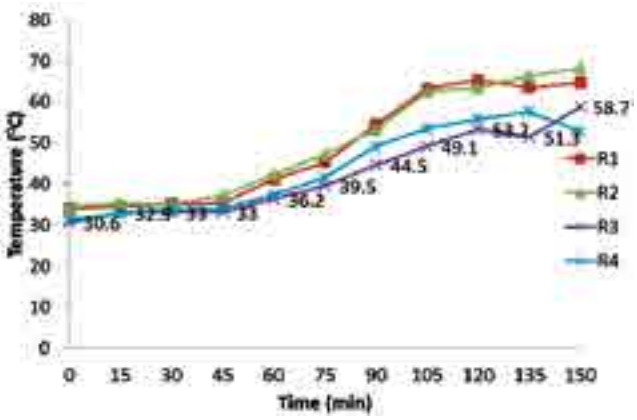
Infrared drying of shrimp

Performance evaluation of portable household electrical fish dryer

Performance evaluation of portable, multi-purpose electrical dryer was done with shrimp, sardine, glassy perchlet and anchovy. Drying characteristic data were analyzed and drying rate curves were plotted.

Performance evaluation of multi-purpose solar thermal conversion system

A systematic arrangement was developed to completely utilize solar energy by converting into thermal and electrical energy to use it for multiple purposes like drying of fish, domestic water heating and solar street lighting. The system consists of an evacuated tube solar water collector, drying chamber, heat exchanger, hot water storage tank, biomass furnace heater cum storage tank, battery, blower, solar photovoltaic panel and insulated hot water tubes. Performance evaluation study revealed that drying chamber temperature of 50-55 °C was achieved when a temperature of 80±5 °C was maintained in the storage tank.



Changes in drying chamber temperature of multi-purpose system with respect to time

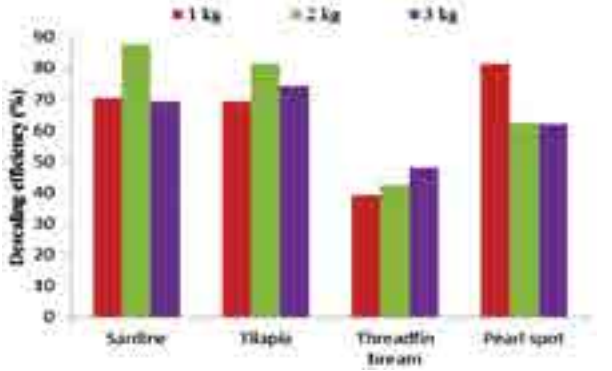
Performance evaluation of ICAR-CIFT fish dryers

Performance evaluation study of solar cabinet dryer (electric backup – 40 kg capacity) was conducted for sardine and nandan (Glassy perchlet) fishes. Similarly, solar tray dryer (electric backup – 20 kg capacity) and biomass- electrical dryer (10 kg capacity) were evaluated with nandan fish. Drying characteristics of shrimp in 5 kg electrical dryer was also conducted.

Redesigning and fabrication of existing ICAR-CIFT solar-LPG hybrid dryer

The existing ICAR-CIFT solar-LPG hybrid dryer was redesigned and fabricated with few notable innovations which included manual wheel-based sun tracking system for solar collector, pre-heating/dehumidification system and automatic drying parameters recording setup.

Redesigned ICAR-CIFTsolar-LPG fybrid dryer



Descaling efficiency under various loading conditions after nine minutes of descaling

Performance evaluation of descaling machine

Performance evaluation of hand-operated descaling machine was done using tilapia, sardine, pearlspot and threadfin bream. It was observed that time requirement for descaling was very less compared to traditional method and requires only a semi-skilled person for operation.

Fish descaling machine with variable drum speed

Hand-operated fish descaling machine

Studies on fish freshness sensor development

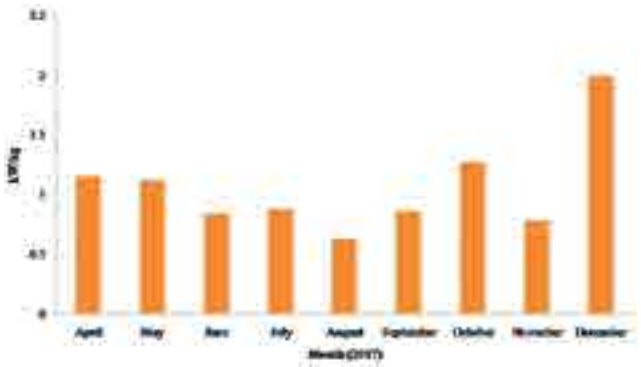
Progressive studies were carried out on fish freshness sensor development by taking Hunter Colour Flex (L, a, b) values of fish eye, gill, skin over seven days with 1-day interval to assess the freshness of fish. Corresponding TVBN values were measured to determine the benchmark value of L* value to develop a sensor.

Change in the fish eye colour during storage

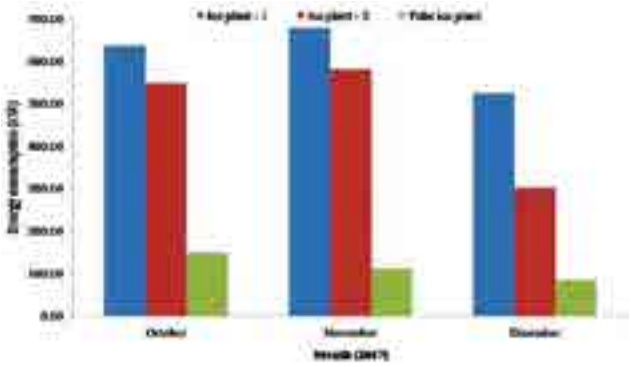
Design and development of tools and technologies for energy and water use optimization in fish processing industries

Analysis of energy consumption pattern of seafood industries

Two seafood firms, *viz.*, M/s Baby Marine International, Kochi, and M/s Choice Group were identified and selected for carrying out the research studies after elaborate discussion with the collaborative research partner, M/s Datamatrix Pvt. Ltd., Pune. The basic carbon footprint monitoring system is put in place initially to check energy consumption pattern by different processes of the industry. Base data on energy consumption was collected using Remote Energy Optimization and Sustainability Services developed by M/s Datamatrix.



Monthly mean specific energy consumption for the plant from April to December, 2017



Monthly mean energy consumption of major feeders of the plant from April to December, 2017

Optimization of energy consumption and scenario analysis

Based on the analysis of the collected data, physical verification of the plant and process was carried out. Finding out optimum energy usage will be the next process. Once the optimum energy for the process is determined, increase or decrease in energy usage with respect to total production can be monitored and accordingly suggestions can be given to the industry based on scenario analysis.

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
- An assessment of the impact of S&T outputs of ICAR-CIFT on the socio-economic fabric of fisheries stakeholders
- Modelling studies for estimation of revenue-based capacity and valuation of selected fishing systems and fish supply chain analysis

Externally funded projects

- Development of clam cluster and clam processing facility at Perumbalam village, Thycatuserry block, Cherthala taluk, Alappuzha
- Indigenous traditional knowledge (ITKs) in marine fisheries sector of Kerala: Documentation and analysis

Most significant achievements

- The perceived strength and weakness of the fish entrepreneurship development are family support and marketing of traditional fish products in the selected study area. Administrative and legal hurdles are the major threats. The opportunity is the Government funded livelihood schemes for the fisherfolk on entrepreneurship development.
- The Entrepreneurial Intention (EI) for the fisheries enterprise was influenced by personal attraction, perceived behavioral control and professional option.
- Seven nodes and actors prevailing in the value chain of reservoir system were identified and for the economic valuation, both the use and non-use values of ecosystem were also identified.
- PESTLE analysis was carried out for identifying the concerns and opportunities in the reservoir fisheries.
- The K-Co-efficient and VPA analysis for the suitability of fish species and biomass available for exploitation showed that at Chulliyar, there is scope for exploitation of the mrigal species.
- The technologies of ICAR-CIFT showed that majority were towards entrepreneurship/industrial application. Large mesh purse seine and ring seine showed higher social and economic impact on the increasing fishing efficiency category.
- Under the resource saving technologies, income level and employment generation rated high for Sagar Kripa and improved propellers.
- The mean capacity utilized by trawlers was 0.72 and 0.74 in Ernakulam and Kollam, respectively. The economic efficiency of trawlers was 0.53 and 0.64, respectively in Ernakulam and Kollam, implying that certain vessels operating at high technical efficiency shows low economic efficiency.

- The Stochastic Frontier Production Function Model revealed that cost of fuel and labour are the major significant factors determining the fishing capacity. The consumer preference using conjoint analysis revealed that income is the significant factor in determining the fish purchasing behavior in Ernakulam and Kollam.
- The construction of the clam processing facility at Perumbalam village under the DST-SEED project has been initiated.
- Two meat-shell separator prototypes have been designed and fabricated.
- ITKs relevant to the fisheries sector, specifically with reference to fishing and oceanographic parameters, fish shoal identification, fishing craft and gear and fish processing have been documented from nine coastal districts of Kerala.

Chief findings

Institute projects

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

Study locales of the project

During the period under report, the present action research was undertaken in three study locales in three districts, one each in Kerala, Andhra Pradesh and Gujarat, selected through purposive random sampling. Accordingly, Valiya Kadamakudy village (L1) in Vypin constituency of Ernakulam district of Kerala, Mangamaripeta village (L2) of K. Nagarampalem Panchayat, Bheemunipatnam Mandal, Visakhapatnam district, Andhra Pradesh and Jamburi village (L3) in Veraval district of Gujarat were selected as the treatment villages and three more located in the same cluster of the respective treatment locales were selected as control villages.

Situational analysis and problem prioritization relevant to entrepreneurship development in fishery

Situational analysis with respect to fish entrepreneurship development was conducted in Valiya Kadamakudy village through SWOT (Strength, Weaknesses, Opportunities and Threats) technique, where the views from five different expert groups *viz.*, fishermen, fisherwomen, vocational school students, public representatives and Parent Teacher Associations (PTAs) were collected through structured schedule with 5-point continuum scale. The perceived attributes of SWOT were finalized through participatory discussion with different groups by using the 'Delphi Technique'. The SWOT analysis was made taking into account the perceived attributes of Strength (9), Weaknesses (8), Opportunities (6) and Threats (8). The quantitative SWOT analysis showed that Kendall's Coefficient of Concordance in case of Strength (w_s), Weaknesses (w_w), Opportunities (w_o) and Threats (w_t) as 0.07. 0.159, 0.187 and 0.187; which were non-significant at 5% Level of Significance, thus showing that there is no association among the different attributes of the factors. Hence there is consistency in expert groups' remark with respect to perceived attributes.

In case of problem prioritization, SWOT-AHP (SWOT-Analytical Hierarchy Process), a multi-attribute decision making (MADM) technique was used in which pair-wise comparisons were made between SWOT factors within every SWOT group and among the SWOT groups, where the relative local priorities and overall (Global) priorities for the SWOT factors were estimated using the 'Eigen Value Technique' to establish hierarchy.

The result of the study conducted in Valiya Kadamakudy village showed that in case of Strength, the experts gave first rank to 'Availability of pokkali lands' followed by 'Presence of institutional support' as second rank; whereas in case of SWOT-AHP technique 'Strong family support for entrepreneurship development' was ranked first followed by 'High economic motivation' as second with factor priority 0.178 and 0.166, respectively having CR (Consistency Ratio) 0.031. Similarly in case of Weakness, the first rank was given to 'Seasonality of the resources' followed by second rank to 'Lack of infrastructure/implements for value addition of fishes' through SWOT technique, but as per SWOT-AHP technique 'Problem in marketing of traditional fish products' and 'Lack of managerial and liasioning abilities' were ranked first with factor priority 0.163 for each followed by 'Poor harvesting techniques and problem in maintenance of crafts and gears' (0.160) with CR 0.076. Similarly, in case of the external factor like Opportunities, the expert group in SWOT analysis ranked 'Existence of vocational secondary school for skill development' as the first one followed by 'Good linkage with public institutions' as second rank and SWOT-AHP showed that 'Govt.

funded livelihood development schemes for fisherfolk' has first priority (0.275) giving equal priority (0.252) to the second ranked factors as like in case of SWOT analysis; whereas among the perceived attributes of Threats; 'Failing of group dynamics among different SHGs' ranked first and 'Competition with other value added fish products available in market' ranked second in case of SWOT analysis, whereas in case of SWOT-AHP 'Administrative and legal hurdles while pursuing the business' was having the first priority (0.220) and most interestingly the first ranked factor of SWOT analysis was found to be in second rank with local factor priority of 0.204 as per SWOT-AHP. As SWOT-AHP could make both the qualitative and quantitative evaluation of perceived attributes for prioritizing the problems with acceptable consistency limit (<10 %), hence that result was accepted for finalizing the action plan for fish entrepreneurship development.

Pair-wise comparison matrix of SWOT factors

SWOT groups	(S)	(W)	(O)	(T)	Priority among the SWOT group
Strengths (S)	**1.000**	0.200	1.000	0.250	**0.091**
Weaknesses (W)	5.000	**1.000**	4.000	0.333	**0.301**
Opportunities (O)	1.000	0.250	**1.000**	0.167	**0.081**
Threats (T)	4.000	3.000	6.000	**1.000**	**0.527**
C. Total	**11.000**	**4.450**	**12.000**	**1.750**	

CI = 0.078, RI = 0.90 (at n=4), CR = CI/RI = 0.0865, Consistency = 9 % (OK)

Assessment of the Entrepreneurial Intention related to fishery sector

The Entrepreneurial Intention (EI) of Vocational Higher Secondary School (VHSC) students (112 Nos.) of Kadamakudy to start an enterprise was assessed. This was measured in respect to personal attraction, perceived behavioural control, subjective norms and professional option. It was observed that all other factors except 'Subjective norm' to have a proportionate extent of distribution over the three level of EI, where Subjective norm showed zero percentage under the high level of EI followed by maximum percentage (87.5%) under medium level of EI. Further, the Path Analysis result revealed that Subjective norm (CR 1.023) have better influence over the entrepreneurial intention (EI) followed by perceived behavioural control, professional option and personal attitude with CR value 2.064, 3.051 and 5.524, respectively.

Respondents were identified for starting up the entrepreneurship on "Fish and fish products" and formed the group. Basic information about the village was collected. Six fisherwomen were identified for starting up a small scale fish-preneurship programme and a group namely "Samudra Fish Worker's Society" was formed. MoU was exchanged between ICAR-CIFT and the Society for preparation of value added products. Capacity building programme on preparation of speciality fish products was conducted.

Economic evaluation of resource use efficiency and management of reservoir ecosystem

Data collection on catch and stocking

Secondary data on catch and stocking at major reservoirs of Kerala were collected from Department of Fisheries. Based on fish production and management, Malampuzha, a medium category reservoir and Chulliyar, Meenkara (Palakkad district, Kerala) and Aliyar (Pollachi district, Tamil Nadu) which are small reservoirs were selected for the study. The fishing activities in the selected dams of Palakkad account for 77% of the total reservoir fish catch from the district. In order to study the reservoir fishery value chain, a preliminary survey was undertaken at Malampuzha, Chulliyar and Meenkara dams and Aliyar dam and from the preliminary data collected, the principal determinants of consumer demand were identified as price, quality, convenience, year-round availability, variety, nutritional concerns, safety and hygiene.

Around 16 different species are landed in the area. The economically valuable species are the major carps, rohu, catla and mrigal which were fetching price ₹ 120, ₹ 120 and ₹ 100 per kg, respectively. Tilapia, pearlspot and *Barbus* species account for considerable volume of catch next to the major carps and fetch price of ₹ 309, ₹ 143 and ₹ 100 per kg, respectively. Fish catch from the reservoirs are traded fresh at the

dam site without any value addition. Removal of fish scales and cutting is done at extra cost. Management of fisheries is a joint task by the Fisheries Co-operative Society of the reservoir fishermen and State Fisheries Department which involves regular stocking of carps.

Seven major nodes and actors could be identified in the value chains for freshwater fish species - fishers, Fishermen Co-operative, State Govt. representatives, local processors/traders, transporters, retailers and consumers. The production node (gear/boat owners and actual fishing) is dominated by men; fishers sell their catch at the dam site as soon as it is landed. State Department plays a role in price fixation which is done from time to time. Small scale processing/handling of fish is done by fishers at the landing site at Aliyar. Traders do not limit themselves to specific markets; they use real time information through contacting others, using mobile phones in making decisions about where to take their fish, based on supply and demand and therefore where the most profit could be made. Transport channels and logistics to retail markets are characterized by use of two-wheelers for quick transport and reduction in costs. About 10 to 12% of catch is locally consumed.

Fish catch data (secondary) on daily basis from the selected reservoirs was compiled and analyzed. Chulliyar reservoir was stocked with four lakh fingerlings at the ratio of 2:1:1. The total catch at Chulliyar was 67 MT and the catch pattern shows that fishery is catla-based (Average weight 2.8 kg per fish). The recovery rate was low for rohu and mrigal. Meenkara reservoir was found to produce 16.65 MT. of fish valued at ₹ 20.81 lakhs whereas the Malampuzha reservoir which operates 33 units has shown fish production of 37.08 MT valued at ₹ 45.12 lakhs.

Studies on economic valuation of reservoir ecosystem

To undertake total economic valuation of the selected site (Aliyar), the array of values which have to be included for the study was identified based on a preliminary survey. The reservoir has an area of 48 ha and covers vast area of agricultural land (2,505 ha of wetlands) under its irrigation. Reservoir and surrounding area is rich in bio-diversity and supports various economic activities. Irrigation, hydel power generation, fishery, tourism, forestry, business/restaurants, grazing, and recreation were the identified values on which data will be generated. Fishing activities support eight fishermen households. Coracles and gillnet gear of 110 mm – 250 mm mesh size (monofilament) is used for the fishery based on catla, rohu, mrigal, cyprus and tilapia. The average quantity of fish catch is recorded as 29 tons per annum and generated revenue was about ₹ 24 lakhs annually.

The listing of use and non-use values of the ecosystem was done based on observations, discussions with stakeholders and review of literature, local communities, and rapid assessment. The direct use values were identified as fish, edible fruits, wood, medicinal plants, birds, tourism. Grazing, habitat/species conservation, irrigation, private fish farming, religious/cultural value were the identified indirect use values. The non-use values were educational, scientific research, future use/protection, and heritage.

Statistical analysis

Chulliyar: Chulliyar reservoir is a high productive reservoir from fishery point of view. Gillnet fishing is practiced all round the year. There are 11 active fishing units operating in the reservoir. Major carps are regularly stocked. The mesh size of nets used for fishing range from 140 to 275 mm. The lean season for fish is from June to August and the peak season is reported as October to December. Based on the total length of the commercially important fish species *viz.*, rohu, catla and mrigal, six groups could be formed namely G1 : 25 to 35 cm, G2 : 35 to 45 cm, G3 : 45 to 55 cm, G4 : 45 to 55 cm, G5 : 55 – 65 cm and G6 : above 65 cm. Based on the log transformed data on length-weight measured from selected samples, the 'b' values in the length-weight relationship were estimated as 3.27, 3.37 and 3.36 for catla, rohu and mrigal, respectively and the estimates were significant at $p<0.01$.

Catch-per-unit effort (CPUE) data collected from selected fishing units was subjected to ANOVA to test difference in CPUE of two fishers in the same area which was found to be insignificant. The average CPUE ranged from 11.32 to 19.48 kg unit^{-1} day^{-1}. Significant difference between CPUE during different months was observed ($p<0.05$).

Malampuzha: Based on the total length of the commercially important fish species *viz.*, rohu, catla and mrigal, five groups could be formed namely G1 : 20 to 35 cm, G2 : 35 to 50 cm, G3 : 50 to 65 cm, G4 : 65 to 80 cm and G5 : above 80 cm. For estimating the 'b' values in the length-weight relationship, the length-

weight data collected from selected units were subjected to regression analysis after log transformation. The 'b' values were 3.10, 3.46 and 3.06 for catla, rohu and mrigal, respectively. The CPUE varied from 2.03 to 24.29 kg unit^{-1} day^{-1}. Significant difference between CPUE during different months was observed ($p<0.01$).

Meenkara: Based on the total length of the commercially important fish species *viz*., rohu, catla and mrigal, six groups could be formed namely G1 : 20 to 30 cm, G2 : 30 to 40 cm, G3 : 40 to 50 cm, G4 : 50 to 60 cm, G5 : 60 – 70 cm and G6 : above 70 cm. The 'b' values in the length-weight relationship were 3.02, 3.16 and 3.26 for catla, rohu and mrigal, respectively which were computed through a regression analysis performed on log transformed length-weight data. The CPUE varied from 2.72 to 7.67 kg unit^{-1} day^{-1}. Significant difference between CPUE during different months was observed ($p<0.05$).

Assessment of biomass

Length-frequency data pertaining to catch of catla and mrigal from selected units of Chulliyar was subjected to statistical analysis. The K-coefficient estimated by fitting VBGF (von Bertalanffy Growth) model was 0.89, 0.75 and 0.79 for catla, rohu and mrigal, respectively indicating the suitability of the water body for growth of these fishes. Similarly the asymptotic length ($L\infty$) using ELEFAN II software was determined. The asymptotic length was computed as 1089 mm, 953 mm and 979 mm for catla, rohu and mrigal. The total mortality (Z) calculated by length converted catch curve was 3.09 for catla and 0.87 for mrigal. Pauly's Empirical Formula was used for estimating total mortality (Z), natural mortality (M) and fishing mortality (F) ($F = Z-M$). VPA analysis by Jones Cohort predicted the biomass available for exploitation for catla and mrigal to be 39.7 t at mid-length 510 mm and 85.0 t at 460 mm, respectively. The analysis shows that the fishery at Chulliyar was catla-based and there is more scope for the exploitation of mrigal.

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

Categorization the S&T outputs developed by ICAR-CIFT and development of measurement devices for selected items

S&T outputs of ICAR-CIFT (past 20 years) from different secondary information sources (Total 768 items) were documented and validated by concerned Scientists from all Divisions of the Institute at two levels through seven semi-structured interview schedules prepared for the purpose. From among the total outputs, the major ones reported to be successfully delivered to stakeholders were estimated to be 63 items, which were prioritized based on analysis of the technology parameters and expected impact, and were classified under four heads: For improving fishing efficiency (14), For improving quality and hygiene in post harvest sector (13), For conserving fishery resources (12), and Promoting entrepreneurship/ industrial application (24).

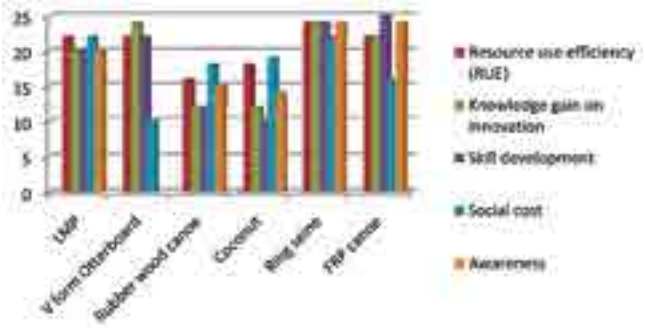
To estimate the total effect of the new technology on a set of outcome variables, on the social and economic segments, suitable indices were selected for assessing impact of each technology and were further grouped for using commonly for technology category. The perceived impact of stakeholders was measured using a combination of interviews, case studies, mailed questionnaires and telephonic interviews. The impact assessment was done following a combination of methods of pre and post as well as control group comparison whereever applicable.

Impact of technologies for improving fishing efficiency

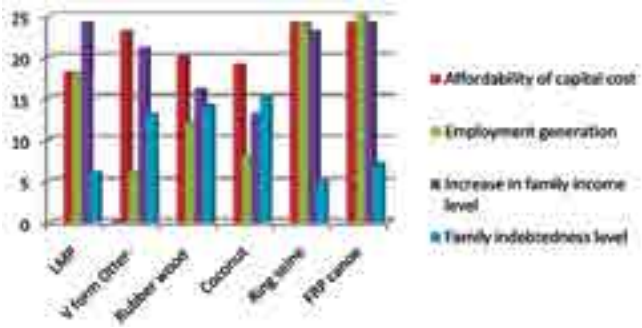
Technologies studied were Large mesh purse seine, V-form otterboard, Rubber wood canoes, Coconut wood canoes, Ring seine and FRP canoes for inland fishery.

Social impact: It was observed that in the case of LMP, ring seine and FRP canoe, overall social impact was comparatively high. In the case of rubber wood canoe, logistics of getting raw material and skill in treatment of wood was pointed out as hurdles for further expansion of the technology.

Economic impact: Similar trend was observed in the case of economic impact also. Employment generation was highlighted as a major gain in LMP, ring seine and FRP canoes, while income generation was very high for LMP, as they operate for three months, minimizing labour management costs and operational costs and get higher catch in most of the trips.



Social impact of technologies for improving fishing efficiency

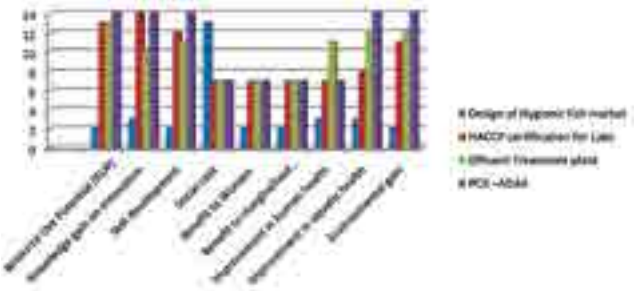


Economic impact of the technologies for improving fishing efficiency

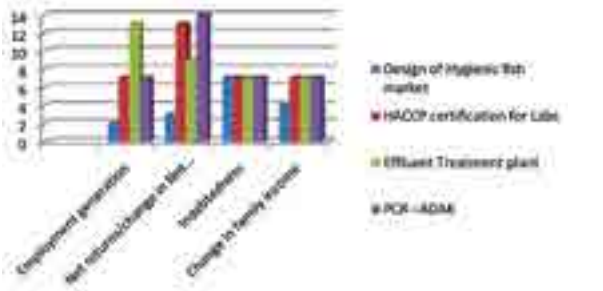
Impact of the technologies for improving quality and hygiene in post harvest sector

Social impact: The technologies studied were design of hygienic fish market, HACCP certification for labs, Effluent Treatment Plant (ETP) and PCR-ADAK. The study revealed that PCR technology, HACCP certification support and Effluent Treatment Plant were rated high for resource use potential, knowledge gain on innovation, improvement in aquatic health and environmental gain. In the case of design for hygienic market, the practical implementation in majority of the markets were not done properly, as reflected in the poor socio-economic impact of the technology output.

Economic impact: Revenue generation was higher in the case of adoption of PCR and HACCP. In the case of technology support given for ETP of processing plants, the installation of the ETP which is mandatory for the plants have indirectly led to initiation of functioning of the plant, thereby giving opportunity for hundreds of workers. This can be taken as a spill over benefit of ICAR-CIFT technology.



Social impact of technologies for improving quality and hygiene in post harvest sector



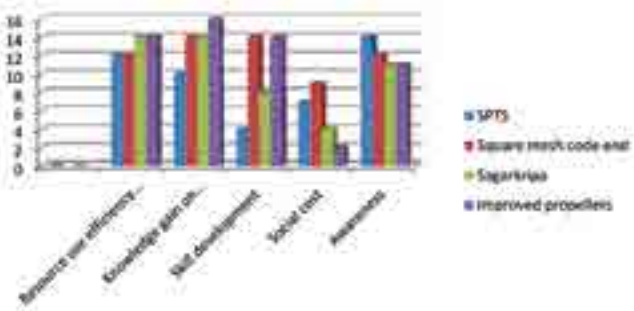
Economic impact of technologies for improving quality and hygiene in post harvest sector

Impact of the technologies for resource conservation

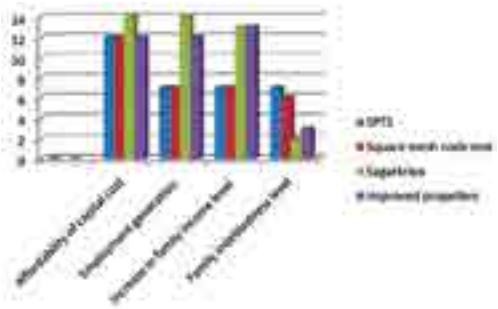
Technologies studied were Semi Pelagic Trawl System (SPTS), Square mesh codend, Sagar Kripa and Improved propellers. It was evident from the study that square mesh codend and improved propellers were rated high with respect to majority of the social impact indicators. The level of awareness about conservation-oriented technologies were on the higher side through a series of demonstrations and awareness programmes held on these technologies. However, the square mesh codend, was not appreciated as the fishers loose shrimp while adopting 40 mm mesh size following the Govt. of Maharashtra rules. Before this minimum 25 mm mesh size was mandatory as per Maharashtra MFRA.

Social impact: The same effect is shown in economic impact also. Family income level as well as employment generation were rated high for Sagar Kripa and improved propellers, as both the technologies have been opearted in commercial fishing boats with proven reduction in fuel expense, which is the major component (>65%) of the cost of total fishing expenditure.

Economic impact: The technologies under the last category, Industrial application/promoting entrepreneurship, except the technology for chitin-chitosan and high density chitosan, majority of the technology support (like battered products, dryfish, fresh fish, 'Fertifish', extruded snack, hybrid driers etc.) focused on women entrepreneurship.



Social impact of technologies for resource conservation



Economic impact of technologies for resource conservation

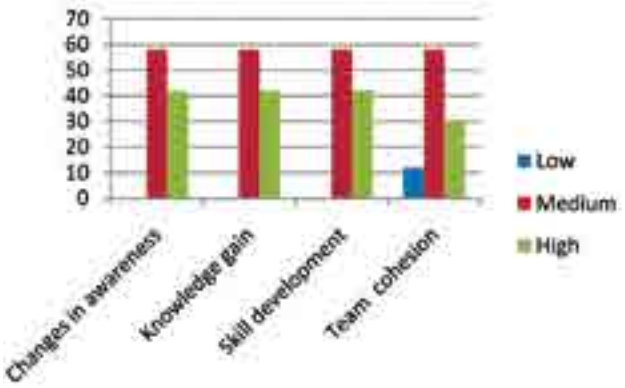
Effect of TOT by ICAR-CIFT: Chitin-chitosan and high density chitosan

The study covered seven chitin production units in Kerala. The information suggests that MATSYAFED, M/s India Seafoods, Kannamaly and M/s Essence Biotech were started with technical guidance of ICAR-CIFT. While the remaining four industries can be taken as the horizontal spread effect of the TOT by ICAR-CIFT. Chitin factory of MATSYAFED, Kollam produces 'Chitone Anti-Fat Capsules' (Based on high density chitosan), which has 75 dealers all over the state.

The average capacity of each industry producing chitin per month varies from 9 to 25 tonnes and the average break-even period achieved by each industry was at 6th to 7th year of its operation. The average quantity of raw material (Shrimp shell waste) used for chitin production by each industry varies from 1000 to 4000 tonnes per annum. Majority of the labourers come from states like Bengal, Assam and Odisha and the average labour per industry varies from 8 to 80 numbers. The chitin production cost is around ₹ 120-125/Kg and the selling price is around ₹ 180-190 /Kg.

Gender impact of the S&T outputs of ICAR-CIFT

Science and technology outputs of ICAR-CIFT on fish processing and value addition has reached to large number of beneficiaries in the form of business units. Out of these business units, 10 women groups were selected on purpose for analyzing the impact of S&T outputs of ICAR-CIFT. Information on profile of value addition units were collected and compared. Socio-economic impact analysis was done based on changes in awareness, knowledge gain, skill development, team cohesion and employment generation. Except the last one, in all categories, majority belonged to medium category. Regarding employment, it was found that 1,76,712 man-days were generated by 10 units which has a major economic impact. Among the constraints perceived by the respondents, lack of customized business model, problem in identifying and exploiting market potential and lack of managerial skills in group enterprises were ranking top in the priority order.



Distribution of the respondents according to socio-behavioural indicators (n =50)

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

Revenue-based capacity estimation of trawlers in Ernakulam and Kollam

Trip-wise quantitative and economic input and output indicators were collected at Cochin Fisheries Harbour, Kerala during January and December, 2017 which is the basis for estimation of revenue-based fishing capacity using Data Envelopment Analysis (DEA). The input and output variables were used to assess the revenue-based fishing capacity of trawlers using DEA. The results of DEA in Ernakulam and Kollam are given in Table.

The mean capacity utilized by the trawlers was 0.72 in Ernakulam and 0.74 in Kollam. This shows that the technical efficiency of the trawlers could be increased by 28 and 26%, respectively in Ernakulam and Kollam. The economic efficiency of trawlers was 0.53 and 0.64, respectively in Ernakulam and Kollam implying that certain vessels which are operating at high technical efficiency show low economic efficiency. The comparison of Technical Efficiency (TE) and Economic efficiency (EE) revealed that there are 21.15 and 24.58 per cent of trawlers operating with full efficiency and were not proportionate with the economic efficiency levels.

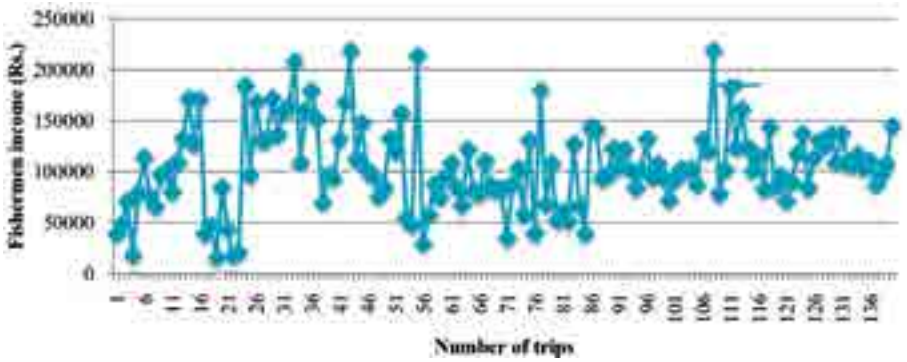
The input-revenue relationship was assessed trip-wise for the trawlers at Cochin Fisheries Harbour, Ernakulam and Neendakara and Sakthikulangara, Kollam, Kerala (for the operational inputs). The technical efficiency and revenue efficiency of trawlers were estimated for Ernakulam and Kollam districts. The efficiency – profitability matrix for the trawler fishery at the selected districts was carried out as part of revenue-based capacity estimation. And the trawlers were distributed into the matrix based on allocative efficiency *viz.*, star vessels, problem vessels, good capture and good landings status. The economic efficiency was much lower than the TE levels in both the districts. Based on the average revenue efficiency scores, it was found that the revenue-based capacity was higher in Kollam than Ernakulam.

Efficiency estimation of trawl fishery in the selected districts

Decision making units	Ernakulam (16.5 -22.5 m trawl)			Kollam (16.5-22.5 m trawl)		
	Technical Efficiency	Allocative Efficiency	Economic Efficiency	Technical Efficiency	Allocative Efficiency	Economic Efficiency
1	0.69	0.88	0.61	0.77	0.95	0.73
2	0.45	0.75	0.34	0.34	0.70	0.24
3	0.78	0.86	0.67	1.00	1.00	1.00
4	0.68	0.88	0.60	0.70	1.00	0.70
5	0.67	0.72	0.48	0.65	0.70	0.46
6	0.77	0.86	0.66	0.78	1.00	0.78
7	0.87	0.18	0.16	0.48	0.70	0.33
8	1.00	1.00	1.00	0.98	0.97	0.95
9	0.57	0.68	0.39	0.85	0.70	0.60
10	0.68	0.54	0.37	0.82	1.00	0.82
Mean	**0.72**	**0.74**	**0.53**	**0.74**	**0.87**	**0.64**

Fishermen income: Growth and determinants

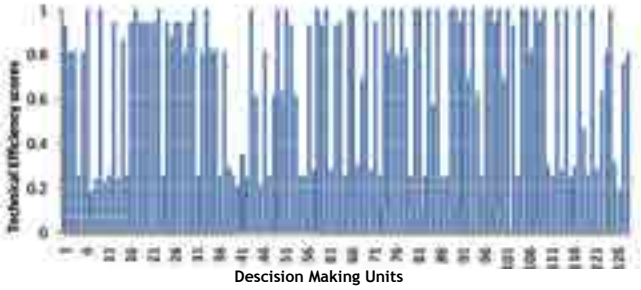
In the revenue-based capacity estimation, fishermen income is one of the output indicators and plays a major role in deciding the profitable nature of fishing activity. The trip-based data of trawlers at Cochin Fisheries Harbour, Cochin were collected for 140 trips. The trawlers income showed high fluctuation between trips with the minimum of ₹ 17,750 to ₹ 1, 80,220 per fishermen. The trawlers income deviated more with mean income than between trips. The possibility of doubling fishermen income was also assessed.



Trend in fishers' income (per trip)

Frequency distribution of fishermen income

The panel data collected was analyzed for efficiency and resource use efficiency towards finding ways for doubling fishers' income. Efficiency was assessed using Data Envelopment Analysis (DEA) and the determinants of efficiency were decomposed using Marmquist Index (MI). Technology and Total Factor Productivity score was low compared to other kind of changes.



Efficiency of fishing operations

Supply chain analysis of domestic fish markets

Market performance of market functionaries such as producers, wholesalers and retailers were assessed using Data Envelopment Analysis (DEA) for the selected fish markets at Ernakulam and Kollam districts. The results are given in Table.

The inter-district comparison of TE revealed that the cumulative mean technical efficiency of producers in Ernakulam is relatively better than Kollam district. The DMUs categorized into various efficiency levels revealed that in Ernakulam, 40 and 36 per cent of respondents are in the efficiency levels of 80-90% and 70-80%, respectively. While in Kollam, it was 14 and 34 per cent. It showed that producers in Ernakulam are relatively more efficient than producers in Kollam district. The inter-district comparison of TE showed that the wholesalers in Kollam district were comparatively high followed by wholesalers in Ernakulam district. It was found that in all the districts, majority of the retailers (33%) have 70-80% efficiency levels (Kollam - 36% and Ernakulam - 33%). From the technical efficiency scores, it was observed that there is a potential to increase the efficiency of market functionaries. The MPTE revealed that the retailers showed high potential towards increasing the technical efficiency.

Results of DEA towards assessing the market performance of selected fish markets in Ernakulam and Kollam

Market functionaries	Cumulative Mean Technical Efficiency (CMTE)	
	Ernakulam	Kollam
Producers	0.92	0.86
Wholesalers	0.91	0.93
Retailers	0.77	0.83

Integration of domestic fish markets

Co-integration among domestic fish markets for the four high value (seerfish, shrimp, pomfret and tuna) and four low value (sardine, mackerel, anchovies and threadfin bream) fish were analyzed using the Johansen Co-integration Test and Vector Error Correction Model.

Possibility of increasing technical efficiency in the selected domestic fish markets in Kerala

Districts	Producers		Wholesalers		Retailers	
	MTE	MPTE	MTE	MPTE	MTE	MPTE
Ernakulam	0.92	0.08	0.91	0.09	0.77	0.23
Kollam	0.86	0.14	0.93	0.07	0.88	0.12

Consumer preferences for fish purchasing behaviour

Consumer preference for fish was assessed using conjoint analysis for the two districts *viz.*, Ernakulam and Kollam.

The conformity of the model was evaluated using the Pearson R and Kentall's Tau. Pearson R Statistics was 0.81 and 0.88 and 0.84 and 0.90 according to Kendall's Tau for Ernakulam and Kollam, respectively. The results of part-worth utilities summarizes the relative importance of attributes in the Ernakulam and Kollam districts of Kerala. It was found that income and price were the most important attributes in Ernakulam and Kollam district.

Relative importance of the attributes in the selected districts

Attributes	Ernakulam	Kollam
Availability	5.14	10.39
Choice	17.57	9.32
Income	35.84	29.83
Price	21.78	27.37
Species	19.67	23.09
Pearson R	0.81	0.88
Kendall Tau	0.84	0.90

Externally Funded Projects

Indian Council of Agricultural Research (ICAR) Projects

Agri-business Incubation

Incubatees registered at ABI Centre

Nine new incubatee companies have registered at ABI Centre during 2017-18, for availing the business support services of ICAR-CIFT. Areas of incubation includes solar dried fish products, ready-to-eat traditional products using jackfruit, extruded fish based snack products, production of antiseptic oinment, cleaned and packed ready-to-cook fish products, production of seaweed-enriched cookies etc.

New product brands developed by ABI Incubatees

Fishoora

Extruded products from fish
M/s Or N App Crunchies, Coimbatore

SEAFOOD WONDERS

Value added products from fish
M/s Seafood Wonders, Vypin

AABBAA

Solar Dried Fish Products
M/s AABBAA Fish Products, Cochin

Hi-Q NATURAL HEALTHY FOOD

Ready-to-eat Jackfruit dishes
M/s Plantzaa Food Industries, Idukki

cheenavala

Cleaned fresh fish
M/s Webap Ventures, Cochin

EMMA FOODS

Solar dried fish products
M/s Emma Foods, Kumbalangi

Professional service functions undertaken

Antiseptic Ointment: The Institute has transferred the technology for production of antiseptic ointment to a startup entrepreneur from Gujarat, Shri Manish H. Thavar, Jain Derasar, Veraval. The trial marketing of the product at the Veravel region has been very successful and there is an increase in product demand among fish handlers.

Handing over agreement to Shri Manish, Veravel, Gujarat for antiseptic oinment

Fishing crafts for Department of Fisheries, Andaman & Nicobar Administration: ICAR-CIFT has joined hands with Department of Fisheries, Andaman

& Nicobar Administration for two consultancy projects to provide drawing, design, cost estimate and technical specifications of (a) FRP boats up to 10 m L_{OA} for the implementation of the scheme titled, 'Assistance to traditional / Artisanal fishermen for Procurement of FRP boats up to 10m L_{OA} as the replacement for traditional / wooden boats including nets, and (b) Motorized boats (25 ft, 30 ft and 36 ft).

Extruded products from fish: ICAR-CIFT has transferred the technology for extruded fish based protein rich snack food 'FISH KURE' through a consultancy agreement with Mrs.Jeeja Aravind, M/s Or N App Crunchies, a manufacturing unit for extruded products is set up at Coimbatore, Tamil Nadu and the products are marketed under the brand name FISHOORA.

ARTIFISHAL: ICAR-CIFT has successfully designed a sail powered fishing vessel 'ARTIFISHAL' which is a 7.0 m L_{OA} fishing craft made of wood suited to undertake ring seining. The technology was transferred to Shri K.S. Razook, M/s Twin's Wood Industries, Edappally, Kochi. The model is widely accepted by the ring seine fishermen in Kerala.

Tripartite agreement for commercialization of solar fish dryer: A tripartite agreement was signed between ICAR-CIFT, M/s Kraftwork Solar Pvt. Ltd. and Shri Anish Mathew, Kottayam, for taking up manufacturing of ICAR-CIFT solar fish dryer with electrical backup (40 kg capacity).

Handing over agreement to M/s Twins Wood Industries, Cochin

Handing over agreement for commercialization of solar dryer

Production of cleaned fish and packaging: ICAR-CIFT provided technical know-how and training to M/s Webap Ventures in cleaned fish processing, hygienic fish handling and its packaging.

Production of value added fish products: ICAR-CIFT provided consultancy services to M/s Capitano Ventures, Thiruvananthapuram for providing technical know-how and training in preparation of value added fish products.

Solar dried fish products

A new business model for solar dried fish products, has been introduced in Cochin, by a start up firm M/s Aabbaa Fish Products with the support of ICAR-CIFT. The dry fish store opened at Chambakkara is now known as an ideal choice for dry fish lovers. The design of the store, the products, and the display settings, suits

Handing over agreement to Shri Eldhose Chacko, M/s WEBAP Ventures

Handing over agreement to M/s Capitano Ventures

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.

Mobile fish vending kiosk: The mobile fish vending kiosks are commercialized to two firms, M/s Sha Cold Storage and Fish Centre, Tripunithura, Cochin and M/s Santhom Mart and Food Court, Mundemveli, Cochin. Details given on Page No. 157.

Ready-to-eat products from Jackfruit: ICAR-CIFT developed ready-to-eat products for the Incubatee company M/s HI-Q Agro Foods, Nadapuram, Kozhikode and optimized the process conditions for the production of Jackfruit pulp, Jackfruit puzhukku, Jackfruit cutlet mix, Jackfruit payasam and Tender Jackfruit. The Client has taken up trial production and marketing of seaweed and jackfruit flour-based cookies using ICAR-CIFT formulation with the guidance of experts from the Institute.

Jackfruit product by M/s HI-Q Agro Foods, developed under the technical guidance of ICAR-CIFT

Product launch of M/s HI-Q Agro Foods

Contract Research Programmes

M/s Tile Marine - Acoustic Pinger: An MoU has been signed between ICAR-CIFT and M/s Tile Marine, a private organization, to carry out a contract research project on 'Studies on efficacy of acoustic pingers in preventing depredation and dolphin entanglement in ring seines'. Pingers are devices which produces ultrasound that keep the bottlenose dolphins and porpoises away from the nets.

Handing over agreement to M/s Tile Marine

M/s Coal India Ltd - Fish Smoking Kilns: The Institute and M/s Coal India Limited has entered into a grant-in-aid contract research agreement for the installation of Community Fish Smoking Kilns (COFISKI) and training cum demonstration for preparation of 'Smoke Cured Fish' using COFISKI. The aim of the project is to provide Community Fish Smoking Kilns for better health, hygiene, quality product with longer shelf life, sustainable income generation and lesser carbon foot print for hinterland women fishers belonging to economically under-privileged SC and ST groups.

Collaborative Research Programmes

Kamadhenu University: A collaborative project agreement was signed with Kamdhenu University, Karmayogi Bhavan, Block - 1, 4th Floor, Sector - 10A, Gandhinagar, Gujarat, on 15 June, 2017, for collaboration in the following aspects: (a) Collaborate in Ph.D. thesis research on disciplines related to fisheries science to be undertaken at ICAR-CIFT and at the Research Centres of ICAR-CIFT by post graduate students who have completed their course work at KU, (b) Undertake collaborative Master's/Ph.D. thesis research activities in other areas of mutual interest to both KU and ICAR-CIFT, and (c) Cooperate in other means for exchanging scientific knowledge and information, such as co-publication of thesis research.

M/s Cochin Shipyard Ltd.: In association with the Central Sector Scheme on Blue Revolution and Make in India, ICAR-CIFT, Kochi and Cochin Shipyard Limited (CSL) has joined hands for a collaborative programme under Neel Kranti Mission, for the design and construction of commercial fishing vessels adhering to international standards. An agreement in this connection was signed on 29 August, 2017 with the aim of creating benchmarks and standards for deep sea commercial fishing vessels, besides enabling end-to-end solutions to the fisheries sector of India. This collaborative programme is expected to address the present challenges and issues faced by the commercial fishing boat industry in India. The programme activities are taken up by the Fishing Technology Division at ICAR-CIFT.

Signing of MoU, between ICAR-CIFT represented by Dr. Ravishankar C.N., Director, and Cochin Shipyard Ltd. represented by Shri Sunny Thomas, Director (Technical)

Handing over agreement to M/s Datamatrix Infotech

M/s Datamatrix Infotech Pvt. Ltd.: ICAR-CIFT entered into a collaborative agreement with M/s Data matrix Infotech Pvt. Ltd., Nigdi, Pune for design and development of tools and technologies for energy and water use optimization in fish processing industries. Datamatrix Infotech Pvt. Ltd., is a technology company focused on optimizing energy and water. The company has made several disruptive technology innovations in addressing the water-energy-food nexus challenges. Collaboration would take place in disciplines related to energy and water use optimization at identified fish processing units nearby ICAR-CIFT, Kochi and ICAR-CIFT Research Center at Visakhapatnam.

M/s Pushpagiri Medical Society: M/s Pushpagiri Medical Society and ICAR-CIFT has entered into a collaborative research programme for the following area: (a) Collaborate in research on disciplines related to extraction, characterization and clinical evaluation of biomolecules of aquatic origin, (b) Undertake collaborative research activities in other areas of mutual interest to both PMS and ICAR-CIFT, and (c) Cooperate in other means for exchanging scientific knowledge and information, such as co-publication of research.

Trademark Registration

Trademark Registration obtained during the period are: FISH MAID® (Registered in Class 29), DRISH® (Class 29), FERTIFISH® (Class 1) and FISHMAGIC® (Class 35).

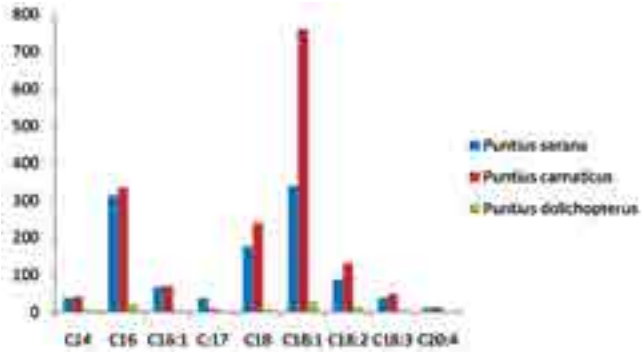
Contract Service Projects

S No:	Description	Client
1.	Supervision for installation and field demonstration of retail fish kiosk	Smt. Seena Shahul, G-22 Biju Vihar, Thekkumbagam, Thripunithura, Ernakulam
2.	Supervision for installation and field demonstration of retail fish kiosk	Smt. Shobha Simon, 305, Sui Summit, ERG Road, Ernakulam
3.	Effluent Treatment Plants	Department of Fisheries, Fishing harbours, Karnataka State
4.	Fabrication of Electrical Dryer (10 Kg)	Krishi Vigyan Kendra, Kerala Agricultural University, Kumarakom P.O., Kottayam - 686 563
5.	NABL accreditation of three labs, Soil Science, Biochemistry and Pathology at ICAR-IISR	ICAR-Indian Institute of Spices Research, IISR Road, Moozhikkal, Kozhikode - 673 012
6.	Certification of Engines and Engine Models i) WD10C278-21, and ii) WP6C185-21	M/s Shandong Heavy Industry Pvt. Ltd., Survy 280/281, Village-Maan, Hinjawadi Phase II, Taluka - Mulshi, District Pune - 411 057, Maharashtra

Nutrient profiling and evaluation of fish as a dietary component

Nutrient profiling of fishes

Nutrient profiling of different food fishes namely *Puntius sarana* (Hamilton, 1822), *P. carnaticus* (Jerdon, 1849), *P. amphibious* (Valenciennes, 1842), *P. bimaculatus* (Bleeker, 1863), *P. dorsalis* (Jerdon, 1849) and *P. dolichopterus* (Plamoottil, 2015) are carried out as a prelude to the development of Omega-3 pills. Higher amount of linoleic acid (18:2) has been obtained from all the fish species studied. Lowest amount was recorded for arachidonic acid (20:4) in all the fishes. Considerable amount of palmitic acid (C16), stearic acid (C18) and oleic acid (C18:1) have been detected in *P. carnaticus* and *P. sarana*. All the fatty acids were comparatively lower in *P. dolichopterus* and higher in *P. carnaticus*.



Comparison of fatty acid content in *P. sarana*, *P. carnaticus* and *P. dolichopterus*

PUFA profiling of deep sea fishes from Gujarat coast

The lipid profile of four marine fishes of Gujarat coast such as milkfish (*Chanos chanos*), pomfret (*Pampus argenteus*), catfish (*Clarias* sp.) and tongue sole (*Cynoglossus* spp.) were evaluated for their fatty acid content. The higher saturated fatty acid content was reported in pomfret followed by catfish, solefish and milkfish. The higher amount of poly unsaturated fatty acid was reported in milkfish. The higher mono unsaturated fatty acid was reported in pomfret.

All India Network project on Fish health

Determination of Emamectin benzoate residues in fish samples using QTRAP Mass Spectrometry

A multi-residue LC/MS method was developed for the quantitative determination of Emamectin and other pesticide residues in fish tissues. QuEChERS extraction was performed using DisQuEQuEChERS, AOAC method sample preparation kit (P/N186004832).

Investigation on the impact of different processing methods on retention of oxytetracycline residues in treated tilapia

Oxytetracycline (OTC) is a primary antibiotic used in the aquaculture industry for the treatment against bacterial pathogen or as prophylactic measure. OTC residues are considered relatively unstable compounds. Temperature during cooking has the largest impact on the loss of OTC residues. In the present study, the effect of different processing methods like boiling, microwave cooking, frying and drying on retention of OTC residues in treated tilapia (*Oreochromis niloticus*) was investigated.

Significant degradation of oxytetracycline was observed after processing methods. Maximum degradation was observed after microwave processing and frying. From the study it is concluded that the processing methods have a significant impact on residual OTC in the tissue. Almost hundred percentage degradation was observed after frying and microwave processing.

Optimization of acquisition methods for the detection of antibiotic residues in fish and shrimp samples

Characterization and development of MRM methods using Electron Spray Ionization techniques in QTRAP Mass Spectrometry for different antibiotic (tetracycline, sulfonamides, chloramphenicol and nitrofuran) residues was attempted to. Samples from the withdrawal and safety studies carried out in the co-institutes (ICAR-CIFA, ICAR-CIBA, ICAR-CMFRI, ICAR-CIFRI and WestBengal University of Aquaculture & Fisheries Sciences) were extracted and analyzed by LC-MS/MS.

National Agricultural Science Fund (NASF) Project

Green fishing systems for tropical seas

Commercialization of the design of long liner cum gillnetter

Design of a 19.75 m trawler cum gillnetter cum long liner was carried out. M/s Goa Shipyard Limited, a partner of the project constructed a 19.75 m combination fishing vessel under Indian Register Classification for Fishing Vessels. Based on the successful multi-day fishing trials at deep sea, a commercial version of the vessel was attempted. The design of a 22.5 L_{OA} commercial long liner cum gillnetter was prepared based on the data base and successful experience at deep sea. The design, technical specification and cost of the vessel was provided to the Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture and Farmers Welfare, New Delhi for implementing the Blue Revolution Scheme. Department of Fisheries, Tamil Nadu constituted a State Level Technical Committee including a member from ICAR-CIFT to implement the scheme under 50% financial assistance from Government of India. M/s Cochin Shipyard Limited was proposed by the Department of Fisheries, Tamil Nadu to construct the first 16 numbers of the vessel for the fishermen from Rameswaram district, Tamil Nadu.

The team from ICAR-CIFT and CSL involved in the project

M/s Cochin Shipyard Limited and ICAR-CIFT entered in to an MoA for the design of 22.5 m long liner cum gillnetter. Details given in Page No. 86.

Low drag trawl technology

Trawling is the most energy intensive fishing method and fuel cost alone contributes up to 75% of operational expenditure of a trawler. It was reported that to catch one kilogram of fish, trawling requires 0.8 kg of fuel. Drag of the trawl is the most important factor contributing to fuel consumption. Drag of trawl depends on factors like weight, design and rigging of the net and the operating conditions. Use of smaller otter boards, adoption of optimized towing speed, thinner twines and large mesh size to reduce twine surface area and opting selective shape of the mesh can bring down the drag and fuel consumption. The objective of the study was to develop a trawl with a thinner and stronger material to reduce the drag and fuel consumption. Comparative trials carried out with 24.47 m fish trawls made of conventional high density polyethylene (HDPE) and new ultra-high molecular weight polyethylene (UHMWPE) revealed that there is significant reduction in drag and fuel consumption for the new trawl. Fuel consumption per kilogram of fish captured was estimated as 2.9 liters for HDPE trawl and 1.9 liters for UHMWPE trawl. Besides reduction in fuel consumption, a drastic cut in carbon emission can be made and larger trawl can be operated with existing engine power.

Dr. Trilochan Mohapatra, Secretary (DARE) and Director General (ICAR) released a new technology christened "ICAR-CIFT-Low Drag Trawl" during a function organized on a cruise on-board Sagar Harita. The Director General was accompanied by Dr. Joykrushna Jena, Deputy Director General (Fisheries Science).

Dr. T. Mohapatra and others on-board the vessel

Releasing of the brochure on ICAR-CIFT-Low Drag Trawl

Department of Biotechnology (DBT) Projects

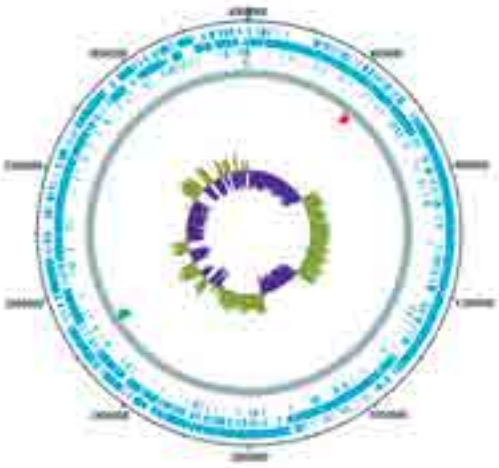
Genetic diversity of *Clostridium botulinum* in seafoods and development of Lateral Flow Immuno Assay (LFIA) for toxinotyoping

Phylogeny of *C. botulinum* based on 16S rRNA sequencing

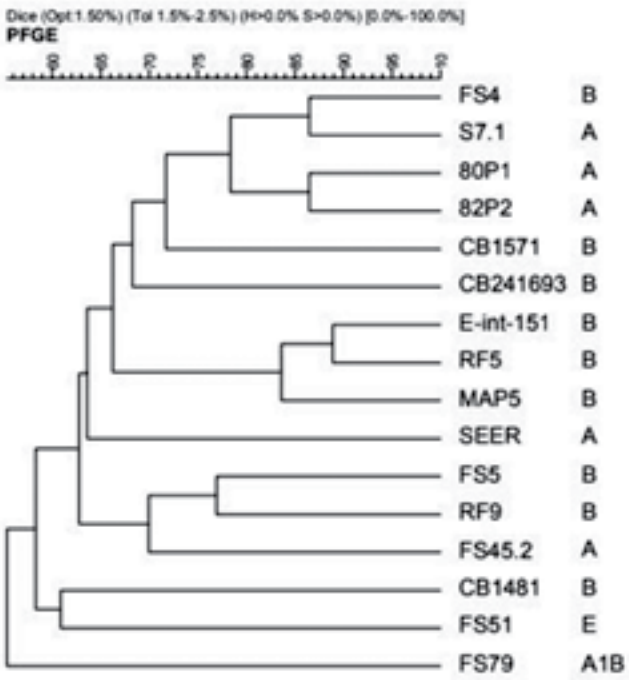
The 16S rRNA gene sequences of 20 isolates of *Clostridium botulinum* strains isolated from seafood were aligned and Molecular Evolutionary Genetics Analysis (MEGA) software version 7.0 was used to infer the maximum likelihood phylogeny. A phylogeny of 16S rRNA sequences was plotted and the strains were found to cluster together. The 16S rRNA sequences were submitted to NCBI with the following accession numbers: MF062268, MF062269, MF062270, MF062271, MF062272, MF062276, MF062277, MF037839.1, MF062498, MF062514, MF040752.1, MF041858.1, MF062273, MF041859.1, MF043257.1, MF062499, MF062275, MF039482 and MF062267.

Molecular diversity of *C. botulinum* strains by Pulse Field Gel Electrophoresis

Sixteen isolates of *C. botulinum* were subjected to restriction digestion with *Sma*I restriction enzyme and separated by PFGE to obtain the macro restriction patterns. The *Sma*I digestion of genomic DNA produced 10-19 bands. The fingerprints thus generated were analyzed in GelCompar II version (5.1) (Applied Maths NV, Belgium). The 16 isolates were grouped into five clusters. The Dice Coefficient of Similarity was used to generate a phylogenic dendrogram to represent the genetic relatedness among the 16 isolates. The minimum similarity between the isolates was 55%. Geographical uniqueness was observed in clusters C1 and C5. Clusters C2, C3, and C4 had isolates from multiple geographical locations. The isolate FS45.2 isolated from ready to eat food imported from New Jersey, USA was grouped with the retail market isolates from India. No consensus was observed in the grouping of serotypes which is in agreement with previous reports in other organisms that serotype relatedness has no relation to genetic relatedness.



Whole genome visualization of *C. botulinum* strain MFB_Julcb7 using DNA plotter software



Phylogenetic analysis of PFGE data for *C. botulinum*

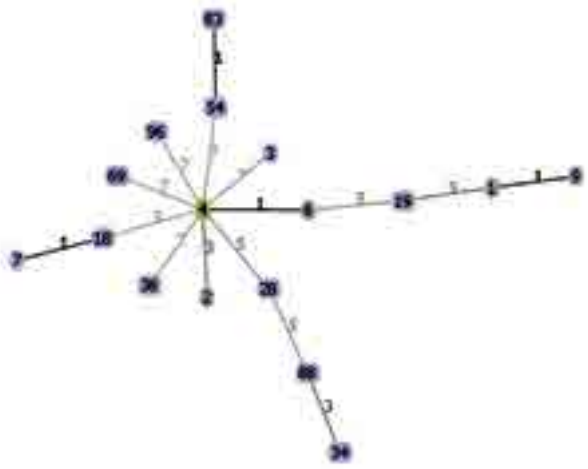
Whole genome sequencing of *C. botulinum* strains

Whole genome sequencing of seven selected *C. botulinum* strains were performed to provide a comprehensive pattern of the genetic variability of Group II population collected from seafood. *In silico* analysis of *C. botulinum* strains including MLST genes phylogeny, whole genome phylogeny and CRISPR identification of the whole genome sequences were performed.

Multi Locus Sequence Typing phylogeny of *C. botulinum* strains

Multi Locus Sequence Typing (MLST) of 25 strains of *C. botulinum* (including seven strains sequenced in the study) was done with seven housekeeping genes;

*aro*E, *ace*K, *mdh*, *opp*B, *hsp*, *rpo*B and *rec*B according to the MLST scheme for *C. botulinum* (https://pubmlst.org/cbotulinum/). MLST analysis of yielded locus frequencies that ranged from 1 to 13 alleles per locus, 17 unique profile patterns or sequence types (ST) were identified. ST 36 and 69 encompassed two strains MFB_julcb4 and MFB_julcb7 (Clonal Group 36), MFB_julcb6 and MFB_julcb8 (Clonal Group 69), respectively. MLST analysis revealed that the newly sequenced *C. botulinum* isolates belonged to ST54, ST96, ST69 and ST36 single locus variant from ST4 and hence form part of clonal complex (CC4). ST83 was a single locus variant of ST54.



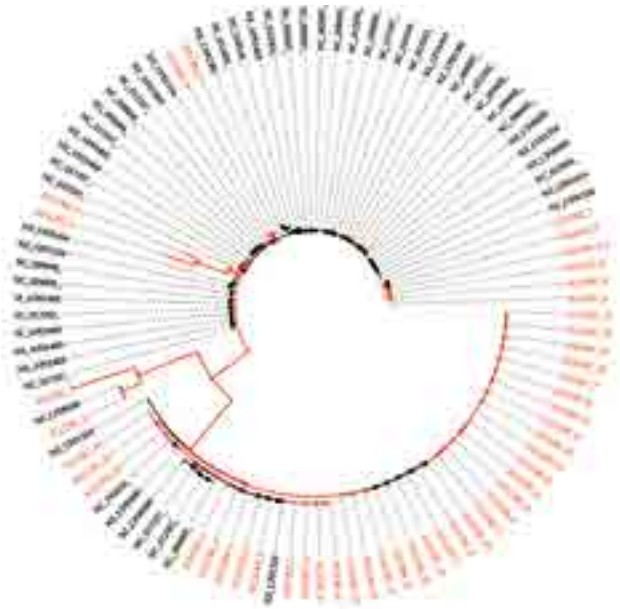
goeBurst clonal analysis of *C. botulinum* isolates from seafood in India

Whole genome phylogeny of *C. botulinum* strains

Whole genome sequences including sequenced data of strains in the study were aligned using Mauve. Approximate Multi-MUMs search distance metric was used to calculate phylogenetic guide tree using local alignments. The MFB_Julcb 1 and MFB_Julcb5 strains fall into the clade of *C. botulinum* prevot_594 strain which produces BoNT/B toxin with genetic change of 0.050. MFB_Julcb6 and MFB_Julcb8 and MFB_Julcb3, MFB_Julcb4 and MFB_Julcb7 were closely related (with genetic change 0.060) and they formed a separate clade related to *C. botulinum* cdc_67071 which also produces BoNT/B toxin.

CRISPR identification of *C. botulinum* strains

Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR), sequences of *C. botulinum* strains were identified using CRISPRs finder CRISPRdb. Analysis of the CRISPR sequences of the seven newly isolated *C. botulinum* isolates revealed 104 CRISPRs sequences with Crispr Types 1 to 17. Clustering of 104 CRISPRs into distinct phylogenetic groups based on Consensus Direct Repeats (CDRs). The red colour indicate the non-proteolytic Group II *C. botulinum* strains isolated and sequenced in the work. The newly isolated and sequenced strains of *C. botulinum* falls under motif6 and Family 7 of CRISPR.

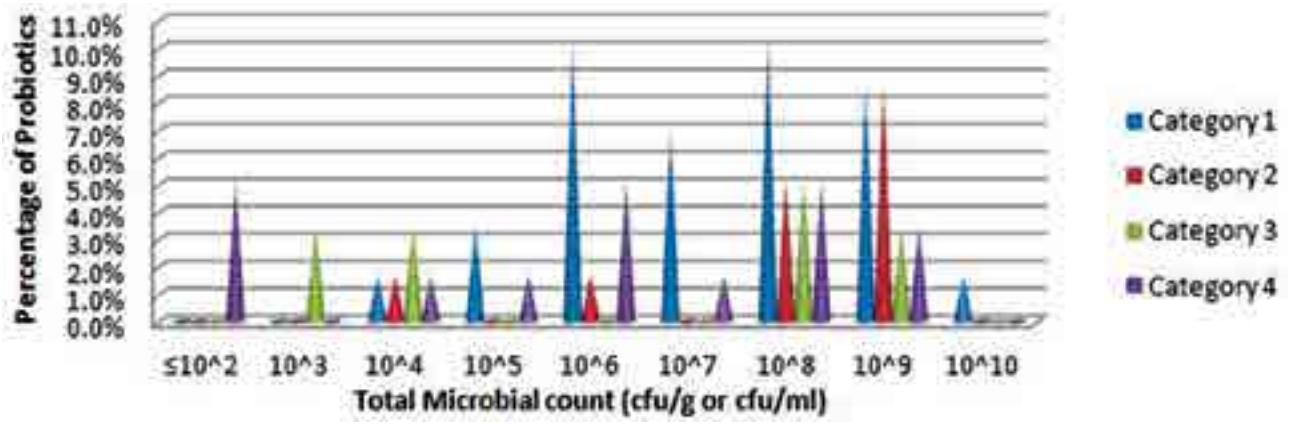


CRISPR prediction in *Clostridium botulinum*

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

Classification of aquaculture probiotics based on microbial composition

Fifty eight commercial aquaculture probiotics manufactured in India, USA and Thailand used by aquaculture farmers from Andhra Pradesh was included in the study. Only 43% of the products (Category I) provided details regarding total microbial count and composition on their labels. 17% of the products provided only the total microbial count on the label (Category II). 16% of the products provided only microbial count (Category III) and 24% of the products did not provide any information regarding total microbial count or composition (Category IV). Predominant microorganisms that were included in the label were *Bacillus* spp., yeast, nitrifying bacteria, *Thiobacillus* spp., *Lactobacillus* spp., *Aspargillus* spp. and *Pediococcus* spp. Major declared benefits on the use of probiotics were water quality improvement, decomposition of settled organic waste, increased survival rate, better feed conversion ratio, inhibition of Vibriosis and stabilized bloom.



Total bacterial counts of probiotics

Microbial analysis of commercial aquaculture probiotics

Enumeration of the probiotic microorganisms was performed for total heterotrophic aerobic and anaerobic bacteria, lactic acid bacteria, fungus and autotrophic bacteria based on the label data for the products which claimed microbial composition to assess the veracity of the label information. Nitrifying, denitrifying bacteria or *Thiobacillus* spp. could not be isolated from any of the 21% products which were claimed to have these organisms. Only 34% of the products were found to have microbial count as claimed on the label. Thirteen of the probiotic products (22.4%) had microbial counts lower than 10^5 CFU per unit amount of product. Fifteen products (25.9%) had microbial load in the range of 10^6-10^7 CFU per unit amount of product. Half of the products sampled contained a microbial concentration in between 10^8-10^9 CFU per unit amount of product.

Qualitative microbial analysis of selected probiotics

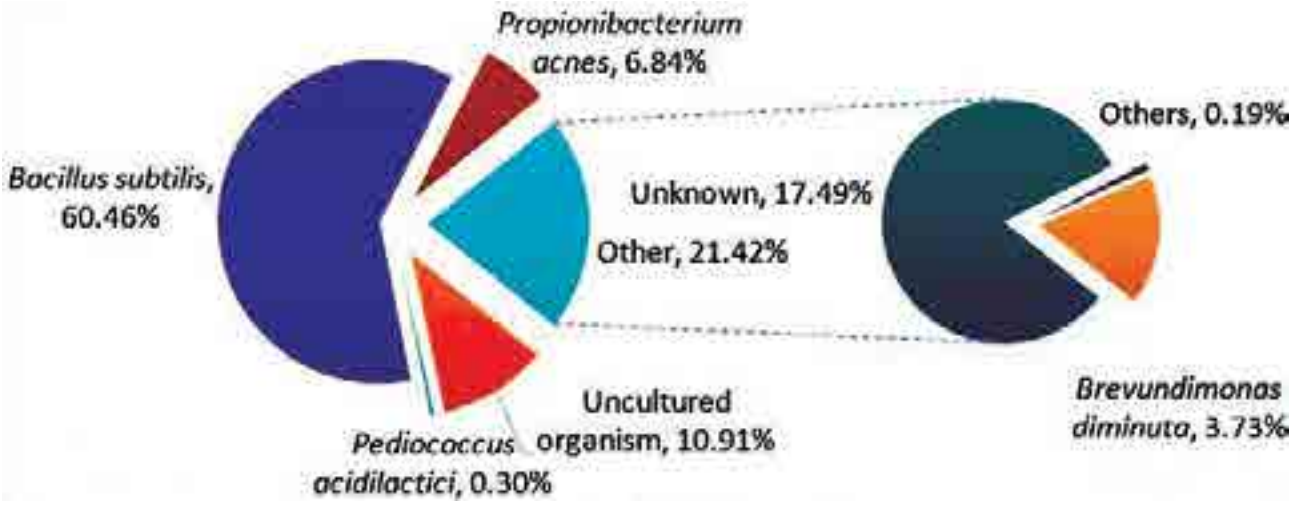
All the products analyzed for qualitative microbiology had *Bacillus subtilis* as per the claims. Product with Code 13 was found to have both the declared microorganisms; *B. subtilis* and *Pediococcus acidilactici*. Product with Code 46 claimed the presence of 10 different species of *Bacillus*, but had only *B. subtilis*. Only one product, out of the 58 probiotics sampled, 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.

Microbial assessment of selected commercial probiotics

Product code and form	Label Claim		Result of microbiological analysis	
	Microbial composition	Concentration (CFU/g)	Microorganisms present	Concentration (CFU/g)
13 Powder	*Bacillus subtilis*	Not mentioned	*B. subtilis*	4.5×10^8
	Pediococuss acidilactici		*Pediococuss acidilactici*	1.5×10^9
40 Powder	*B. subtilis*	1×10^5	*B. subtilis*	1.95×10^6
46 Powder	*B. subtilis*	7×10^8	*B. subtilis*	2.5×10^8
	C. amyloliquefaciens	2×10^8		
	B. licheniformis	5×10^8		
	B. megaterium	5×10^8		
	B. pumilus	5×10^8		
	B. polymyxa	5×10^8		
	Alkaligenes faecalis	1×10^9		
	Saccharomyces cerevisiae	1×10^8		
	Nitrobacter	2×10^4		
	Nitrosomonas	2×10^4		

Microbiome analysis of commercial probiotics using next generation sequencing

16S ribosomal RNA Amplicon Sequencing of V3 region performed using Illumina MiSeq platform for product with Code Number 13 revealed the presence of *Bacillus subtilis* and *Pediococcus acidilactici* with a read percentage of 60.46 and 0.29, respectively, both of which were declared in the label. Ten bacterial species that were not declared on the label were also found. Among the 10 non-declared bacterial species detected, 20 OTUs of uncultured bacteria, six OTUs of *Propionibacterium acne* and 2 OTUs of *Brevundimonas dimnuta*, were found in abundance with a corresponding read percentage of 9.95, 6.84 and 3.73. Approximately, 17.45% of the reads belonged to the unknown category.



Species-wise distribution of probiotic (Code 13) based on total reads

Department of Science and Technology (DST) Projects

Development of clam cluster and clam processing facility at Perumbalam village, Thycatuserry block, Cherthala taluk, Alappuzha district, Kerala

Stakeholder confidence and capacity building

Continuing the confidence building activities among stakeholders, four meetings were organized in collaboration with the local partners of the project, *viz.*, Perumbalam Panchyath and M/s Haritha Farmer's Club for the cluster members. Simultaneously, capacity building activities were taken up with three programmes being organized for 57 cluster members at the Institute on hygienic handling, depuration, processing and value addition.

Fabrication of equipment for clam processing

Equipment were designed and fabricated under the project for use of small scale commercial clam processers. This included a boiling and cooking unit assembly that will be used for generating steam and cooking the raw clams before shucking. The boiling chamber can produce continuous steam by burning biomass of about 7 kg for 40 minutes. The cooking unit is comprised of two chambers, each of which can accommodate 50 kg of clam in five trays at a time.

Separating meat from the boiled clam is a time consuming process and is done manually at present. To ease the drudgery and to improve the locally

Mini boiler with steaming chamber (Hybrid: Biomass + LPG)

existing crude models, two rotary type meat shell separator prototypes were designed and fabricated at the Institute, one with a 20 mm circular mesh and the other with 15 mm square mesh. Food grade steel was used for fabrication. The drum length was 1.8 m and the diameter 50 cm. The height of the rotary shaft was 3.5 feet which makes it convenient for operation. The cost of fabrication was ₹ 36000 for 20 mm and ₹ 38000 for 15 mm square mesh drum. Initial trials show that 10 kg of cooked whole clam can be shucked in two minutes.

Meat shell separator

Economics of operation

Time analysis of fisher persons involved in clam picking and processing activities revealed that the average time for clam picking was 6-7 hours. The processing and marketing which is undertaken by women took up to 6 hours. For the facility being established, the cooking time was standardized at 10 minutes per batch (100 kg of raw, depurated clam for each batch). A preliminary investment analysis was done for the clam processing unit for a one tonne operating capacity per day with an assumption of 20 days of operation per month. The initial capital investment was ₹ 26.54 lakhs. The total annual cost (fixed and variable) was ₹ 42.52 lakhs. Assuming two scenarios of maximum retail price for clam meat from the unit at ₹ 250/Kg and ₹ 300/Kg and the shell fetching ₹ 2.50 per kg, the annual net profit, BCR, NPV and IRR were worked out as ₹ 1.55, 149.79 lakhs, 87% and ₹ 1.83, 241.07 and 133%, respectively. Based on preliminary marketing studies with value added products (clam cutlet) prepared by the cluster members, and assuming 20% of the clam meat produced at the unit is utilized for value addition, the BCR, NPV and IRR for the earlier two scenarios was ₹ 1.71, 202.59, 114% and ₹ 1.94, 275.61 and 150%, respectively.

Design and construction of processing unit

Construction of the processing facility was initiated which was inaugurated by Dr. Ravishankar C.N., Director, ICAR-CIFT on 8th January 2018, in the presence of Shri K.S. Shibu, Perumbalam Panchayat President and other people's representatives of Perumbalam.

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

Workshops on entrepreneurial skill development

Survey on social status and need for entrepreneurship development for Sidi tribal women and Kharwa community women were carried out. Based on this a series of trainings and workshops were organized in various aspects of fish processing, value addition, food safety, packaging and entrepreneurship. Workshops on 'Development of entrepreneurial skill to empower women from backward communities' and 'Safe and quality fish production' for Sidi tribal women were organized during 14-15 November, 2017 and for

Release of brochure on 'Safe and good quality fish for healthy eating'

Trainees with faculty and guests

Demonstration of hygienic handling of fish

Demonstration of preparation of value added fishery products

Kharwa fisherwomen during 17-18 January, 2018. Shri Piyush Bhai Fofandi, President, Seafood Exporters Association of India (Gujarat Chapter), inaugurated the programmes and stressed on the importance of training programmes for creating awareness among fishing community and tribal fishers on hygienic handling of fish during harvest and post harvest periods. Lectures were delivered on development of entrepreneurial skill in the area of fish processing, importance of fish in human diet and basic concepts of hygiene and sanitation. Practical sessions were conducted on hygienic handling of fish and proper icing for safe and quality production.

Training/skill development programme on 'Renewable energy-based hygienic fish drying methods'

A practical oriented training/skill development programme was organized for 20 Sidi tribal women during 27-28 February, 2018. The chief guest of valedictory function was Shri Lakham Bhai Bhensla, President, Kharwa Fishermen Community.

Training on 'Improved packaging and labelling methods for producing better quality fish'

Training/capacity building programme on 'Improved packaging and labelling methods for producing better quality fish' was organized for 20 Kharwa fisherwomen on 8 March, 2018. Dr. Nimisha Makhansa, the leading Gynaecologist of Veraval and Chief Guest of International Women's Day Celebrations distributed certificates to the trainees.

A similar training programme was organized for 20 Sidi tribal women on 27 March, 2018. Preparation, packaging and labelling of various value-added fishery products were demonstrated to the trainees.

The trainees with faculty and guests

Practical session during the training

Dr. S. Remya speaking on the occasion

Fish pickle and dried Bombay duck prepared

Indian National Centre for Ocean Information (INCOIS) Project

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

ITKs relevant to fishing and fish processing were documented from nine coastal districts of Kerala under the project during the period 2017-18. The ITKs were collected after informed consent was obtained from the respondents. Attempts were made to validate selected ITKs through literature reviews, questionnaire-based responses from experts as well as an expert workshop held at ICAR-CIFT, Kochi on 2 March, 2017 which was followed up with personal discussions with the experts on several occasions. Field level filming and documentation as a part of documentation and dissemination of ITKs had also been carried out and three films in Malayalam titled 'Beyond the waves' were produced.

Selected and validated ITKs

- "If the westerly wind prevails, the water level increases and the fish are plenty and can be easily detected by the fisherman" - Shri P.K. Karthikeyan (70), Azheekkode, Thrissur.

  There is a significant influence of monsoon on the fish availability along the coast. The sea conditions change with the onset of the south west monsoon (June-September), and the behavior of the south-westerly winds along the west coast, the colder, nutrient-rich and oxygen depleted waters from the sub-surface replace the surface water from the coast. This leads to growth of phytoplankton, mostly diatoms and dinoflagellates, which in turn results in increased productivity.

- "When the water currents are strong, the fish availability is less" – Shri P.J. Antony (48), Chethy, Alappuzha.

  Biological and ecological characteristics of marine ecosystems are largely affected by the water currents. At the time of pre-monsoon period, northerly current disappear and southerly flow will be restricted to a narrow belt. When the currents are low, there is a possibility of few fishes which prefer low currents to congregate in shoals and hence, this increases the chance of good fishery in these areas.

- "An experienced fisherman can predict a rough sea by observing the way the wind blows" - Shri Thankachan (58), Munambam, Ernakulam.

  Wind generates local wind waves and long ocean-swells and therefore wind is considered as the driving force of weather at sea. This can be related with the fishers' statement that the weather can be predicted based on the direction of wind.

- "The presence of kingfish is an indication of the presence of mackerel as they are predator and prey" – Shri Preman (52), Vellayil, Kozhikode.

  Studies have shown that the gut content of kingfish mainly comprised of mackerel, whitebaits etc. Thus the presence of kingfish could be an indication of the presence of mackerel.

- "The availability of smaller fishes will be high within a distance of 8 maaru (1 maaru = one fathom = 1.8 m)" – Shri Shaji (26), Thiruvithara, Thrissur.

  The state of Kerala possess 3700 sq. km of continental shelf which is about half of the shelf area of south west coast. Moreover, the shelf area of the state is adjacent to the coast, which enables near-shore fishing. It is estimated that the potential yield from a depth range of 200 m was nearly as 8 lakh tonnes, It validates the belief of fishermen (as recorded also from Shri Shaji, Thiruvithara, Thrissur) that fish were available in plenty near shore waters up to a depth of 15 *paakam*.

- "Seahorses, dried and powdered, mixed with honey is used to cure asthma and other breathing troubles" - Shri Vijayan (59), Perinjanam, Thrissur.

  Seahorses belong to the Syngnathidae family and have been used in China and Caribbean coast of Mexico as traditional medicine for asthma, infections of the throat, insomnia, and abdominal pain.

- "In order to increase the strength of the net, treatments include immersing the nets in water boiled with dried kadukka (*Terminalia chebula*) nuts" – Shri Suku (65), Kuzhuppilly, Ernakulam; Shri Aboobakar (61), Puthuponnani, Malappuram; Shri Jalaludeen (41), Chavakkad, Thrissur.
- "Or the bark of a tree locally called as kalasham (*Lannea coromandelica*) once in a week" – Shri Jalaludeen (41), Chavakkad, Thrissur; Shri Purushothaman (58), Neerkadavu, Kannur.
- "The leaves of local plant munja (*Premna mollissima*) is ground and mixed in water and boiled before immersing the nets and this in turn improves the strength of nets" – Shri Sivadasan (80), Perumppilly, Ernakulam.

Studies have shown that fishing gear treatment and maintenance was carried out using locally available plant resins and other by-products.

National Fisheries Development Board (NFDB) Project

National surveillance programme for aquatic animal diseases

Active and passive surveillance of aquaculture farms for OIE-listed pathogens

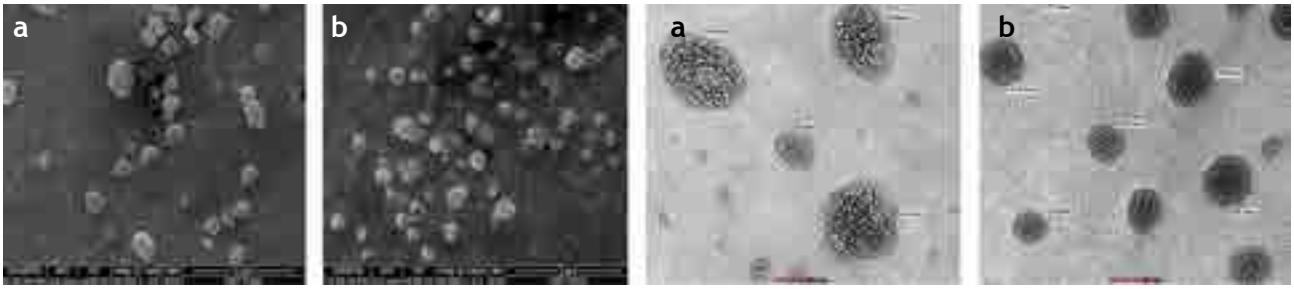
One hundred and eighty six samples were collected from 23 finfish and eight shellfish farms and screened for OIE-listed pathogens. The baseline data of these farms were also collected. All the 186 fish samples were found to be negative for KHV and SVCV and among the 48 shrimp samples tested for WSSV, YHV, TSV, IHHNV, HPV, MBV, EHP and AHPND, three samples were found to be positive for WSSV and negative for all the remaining pathogens. Twenty five farms were visited in Ernakulam, Kottayam and Alappuzha districts of Kerala as a part of active surveillance. Physico-chemical parameters such as temperature, pH, dissolved oxygen and un-ionized ammonia were estimated in the field level. Management practices to be followed at the farms were suggested to the farmers. Baseline data of 26 fish and shrimp hatcheries from five districts of Kerala (Palakkad, Thrissur, Ernakulam, Kottayam and Alappuzha) were also collected. Three disease outbreak cases were investigated in both shellfish and finfish aquaculture farms. Among these two were due to infection with WSSV and the other due to the ammonia toxicity and a parasitic infection.

ICAR-National Fellow Project

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

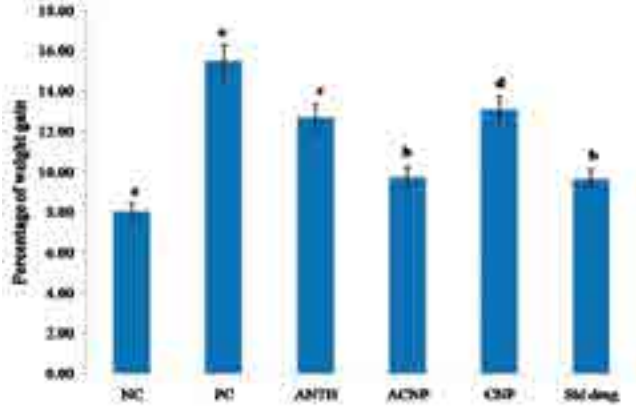
Anthocyanin-loaded chitosan carriers for nutraceutical applications

Chitosan nano particles were prepared by ionic gelation method for the entrapment of anthocyanin as an effective strategy to enhance their *in vivo* bio-availability and *in vitro* stability. Electron microscopy (SEM and TEM) analysis indicated that the nano particles developed were uniform in size distribution with an average particle size of 160±20 nm.

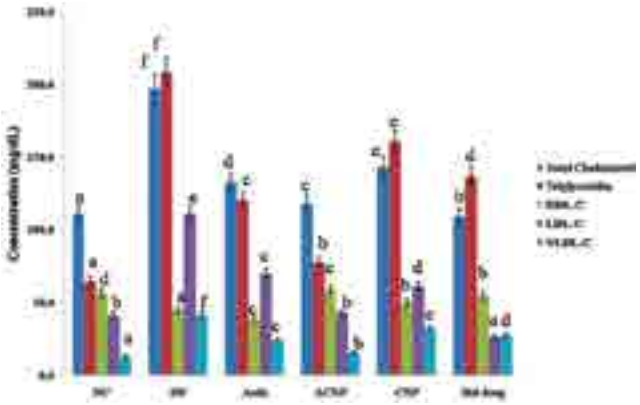


SEM and TEM image of chitosan nano particles (a) and anthocyanin-loaded chitosan nano particles (b)

Oral supplementation of anthocyanin loaded nano particles were found to have hypolipidemic effect in high fat-alcohol fed experimental rats. Figure below shows the average weight gain percentage of experimental rats during the 60 days of study. The high fat-fed group animals had maximum weight gain which is significantly different from normal control and anthocyanin-fed groups. ACNP-treated group exhibited the highest hypolipidemic effect.

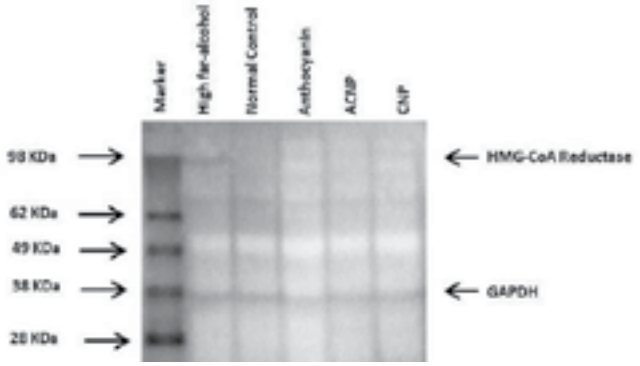


Percentage weight gain in experimental rats after 60 days of oral supplementation of test materials along with high fat and alcohol



Serum lipid profile in experimental rats after 60 days of oral supplementation of test materials along with high fat and alcohol

HMG-CoA reductase and fatty acid synthase are the major enzymes involved in lipid metabolism. Western blot analysis of these enzymes substantiated the hypolipidemic potential of anthocyanin-loaded chitosan nano particles (ACNP). HMG-CoA reductase and fatty acid synthase were analyzed in liver tissue homogenate. Both of these enzymes were detectable in high fat-alcohol fed control group and found in negligible amounts in test material supplemented groups.



Western blot of HMG-CoA reductase

Oral supplementation of anthocyanin-loaded nano particles protected gastric mucosa against HCl-ethanol-induced damage by decreasing the volume and acidity of gastric juice.

Fish collagen was extracted from skin, scales, and air bladder of three different species (*Sphyrnae mokkaran*, *Pangasius hypophthalmus* and *Nemipterus japonicus*). Electrophoretic pattern analysis of collagen extract from different sources revealed the presence of α1 and α2 subunits in a ratio 2:1 indicating that the collagens belong to Type I, as also their cross-linked dimers and trimers are present.

Bioactive collagen peptides were prepared through enzymatic digestion of acid soluble fraction of skin collagen from hammerhead shark (*Sphyrnae mokkaran*) followed by subsequent column chromatographic fractionation.

Collagen peptides were found to exhibit 94% radical scavenging activity analyzed using ABTS assay. The fractions with maximum activity were pooled. The results are represented as activity equivalent to the concentration of BHA.

Gross pathological analysis of gastric mucosa (a) Normal control, (b) HCl-alcohol treated group, (c) ACNP treated, (d) Anthocyanin treated, and (e) CNP treated

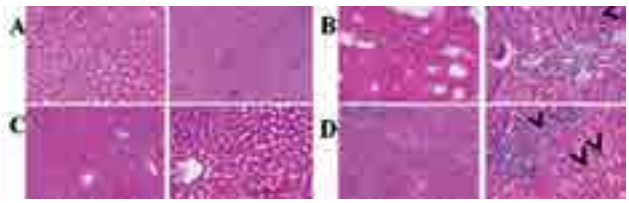
(A) Collagen crude hydrolysate, and (B) Bioactive peptide fractions

Amelioration of high fat-alcohol induced hyper-lipidemia

Collagen peptides were evaluated to possess the ability to ameliorate diet-induced hyperlipidemia in experimental rats. The expression levels of fatty acid synthase, LCAT, and HMG Co-A reductase were found to be regulated in collagen peptide treated animals. Collagen peptides were found to neutralize the oxidative stress induced by the intake of oxidized fat in diet by enhancing the expression levels of antioxidant enzymes as well as prevented membrane lipid peroxidation.

Hepato-protective activity of fish collagen peptides

Fish collagen peptides were found to be capable of maintaining the normal liver parenchyma, diminish the micro vesicular steatosis and moderate the level of inflammatory infiltrate in high fat-alcohol induced experimental rats.

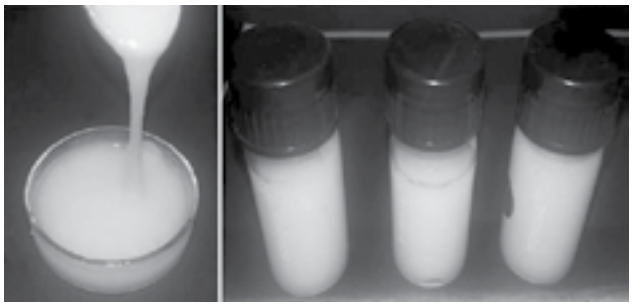


(A) Normal control (NC), (B) High fat (PC) fed positive control, (C) FCP fed animals, (D) Standard drug fed animals (*black arrow indicating the lymphocyte infiltration to the tissues)

Hydoxyapatite was prepared from scales of *Nemipterus japonicas* after collagen extraction. Dried powdered scale containing hydroxyapatite was extracted from *N. japonicas* and characterized by SEM-EDAX and FTIR spectroscopy revealing the presence of protein in significant quantities. Hence deproteinzation is required to get pure hydroxyapatite which may be used for bone regeneration applications.

A pain relieving balm with squalene as an active component was developed. *Cissus quadrangularis* extract was added as an additional component which has healing property in bone ailments.

A skin moisturizing lotion was developed with collagen, chitosan and alginate as main ingredients.



Skin moisturizing lotion with chitosan, alginate and collagen as active components

Export Inspection Council of India (EICI) Project

Preparation of pictorial guidelines based on freshness ratings for the species of fishes exported to European Union

Pictorial guidelines for fish and shellfish

Sensory grading of the fish and shellfish as per EU scheme (EC Regulation 2406/96) was developed with pictorial guidelines. As per European Union guidelines, freshness category of fish species is graded as E, A and B for fish and cephalopods and E and A for shrimps. This gradation is assessed based on sensory parameters (eyes, gill, operculum, skin, smell, flesh mucus and overall appearance), which was validated by biochemical (TVBN, TMA, TBA and pH) and microbiological (APC, *Pseudomonas* count and H_2S producer count) parameters.

Pictorial guidelines were prepared for 16 species of fish that included famed freshwater fish (*Catla catla*, *Labeo rohita*, *Cirrhinus mrigala*, *Ctenopharyngodon idella*, *Oreochromis mossombicus*, *Pangasianodon hypophthalmus*), farmed brackishwater shrimp (*Litopenaeus vannamei*), wild marine shrimp (*Penaeus*

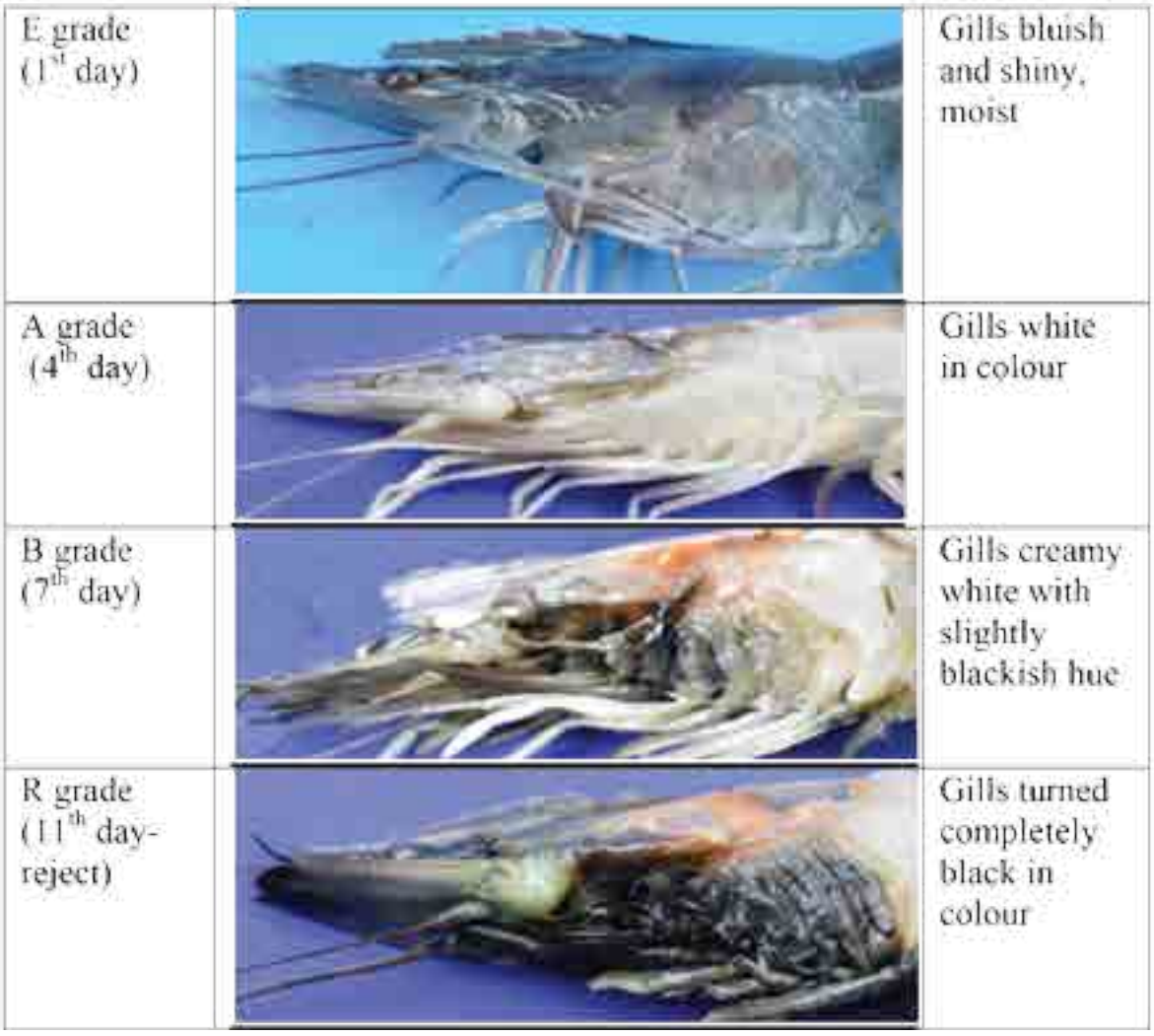
monodon), Cuttlefish (*Sepia aculeate*) and marine fish (*Scomberoides lyson*, *Priacanthus hamrur*, *Pennahia anea*, *Pentaprion longimonas*, *Eubleekeria splendens*, *Himantira gerridae* and *Katsuwonus pelamis*).

Fish assessed from various locations

Visakhapatnam: Rohu (*Labeo rohita*), Catla (*Catla catla*), Mrigal (*Cirrhinus mrigala*), Grass carp (*Ctenopharyngodon idella*), Mozambique tilapia (*Oreochromis mossambicus*) and Rainbow runner (*Elagatis bipinnulata*).

Kochi: Golden-lined spine foot/rabbitfish (*Siganus lineatus*), Swordfish (*Xiphias gladius*), Moonfish (*Mene maculata*), Indian goatfish (*Parupeneus indicus*), Large scaled terapon (*Terapon theraps*), Pink ear emperor (*Lethrinus lentjan*), Indian squid (*Loligo duvaucelii*), Malabar blood snapper (*Lutjanus malabaricus*), Tomato hind (*Cephanopholis sonnerati*) and Malabar trevally (*Carangoides malabaricus*).

Veraval: Coromandel flying fish (*Hirundichthys coromandelensis*), Silver pomfret (*Pampus argenteus*) and Longfin mojarra (*Pentaprion longimanus*).



Pictorial guidelines for *Litopenaeus vannamei*

***Catla catla* (Catla)**

Average Weight : 1392.34g
Average Length : 44.125

Freshness Rating

Parameter	Freshness Category			
	Extra	A	B	Rejection Category (Not admitted)
Skin				
	Bright, Gold, Shiny	Silver shiny head region became slight dark	Shining was reduced, scales were blackend	Scales were turned black, shining was completely lost, softening of belly and blackening of tail and pectoral fin
Eye				
	Black eye, clear pupil, convex, no blood incarnation	Slightly shrunken back eye, clear pupil, eye found to have blood incarnation	Shrunken dull black eye, flat pupil, eye found to have blood incarnation	Opaque dull black eye, flat pupil, blood incarnation turns pale red colour
Gill				
	Brick red gill	Dark red gill	Light red gill	Pale red gill
Gill cover				
	Gill cover is silver shiny with pink edges	Gill cover is dull silver shiny pink, edges turned dull, darkening at posterior region	Gill cover is dull pale brown colour, pink edges turned pale yellow, darkening at posterior region	Gill cover is dull pale brown colour, edges turned pale brown, black wrinkles at posterior region
Smell of gill	Seaweedy	Seaweedy	Fishy smell	Spoil smell
Flesh	Brick red and stiff	Dark red and stiff	Pale red soft	Pale red and further softened

***Xiphias gladius* (Swordfish)**	
	Average Weight: 48 kg Average Length :1.50 m

Freshness Rating

Parameter	Freshness Category			
	Extra	**A**	**B**	**Rejection category (Not admitted)**
Skin				
	Bright pigmentation, bright, shining iridescent colours; clear distinction between dorsal and central surfaces	Bright pigmentation; bright, clear distinction between dorsal and central surfaces	Dull, lustreless, insipid colours; skin creased when fish curved	Dull pigmentation, skin creased
Eye				
	Convex, bright dark blue-black bright pupil, transparent 'eyelid'	Convex and slightly sunken; dark pupil; slightly opalescent cornea	Flat, blurred opaque pupil	Concave in the centre of eye, fully opaque

Gill				
	Dark red , white gill arch, no mucus	Blackish red, paler at edges, transparent to milky mucus, greyish gill arch	Tinge of greenish in colour; sticky mucus	Marked bleaching, thick bacterial slime
Gill cover				
	Dark Silvery	Faded silvery	Light bluish tinge, whitish	Light bluish tinge, bleached
Smell	Fresh seaweed	Slightly sulphureous	Rancid oil	Putrid
Flesh	Firm and elastic	Firm and elastic and difficult to detach	Soft and slightly firm	Very soft and loosen
Peritoneum	Transparent, difficult to detach	Transparent and non-detachable	Brownish	Liquefied and ruptured

Food and Agricultural Organization (FAO) Project

Assessment of food loss from selected gillnet and trammel net fisheries in India

Primary data collection

Primary data was collected from 12 selected study sites (Jaleshwar, Veraval, Inayam-Kadiyapatnam belt, Thoothoor, Bhavanisagar, Visakhapatnam, Kakinada and Machilipatnam) in the states of Gujarat, Kerala, Tamil Nadu and Andhra Pradesh along west and east coast. The data collected relates to fish and gear loss in gillnet fisheries in the non-motorized, motorized and mechanized sub-sectors; trammel net fisheries in Kerala and Tamil Nadu; lobster gillnets of Tamil Nadu; and inland gillnet fisheries in the Bhavanisagar reservoir of Tamil Nadu.

Primary data collection

Organization of workshops

A mid-term review workshop to review the work carried out against the proposed targets was organized. Further, towards the end of the project, a National Stakeholder Workshop was organized with 36 stakeholders and validated the findings of the study.

Mid-term review workshop in progress

Study sites

Quantification of fish loss

Quantified the fish loss from gillnets and trammel nets in terms of: (1). Physical loss, and (2). Loss of economic value due to quality loss. Physical loss assessment included losses at different stages such as pre-harvest, harvest and post-harvest (up to the first sale stage). Of the total fish loss, the pre-harvest loss was the maximum, followed by post harvest and harvest losses. Pre-harvest loss incurred mainly due to depredation. Maximum loss due to depredation was from mechanized and motorized sub-sectors targeting tuna and other large pelagics. Among specific nets, the fish loss was predominant in trammel net and lobster nets.

Depredated sardine catch observed at Jaleshwar, Gujarat

Bycatch and discards mainly contributed to the post harvest losses. Long soaking time, long fishing trips and lack of or improper preservation were identified as the main reasons for quality degradation of the catch. There was wide variation in the fish loss incurred by the different sub-sectors in terms of the scale of fishing operation and the target fishery. The fish loss along the value chain *viz.*, from the producers to the first sale point was also quantified.

Physical and quality loss of fish by different means; (A). Discarded catch, (B). Improper post harvest handling, (C). Catch kept in unhigienicc places, and (D). Inadequate icing

Assessment of fishing gear loss

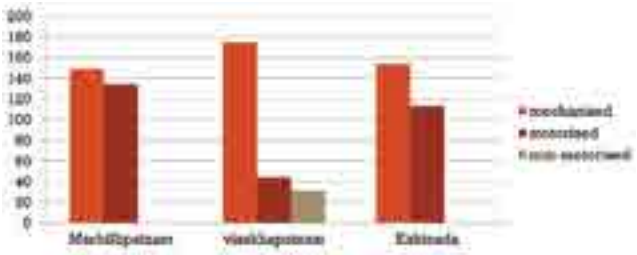
Fishing gear discarded on beach

Fishing gear loss assessment covered abandoned, lost and otherwise discarded gear (ALDFG), *viz.*, type and quantity of gear loss. The loss of gear (abandoned, discarded and lost) was substantial in the gillnet and trammel net fisheries in the marine sector with wide inter-sectoral and regional variations. The gear discard was negligible while the abandoned and lost gear was significant in quantity.

Vessel-gear conflicts, damage caused by pufferfish and big fishes including whale shark, natural and man-made obstructions in the sea bottom, rough weather etc. are the major causes for gear loss. Impact of losses, affected stakeholders, implications of losses on the fishers' livelihood and suggestions on technological and management options to reduce losses also were covered in the study.

Assessment of food loss from selected gillnet and trammel net fisheries of Andhra Pradesh

In Andhra Pradesh, when average losses of the gillnet operating in different fishing systems are counted over a year (using the previous year's losses as an indicator), the losses varied from 55 kg to 300 kg per annum or 15% to 40% of the total weight of nets carried on-board. The average cost of replacement of these nets ranged from ₹ 20,000 in the small FRP boats of Mangamaripeta to as high as ₹ 150,000 in the mechanized gillnetters of Machilipatnam. The low investment capacities and the short fishing durations of the Mangamaripeta fishers is cited as the reason for their estimates of the losses of fish and nets being on the lower side. The study revealed that in the gillnet and trammel net fisheries of the country, there exist losses in terms of food and gear loss. Though the direct food loss forms less than 0.5% of the total catch, the gear loss comes up to 80% of the total gear in some sector. This loss has an indirect impact on the income of the fishermen. A set of ten recommendations based on the key findings from the study is put forwarded in order to focus on the more important priorities from the fishers' perspective.



Average amount of gear components lost per year (MT)

Bangalore Water Supply and Sewage Board (BWSSB) Project

Feasibility study on coastal reservoir concept to impound Netravati river flood waters: A sustainable strategy for water resource development for Mangaluru and Bengaluru

A feasibility study was conducted along with Indian Institute of Science, Bengaluru (Lead institute), Amrita Viswa Vidyapeeth, Coimbatore and NIT, Suratkal on coastal reservoir concept to impound Netravati river flood waters for water resource development for Mangaluru and Bengaluru. Visited sites and participated in discussions at Mangaluru during June 2017. Presented the results in the first International workshop on 'Coastal reservoirs in India' and Review meeting of the Project held at Amrita University Campus, Coimbatore on 19 July, 2017. The feasibility report was prepared and subsequently submitted to Shri K.J. George, Hon'ble Minister for Bengaluru Development, Govt. of Karnataka on 7 August, 2017 for further action.

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Communicating Research Outcome

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 International Symposium on 'Aquatic animal health and epidemiology for sustainable Asian aquaculture' (ICAR-NBFGR, Lucknow, 20-21 April, 2017), Workshop on 'Emerging technologies in agriculture and food sector' (Bengaluru, 12 July, 2017), Workshop on 'Application of Single Molecule Real Time (SMART) sequencing and bioinformatics analysis' (ICAR-NBFGR, Lucknow, 25-26 July, 2017), Workshop on 'Good practices in quantitative social science research' (ICAR-CTCRI, Thiruvananthapuram, 17-22 August, 2017), Seminar on 'Strategies, innovations and sustainable management for enhancing coldwater fisheries and aquaculture' (ICAR-DCFR, Bhimtal, 22-24 September, 2017), Research conclave on 'Packaging: The growth driver' (IIP, Delhi, 27-28 October, 2017), 27th Swadeshi Science Congress on 'Science and technology for societal development' (Amrita Vishwa Vidyapeetham, Amrita University, Kollam, 7-9 November, 2017), 11th Indian Fisheries and Aquaculture Forum on 'Fostering innovations in fisheries and aquaculture: Focus on sustainability and safety' (Kochi, 21-24 November, 2017), International conference on 'Statistics for 21st century' (Kerala University, Thiruvananthapuram, 14-16 December, 2017), International Symposium on 'Advances in sustainable polymers' (IIT, Guwahati, 8-11 January, 2018), International conference on 'Remote sensing for ecosystem analysis and fisheries' (Kochi, 15-17 January, 2018), International Extension Congress 2018 on 'New horizons of extension – Challenge and opportunities' (Bhubaneswar, 1-3 February, 2018), National Symposium on 'Recent trends in science and technology' (Christ College, Rajkot, 11 February, 2018), International conference on 'Advanced applications of radiation technology' (Mumbai, 5-7 March, 2018) and International Conference on 'Invigorating transformation of farm extension towards sustainable development: Futuristic challenges and prospects' (TNAU, Coimbatore, 9-10 March, 2018). Research 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.	Hypocholesteromic effect of Ulvan extracted from *Ulva lactuca*	1	Kochi (1 April - 30 June, 2017)
2.	Effect of moringa leaf extract and vitamin B-12 loaded chirosan on anti-ulcer activity in rat models	1	Kochi (1 April - 30 June, 2017)
3.	Evaluation of functional properties of proteins from seaweeds in comparison to fish protein	1	Kochi (1 April - 30 June, 2017)
4.	Development of extruded products and value addition of mussel meat	1	Kochi (3-4 April, 2017)
5.	Isolation and antimicrobial sensitivity pattern of Salmonella from dry fish	1	Kochi (3 April – 6 July, 2017)
6.	HACCP in seafoods	14	Mumbai (3-7 April, 2017)
7.	Development of restructured surimi balls: A comparative evlauation on high pressure and heat processing on shelf life characteristics	1	Kochi (3 April – 5 August, 2017)
8.	Shelf life of milkfish (*Chanos chanos*) in palm sheath container during chilled storage	1	Kochi (3 April – 5 August, 2017)

Sl. No.	Subject	No. of beneficiaries	Venue and date
9.	Improved utilization of sardine head waste: Preparation and characterization of protein hydrolysate	1	Kochi (3 April – 5 August, 2017)
10.	Effect of sodium metabisulphite on properties of seaweed supplemented semi sweet biscuit	1	Kochi (3 April – 5 August, 2017)
11.	The effect of iced storage on the physico-chemical, microbial and functional quality of farmed Nile tilapia (*Orechromis niloticus*)	1	Kochi (3 April – 5 August, 2017)
12.	Quality evalauation of fish meal and oil	1	Kochi (20 March – 4 April, 2017)
13.	Incidence of coagulase negative Staphylococci in salt cured dry fish and its antimicrobial resistance patterns	1	Kochi (7 April – 18 July, 2017)
14.	Isolation and biochemical characterization of *Vibrio mimicus* from fish and aquatic environment	1	Kochi (7 April – 18 July, 2017)
15.	Standardization of pasteurized carb spread	1	Kochi (10 March – 10 April, 2017)
16.	Preparation of clam and fish products	35	Chempu, Ernakulam (20 April, 2017)
17.	Fabrication of CIFT-TED	20	Guindi Forest Park, Chennai (27-28 April, 2017)
18.	Evaluation of the extraction efficiency of various solvents on the yield and bioactivities of brown seaweeds *Sargassus wightii* and *Turbinaria conoides*	1	Kochi (1 February - 29 April, 2017)
19.	Laboratory techniques for microbiological examination of seafood	7	Kochi (1-12 May, 2017)
20.	Concepts of HACCP and microbiological quality analysis of seafood	8	Veraval (1-6 May, 2017)
21.	Fish processing and quality control	24	Kochi (2-16 May, 2017)
22.	Clam meat processing and value addition	32	Kochi (3-4 May, 2017)
23.	Seafood quality assurance	15	Kochi (8-12 May, 2017)
24.	Fish drying and processing technologies	20	Kadamakkudi (11-12 May, 2017)
25.	HACCP concepts	34	Kochi (15-19 May, 2017)
26.	Development of value added products from freshwater fish	20	Kochi (16-20 May, 2017)
27.	Utilization of fish waste	40	Thopumpaday, Kochi (17 May, 2017)
28.	Hygienic handling of fish, preservation and value addition of fish	30	Eluru, West Godavari, A.P. (21 May, 2017)
29.	Conversion of diamond mesh to square mesh codend	8	Veraval (25 May, 2017)
30.	Conversion of diamond mesh to square mesh codend	28	Diu (26 May, 2017)
31.	Conversion of diamond mesh to square mesh codend	30	Porbandar (27 May, 2017)

Sl. No.	Subject	No. of beneficiaries	Venue and date
32.	Value added fish products	26	Digad, Maharashtra (30-31 May, 2017)
33.	Instruments and techniques in biochemical analysis	2	Kochi (1-30 June, 2017)
34.	Fabrication of square mesh codend	18	Machilipatnam, A.P. (3 June, 2017)
35.	Microwave vacuum drying of Indian mackerel	1	Visakhapatnam (5-21 June, 2017)
36.	Fresh seafood handling protocols, value addition and seafood quality	7	Kochi (7-9 June, 2017)
37.	Engineering interventions in post harvest fisheries sector	1	Kochi (8-30 June, 29017)
38.	Packaging of seafood products	15	Kochi (12-14 June, 2017)
39.	Microbiology	1	Visakhapatnam (13-24 June, 2017)
40.	Development of extruded snacks and value added products	10	Kochi (15-17 June, 2017)
41.	Chloramphenicol residue analysis by ELISA in shrimps	9	Mumbai (15-17 June, 2017)
42.	Fish processing and value addition	17	Kochi (19-28 June, 2017)
43.	Microbiological examination of seafood/water with special reference to *Listeria monocytogens* and fecal Streptococci	1	Kochi (21-27 June, 2017)
44.	Conversion of diamond mesh codened to square mesh codend	34	Porbandar, Gujarat (29 June, 2017)
45.	In-house training programme in Engineering	2	Kochi (7-17 July, 2017)
46.	Total quality assurance in seafoods	10	Mumbai (10-15 July, 2017)
47.	Laboratory methods for microbiological examination of seafood	9	Visakhapatnam (10-22 July, 2017)
48.	Industrial training in engineering	2	Kochi (11-15 July, 2017)
49.	Modern analytical techniques in Biochemistry	13	Kochi (11-21 July, 2017)
50.	Conversion of diamond mesh codened to square mesh codend	30	Mangrol, Gujarat (13 July, 2017)
51.	Conversion of diamond mesh codened to square mesh codend	26	Sasan Dock (17-18 July, 2017)
52.	Conversion of diamond mesh codened to square mesh codend	26	Harnie, Maharashtra (19 July, 2017)
53.	Conversion of diamond mesh codened to square mesh codend	24	Ratnagiri, Maharashtra (20 July, 2017)
54.	Conversion of diamond mesh codened to square mesh codend	28	Malvan, Maharashtra (21 July, 2017)
55.	Fabrication of 40 mm square mesh codends for trawls/dolnet fishing gear	30	Thane, Maharashtra (21-22 July, 2017)

Sl. No.	Subject	No. of beneficiaries	Venue and date
56.	ELISA method for the analysis of chloramphenicol	4	Mumbi (22 July, 2017)
57.	Gear fabrication	30	Veraval (25 July, 2017)
58.	Chloramphenicol residue analysis in shrimps	6	Mumbai (25-27 July, 2017)
59.	ELISA method for the analysis of chloramphenicol	6	Mumbai (29 July, 2017)
60.	Microbiological examination of seafood	21	Kochi (1-7 August, 2017)
61.	Mending of fishing nets	30	Veraval (3 August, 2017)
62.	Net mending and fabrication	6	Visakhapatnam (7-9 August, 2017)
63.	Fish processing technology	10	Kochi (7-11 August, 2017)
64.	On job training in FP, QAM and MFB Divisions	28	Kochi (7-14 August, 2017)
65.	Advanced fish drying using fish dryers	12	Kochi (8 August, 2017)
66.	Post harvest technology for preservation and value addition of marine resources	15	Kochi (16-21 August, 2017)
67.	Minimizing microbial hazards in aquaculture	18	Eluru, A.P. (17 August, 2017)
68.	Product development under Rural Entrepreneurship Awareness Development Yojana	18	Veraval (21-31 August, 2017)
69.	HACCP concepts	20	Kochi (22-26 August, 2017)
70.	Conversion of diamond mesh codened to square mesh codend	30	Mangrol, Gujarat (27 August, 2017)
71.	Institutional training in Engineering	5	Kochi (29 August – 18 September, 2017)
72.	Value added specialty fish products	5	Visakhapatnam (6-8 September, 2017)
73.	Recent trends in harvest and post harvest technologies in fisheries	22	Kochi (12-26 September, 2017)
74.	Value added specialty fish products	8	Visakhapatnam (22-23 September, 2017)
75.	Processing and value addition of fish and shellfish	10	Kochi (11-13 October, 2017)
76.	ISO-22000 – HACCP for seafood industry	3	Kochi (16-28 October, 2017)
77.	Novel fish drying techniques	12	Kochi (24-25 October, 2017)
78.	Value added products from fish and prawn	20	KVK, RARS, Kumarakom (2-3 November, 2017)
79.	Biochemical and microbiological quality analysis of fish	17	Veraval (6-10 November, 2017)
80.	Development of entrepreneurship skill	20	Veraval (14 November, 2017)
81.	Analysis of veterinary drug residues including antibiotics	14	Kochi (14-18 November, 2017)
82.	Safe and quality fish production	20	Veraval (15 November, 2017)
83.	Protocols for production of high value secondary products from industrial fish and shellfish processing	9	Kochi (27 November – 21 December, 2017)

Sl. No.	Subject	No. of beneficiaries	Venue and date
84.	Anti-microbial resistance in fish and aquatic environment	1	Kochi (7-20 December, 2017)
85.	Preparation of fish protein hydrolysates	1	Visakhapatnam (14-23 December, 2017)
86.	Preparation of gelatin hydrolysates	1	Visakhapatnam (14-23 December, 2017)
87.	Value added fish products and hygienic handing of fish	30	Visakhapatnam (16-18 December, 2017)
88.	Canning technology	10	Kochi (15 December, 2017)
89.	A study on understanding the diversity of MRSA clone in seafood	1	Kochi (1 January -7 April, 2018)
90.	Studies on occurrence of *Vibrio mimicus* in fish and fishery products	1	Kochi (1 January -7 April, 2018)
91.	Monitoring the incidence of ESBL producing *E. coli* and it's antimicrobial resistance patterns in seafood	1	Kochi (1 January -7 April, 2018)
92.	Effect of temperature on growth of *Vibrio parahaemolyticus* subjected to chemical treatment in fish and fishery products	1	Kochi (1 January -7 April, 2018)
93.	Preparation of chitin and chitosan	2	Kochi (3-4 January, 2018)
94.	Conversion of diamond mesh codened to square mesh codend	34	Munambam, Ernakulam (4-5 January, 2018)
95.	Enhancing farm income through entrepreneurship development in fishing and fish processing	22	Kochi (5-25 January, 2018)
96.	Antibacterial effect of green tea extract encapsulated nano chitosan for control of *Vibrio harveyi*	1	Kochi (5 January -7 April, 2018)
97.	Proximate composition of fish	1	Kochi (8-12 January, 2018)
98.	Quality inspection of fish, concept of cold chain and value addition	20	Kochi (15-20 January, 2018)
99.	Development of entrepreneurial skill to empower women from backward communities	20	Verval (17 January, 2018)
100.	Safe and quality fish production	20	Verval (18 January, 2018)
101.	Quality inspection of fish, concept of cold storage and value addition	20	Kochi (15-20 January, 2018)
102.	Dried squid shred by different drying methods	1	Visakhapatnam (22-31 January, 2018)
103.	Extraction of seafood flavour peptides from shrimp	1	Visakhapatnam (22-31 January, 2018)
104.	Chitins: Preparation and quality evaluation	1	Kochi (24-27 January, 2018)
105.	Fabrication/conversion of square mesh codend from diamond mesh netting	48	Neendakara fishing harbor, Kollam (25 January, 2018)
106.	Quality evaluation of tuna	1	Visakhapatnam (25 January - 3 February, 2018)

Sl. No.	Subject	No. of beneficiaries	Venue and date
107.	Microbiology	1	Visakhapatnam (27 January – 18 February, 2018)
108.	Value added fish products and hygienic handling of fish	30	Visakhapatnam (29-31 January, 2018)
109.	Microbiological quality analysis of seafood	20	Veraval (29 January – 3 February, 2018)
110.	Value added products from fish and clam	20	Chempu, Ernakulam (30-31 January, 2018)
111.	Fish drying and chilling	20	Kochi (6-21 February, 2018)
112.	Indian Food Laboratory Network (INFoLNET) demonstration programme	16	Kochi (6-20 February, 2018)
113.	In-plant training in fish processing engineering	19	Kochi (6 February – 6 March, 2018)
114.	Processing and quality aspects in fisheries	25	Kochi (12-17 February, 2018)
115.	HACCP/fish processing methods		Kochi (16-17 February, 2018)
116.	Production and quality evaluation of chitin and chitosan from prawn shell waste	1	Kochi (19-20 February, 2018)
117.	Hygienic handling and value addition of fish	20	Visakhapatnam (20-21 February, 2018)
118.	Fish processing and value addition	17	Kochi (21 February – 6 March, 2018)
119.	Antibotic resistance screening	6	Kochi (26 February – 2 March, 2018)
120.	Renewable energy based hygienic fish drying method	20	Veraval (27-28 February, 2018)
121.	Fish-preneurship for livelihood security: Scopes and opportunities	22	Kochi (27 February – 6 March, 2018)
122.	Effect of process parameters on nutritional quality and bio-functional properties of fish head stock	1	Kochi (1 December, 2017 – 1 March, 2018)
123.	Value added fishery products	20	Kochi (1-2 March, 2018)
124.	Value added fishery products	22	Kochi (5-6 March, 2018)
125.	Hygienic fish vending	58	Puducherry (6 March, 2018)
126.	Seafood quality assurance and water analysis	1	Kochi (5-15 March, 2018)
127.	Proximate analysis of fish	1	Kochi (5-16 March, 2018)
128.	Retort pouch processing of fish and shellfish	7	Kochi (7-9 March, 2018)
129.	Production of value added products from clam meat	18	Kochi (6 February – 6 March, 2018)
130.	Improved packaging and labeling methods for producing better quality fish	20	Veraval (8 March, 2018)
131.	Preparation of clam and fish products	30	Chempu, Ernakulam (16 March, 2018)
132.	Clam meat processing and value addition	25	Kochi (17 March, 2018)
133.	Fabrication of CIFT-TED	25	Guindy, Chennai (12-13 March, 2018)

Sl. No.	Subject	No. of beneficiaries	Venue and date
134.	Speciality fish products	30	Mangamaripetta, Visakhapatnam (24 March, 2018)
135.	Fishing capacity management of trawl fishery	36	Cochin Fisheries Harbour, Thoppumpaday, Ernakulam (28 March, 2018)
	Indicates out station programmes		

Participants of Clam meat processing and value addition (Kochi)

Distribution of certificate to Sidi tribal trainee (Veraval)

Fabrication of square mesh codend (Machilipatnam)

Net mending and fabrication (Visakhapatnam)

Value added speciality products (Visakhapatnam)

Distribution of FRP canoe (Digad)

Value added fish products (Digad)

Demonstration of ELISA method to EIA officials (Mumbai)

Quality inspection (Kochi)

Training at Puducherry (Participants and faculty)

Speciality fish products (Visakhapatnam)

Fish drying and processing technologies (Kochi)

Production of value added products from clam meat (Kochi)

Fish drying and chilling (Kochi)

Outreach programmes

During the period (April 2017 to March 2018) a total of 24 training/awareness programmes on various aspects of harvest and post harvest technologies were conducted outside the Institute as indicated in screen in the previous Chapter on 'Training/Awareness Imparted'.

Exhibitions

The Institute participated in the following exhibitions during the period:

- 'Mathrubhumi Karshika Mela' organized by Mathrubhumi Group at Payyannur during 1-5 April, 2017.
- 'Karshika Mela' at Motihari, Bihar during 13-19 April, 2017.
- Exhibition held in connection with International symposium on 'Aquatic animal health and epidemiology for sustainable Asian aquaculture' held at ICAR-NBFGR, Lucknow during 20-21 April, 2017.
- 'Aqua Aquaria India' organized by MPEDA, Kochi at Mangaluru during 14-16 May, 2017.
- 'Matsyotsav and Matsya Adalath' exhibition held at Kollam during 27-29 May, 2017.
- Exhibition held in connection with 19th All India Congress of Zoology and International symposium held at ICAR-CIFRI, Barrackpore during 9-11 June, 2017.
- 'Matsya Fest and Matsya Adalat' held at Thanur, Malappuram during 7-9 July, 2017.
- 'Matsya Fest and Matsya Adalat' held at Thiruvananthapuram during 10-12 July, 2017.
- 'Matsya Fest and Matsya Adalat' held at Kochi during 25-27 July, 2017.
- 'Matsya Fest and Matsya Adalat' held at Alappuzha during 13-15 August, 2017.
- 'Young Entrepreneurs Summit - 2017', a one day exhibition organized by KSIDC, Govt. of Kerala at Kochi on 12 September, 2017.
- 'AQUBIZ-2017' held at Vijayawada during 15-17 September, 2017.
- Exhibition held in connection with the National seminar on 'Strategies, innovations and sustainable management for enhancing coldwater fisheries and aquaculture' held at ICAR-DCFR, Bhimtal during 22-24 September, 2017.
- 'Mathrubhumi Karshika Mela – 2017' held at Vaikom during 27 September to 3 October, 2017.
- Exhibition held in connection with the Diamond Jubilee Celebrations of St. Michael's College, Cherthala during 10-15 October, 2017.
- 3rd India International Science Festival held at Anna University, Chennai during 13-16 October, 2017.
- Exhibition held in connection with 'Tuber crops technology conclave and Agri-start up Meet 2017' held at ICAR-CTCRI, Thiruvananthapuram during 27-28 October, 2017.
- World Food India – 2017 organized by Ministry of Food Processing, Govt. of India at New Delhi during 3-5 November, 2017.
- 27th Swadeshi Science Congress – 2017 on 'Science and technology for societal development' held at Amrita Viswa Vidyapeetham, Kollam during 7-9 November, 2017.
- World Fisheries Day Exhibition organized by NFDB, Hyderabad at New Delhi during 21-23 November, 2017.
- Exhibition held in connection with 11th Indian Fisheries and Aquaculture Forum on 'Fostering innovations in fisheries and aquaculture: Focus on sustainability and safety' held at Kochi during 21-24 November, 2017.
- Exhibition held in connection with National Seminar on 'Science and Geopolitics of Himalayan-Arctic-Antartic' held at New Delhi during 30 November - 1 December, 2017.

- 'Karnataka Matsya Mela 2017' held at Bengaluru during 8-11 December, 2017.
- Albertian International Education Expo organized by St. Albert's College, Kochi during 4-6 January, 2018.
- Kisan Mela and Agri-Business Meet organized by ICAR-CPCRI, Kasaragod during 5-10 January, 2018.
- Machinery Expo-2018 organized by Department of Industries, Govt. of Kerala at Kochi during 12-15 January, 2018.
- Exhibition held in connection with International conference on 'Remote sensing for ecosystem analysis and fisheries' organized by ICAR-CMFRI, Kochi during 15-17 January, 2018.
- Exhibition held in connection with the 1st International Extension Congress-2018 on 'New horizons of extension: Challenges and opportunities' held at ICAR-CIWA, Bhubaneswar during 1-3 February, 2018.
- 'Agro-Food Pro-2018' organized by Department of Industries, Govt. of Kerala at Thrissur during 10-13 March, 2018.
- 'Aquaex India' organized by SIFA at Hyderabad during 15-17 March, 2018.
- 'Krishi Unnathi Mela' organized by ICAR at New Delhi during 16-19 March, 2018.
- Innovations for Festival of Innovation and Entrepreneurship (FINE) Exhibition at Rashtrapathi Bhavan, New Delhi during 19-23 March, 2018.

ICAR-NBFGR, Lucknow

3rd IISF at Chennai

Shri Ch. Adi Narayana Reddy, Honourable Minister for Marketing & Warehousing, Animal Husbandry, Dairy Development, Fisheries and Cooperatives, Government of Andhra Pradesh visiting ICAR-CIFT stall at Aquabiz 2017

Shri Radha Mohan Singh, Honorable Union Minister of Agriculture and Farmers Welfare visiting ICAR-CIFT stall at World Fisheries Day exhibition

Karnataka Matsya Mela 2017 at Bengaluru

ICAR-CIFT stall at Extension Congress exhibition

Aquaex India 2018 at Hyderabad

Krishi Unnathi Mela at New Delhi

Hon'ble Union Minister for Agriculture and Farmers Welfare, Shri Radha Mohan Singh visiting ICAR-CIFT Exhibition Stall at 'Krishi Unnathi Mela'

Dr. P. Pravin, ADG (M.Fy.), ICAR at Festival of Innovation and Entrepreneurship (FINE) Exhibition at New Delhi

Matsya Adalat (Kochi)

Smt. J. Mercykutty Amma, Hon'ble Minister for Fisheries at Kollam stall

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

Dr. Manoj P. Samuel, HOD, Engineering delivered a radio talk on "CIFT fish dryers and other engineering technologies" (In Malayalam) through AIR, Kochi FM on 13 July, 2017.

A documentary on 'Hygienic fish vending kiosk' was broadcasted by AIR Kochi FM during the Kisan Vani programme on 22 February, 2018.

Doordarshan Programme

Dr. Manoj P. Samuel, HOD, Engineering participated in a Live Phone-in Programme in 'Krishi Darshan' at Doordarshan, Thiruvananthapuram on 26 May, 2017.

Workshops/Short Courses/Seminars etc. conducted

National Seminar on Post Harvest Fisheries Engineering: A National seminar on "Recent advances in post harvest fisheries engineering" was organized jointly by ICAR-CIFT and the Society of Fisheries Technologies (India) (SOFT-I) at ICAR-CIFT, Kochi on 23 September, 2017. Dr. Ravishankar C.N., Director, ICAR-CIFT presided over the inagural function. Around 140 delegates participated in the seminar deliberations.

Dr. Ravishankar C.N. delivering the presidential address

11th Indian Fisheries and Aquaculture Forum: The 11th Indian Fisheries and Aquaculture Forum (11th IFAF) on 'Fostering innovations in fisheries and aquaculture: Focus on sustainability and safety' was hosted by ICAR-CIFT in collaboration with Asian Fisheries Society Indian Branch (AFSIB) during 21-24 November, 2017 at Kochi. The Forum was inaugurated by Shri M. Venkaiah Naidu, Hon'ble Vice President of India. Shri Justice (Retd.) P. Sathasivam, Hon'ble Governor of Kerala, Dr. T. Mohapatra, Secretary, DARE and DG, ICAR, New Delhi, Smt. J. Mercykutty Amma, Minister for Fisheries, Harbour Engineering and Cashew Industry, Govt. of Kerala, Dr. K.T. Jaleel, Minister for Local Administration, Govt. of Kerala, Shri K.V. Thomas, MP, Ernakulam, Dr. J.K. Jena,

Hon'ble Vice President inaugurating 11th IFAF

Release of the Book of Abstracts of 11th IFAF (L to R: Dr. Ravishankar C.N., Dr. T. Mohapatra, Smt. J. Mercykutty Amma, Shri Justice (Retd.) P. Sathasivam, Shri Venkaiah Naidu, Dr. K.T. Jaleel, Prof. K.V. Thomas and Dr. J.K. Jena)

DDG (Fishery Science), ICAR, New Delhi were a few of the other dignitaries who attended the function. The Technical Sessions were spread over ten themes, *viz*. Fisheries resources: Genetics, biodiversity and management, Fishing systems for sustainable fisheries, Fishery biology, toxicology and environment, Aquaculture production, Aquatic animal health management, Adding value to fish: Avenues in fish processing and packaging, Safe fish: Quality, risk assessment and regulations, Fishomics and frontier sciences for blue-bio-economy, Socio-economics, gender, capacity building and livelihood and Fisheries trade, policy and governance. There was a special theme on Gender in aquaculture and fisheries in India. A total of 95 eminent personalities from India and abroad chaired and co-chaired the various sessions and also delivered invited lectures on the themes. About 900 oral and poster presentation were made by the delegates from all over India and abroad. Each session concluded by recommendations and lastly salient recommendations were approved in the Plenary Session conducted on 24 November, 2017.

Winter School on 'Antimicrobial Resistance': A winter School on 'Antimicrobial resistance in fish and aquatic environment and its impact on human health' was held during 1-21 December, 2017. Twenty five trainees from ICAR institutions, State Agricultural Universities, Veterinary Colleges, State Department of Fisheries and other Colleges, in various profiles ranging from Scientists, Assistant Professors, Associate Professors, Field Officers etc. representing nine states *viz*., Andhra Pradesh, Arunachal Pradesh, Kashmir, Kerala, Madhya Pradesh, Rajasthan, Uttar Pradesh, Uttarakhand and Tamil Nadu participated in the programme. Prof. (Dr.) A. Ramachandran, Vice Chancellor, Kerala University of Fisheries and Ocean Studies, Kochi inaugurated the programme on 1 December, 2017. Dr. A. Gopalakrishnan, Director, ICAR-CMFRI, Kochi and Chief Guest of the valedictory function distributed certificates to the participants.

Prof. A. Ramachandran, Vice Chancellor, KUFOS and Dr. A. Gopalakrishnan, Director, ICAR-CMFRI addressing the participants

Hands on practicals in progress

Winter School on 'Fish-preneurship Development': An ICAR sponsored Winter School on 'Enhancing farm income through entrepreneurship development in fishing and fish processing' was conducted at ICAR-CIFT, Kochi during 5-15 January, 2018. Dr. K. Nirmal Babu, Director, ICAR-Indian Institute of Spices Research, Kozhikode inaugurated the Winter Schol on 5 January, 2018 in a function presided over by Dr. Ravishankar

Dr. K. Nirmal Babu inaugurating the Winter School

Hands on practicals in progress

C.N., Director ICAR-CIFT, Kochi. Twenty one scientists from SAUs, ICAR institutes and KVKs covering 10 different states of the country namely, J&K, Punjab, Maharashtra, Gujarat, Sikkim, Chattisgarh, Madhya Pradesh, Andhra Pradesh, Tamil Nadu and Kerala attended the Winter School.

Participants of the National Stakeholder Workshop

Stakeholder Workshop: A 'National Stakeholder Workshop' of the FAO funded project on 'Assessment of food loss from selected gillnet and trammel net fisheries of India' was organized at ICAR-CIFT, Kochi on 15 December, 2017. The main objective of the Workshop was to validate the findings of the study and to get inputs from stakeholders for refinement of the findings. Thirty four participants including the project team, representatives from State Fisheries Department, governmental and non-governmental organizations, fishing industry, academic institutions, research institutions and fishermen groups took part in the workshop.

Winter School on 'Marine nutrients': A 21 days ICAR sponsored Winter School on "Marine nutrients for fighting malnutrition: Recent advances in marine biomolecules for human nutrition and healthcare" was conducted at ICAR-CIFT, Kochi during 1-21 February, 2018. Dr. Inbasekhar, IAS, Sub Collector, Fort Cochin was the Chief Guest of the valedictory function which was presided over by Dr. Ravishankar C.N., Director ICAR-CIFT. The Winter School was attended by 25 participants from eight different states of the country.

Dr. R. Chandra Babu, VC, KAU inaugurating the Winter School

Dr. Inbasekhar, IAS, Asst. Collector, Ernakulam distributing certificate to a participant

APFISHTECH-2018: ICAR-CIFT, Kochi and Society of Fisheries Technologists, (India), SOFT(I) Kochi jointly organized a National Seminar on 'Opportunities and challenges in Indian fisheries and aquaculture: Andhra Pradesh perspective' (APFISHTECH-2018) at Visakhapatnam during 23-24 March, 2018. Shri V. Padmanabham, President, Seafood Exporters Association of India inaugurated the Seminar and released the Book of Abstracts. Dr. J.K. Sundaray, Director, ICAR-Central Institute of Freshwater Aquaculture, Bhubaneswar was the Guest of Honour.

Inauguration of APFISHTECH

Inaugural session in progress

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, Trissur
- Academic Council, ICAR-CIFE, Mumbai
- Technical Committee, Food Safety Standards Authority of India, Govt. of India
- 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-Niche area of excellence projects, ICAR, New Delhi
- Internal Review Committee of ICAR Niche Area of Excellence 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, Inland Fisheries Society of India

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

As Member

- Academic Council of KUFOS, Kochi
- Assessment committee in the area of Bioscience and Biotechnology of CSIR-CLRI, Chennai
- Governing Body of NIFAM, Govt. of Kerala
- Departmental Promotion Committee of ICAR-CIFE, Mumbai
- External examiner, Sri Venkateswara Veterinary University, Tirupathy
- Expert committee for assessing the progress of UGC-BSR Fellows, CUST, Kochi

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

As Member

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

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

As Member

- Committee of AQUDIRECT.ORG
- Assessment panel of experts of EIC and MPEDA

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

As Chief Editor

- Fishery Technology

As Member

- Expert committee on Fisheries for amendment of KMFRA, Govt. of Kerala
- Expert committee on Fisheries policy constitution, Govt. of Kerala
- National Research Advisory Committee of National Innovation Foundation, Gandhi Nagar, Gujarat
- National Steering Committee for Agriculture Sector, TIFAC, DST, Govt. of India
- Expert committee constituted by Govt. of Kerala for formulation of the conceptual framework for drawing 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

- Reviewer, Agricultural Science Research Journal and Journal of Plantation Crops
- Editorial Board, Indian Journal of Hill Farming
- Extension Education Council, KUFOS, Kochi
- Editor, Indian Research Journal of Extension Education

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

As Chairman

- MBA student of School of Agri-Business Management, PJTSAU, Hyderabad

As Member

- As Empanelled Commercial Expert, AgrInnovate India Ltd. (ICAR)
- Technical committee for installing a Signature Room at MPEDA, Kochi

Dr. A.A. Zynudheen, Principal Scientist and Head Incharge, Quality Assurance and Management Division

As Member

- Assessment panel of experts for approval of seafood processing plants for EU
- Board of Examiners, M.Sc., Industrial Fisheries, CUSAT, Kochi and M.Sc., Aquaculture, Calicut University, Kozhikode

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

As Member

- Review pnel of Fishery Survey of India

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

Dr. A.K. Jha, Scientist and Scientist Incharge, Veraval Research Centre

As Member

- Assessment panel of experts for approval of seafood processing plants for EU
- Advisory Committee,Veraval Fisheries College, GAU, Junagadh
- Advisory Committee, Kamadhenu University, Gandhi Nagar

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

As Member

- Assessment panel of experts for approval of seafood processing plants for EU
- External examiner, Manonmaniyam Sundaranar University, Tirunelveli

Shri M. Nasser, Principal Scientist

As Member

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

Dr. Saly N. Thomas, Principal Scientist

As Chairperson

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

As Member

- Expert committee constituted by Matsyafed, Kerala for the implementation of fish net factory at Thiruvananthapuram
- Institute Management Committee, ICAR-CMFRI, Kochi
- Assessment of Technical personnel for promotion, ICAR-CMFRI, Kochi
- Examination committee of Tamil Nadu Fisheries University, Chennai

Dr. M.P. Remesan, Principal Scientist

As Member

- Examination committee for M.Sc., Fisheries Engineering Technology, KUFOS, Kochi

Dr. Nikita Gopal, Principal Scientist

As Member

- Programme Chair, GAF-India Special International Symposium at 11th IFAF
- Lead Editor, Asian Fisheries Science Special Issue 30(S) of the Asian Fisheries Society
- Editor, Fishery Technology
- Reviewer, Maritime Studies, Lake and Reservoir Management, Journal of Marine Biological Association of India and Indian Journal of Fisheries

Dr. V. Geethalakshmi, Principal Scientist

As Member

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

- Examiner for PG Statistics courses of KUFOS, Kochi and MG University, Kottayam
- Reviewer, Fishery Technology, Indian Journal of Fisheries, Agricultural Science Research Journal and Journal of Fisheries and Life Sciences

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

- Internal Complaints Committee, CIFNET, Kochi
- Passing Board, CUSAT, Kochi
- Assessment panel of experts for approval of seafood processing plants for EU
- Board of examiners, KUFOS, Kochi/CUSAT, Kochi/ICAR-CIFE, Mumbai/TNFU, Nagapattinam/KAU, Thrissur
- Registered guide, CUSAT, Kochi

Dr. S. Ashaleta, Principal Scientist

As Member

- Executive Committee, 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
- Board of examiners, Calicut University, Calicut/CUSAT, Kochi/MG University, Kottayam
- Subsidy Committee for setting up of cold storage facilities, MPEDA, Kochi

Dr. B. Madhusudana Rao, Principal Scientist

As Member

- Assessment panel of experts of EIC and MPEDA

Dr. Toms C. Joseph, Principal Scientist

As Member

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

Dr. G.K. Sivaraman, Principal Scientist

As Member

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

Dr. S.K. Panda, Principal Scientist

As Chairman

- FSSAI Scientific panel on Fish and fishery products

As Member

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

- Methods review group of FSSAI, New Delhi for development of official testing methods fro analysis of physical, chemical and biological hazards in food products
- Codex Electronic Working Group on the Revision of the general principles of food hygiene

Dr. A. Suresh, Principal Scientist
As Member

- External examiner for B.Sc.-M.Sc. (Integrated) course of KAU, Thrissur

Dr. K.K. Asha, Principal Scientist
As Member

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

Dr. V.R. Madhu, Principal Scientist
As Member

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

Dr. C.O. Mohan, Senior Scientist
As Member

- Assessment panel of experts for approval of seafood processing plants for EU
- Subsidy committee on Cold store and other machines, MPEDA, Kochi
- Faculty, Marine Sciences, CUSAT, Kochi
- Editor, Journal of Food Quality (Special issue)

Shri M.V. Baiju, Senior Scientist
As Member

- Expert committee of MPEDA, Kochi to provide subsidy for installation of insulated fish hold and refrigeration onboard fishing vessels
- Board of Studies, KUFOS, Kochi
- Tender committee of Fishery Survey of India for the purchase of generators for the vessel Matsya Varshini
- Technical committee of Department of Fisheries, Govt. of Tamil Nadu for the implementation of Blue Revolution Scheme of Ministry of Agriculture and Farmers Welfare, Govt. of India
- Committee constituted by CIFNET, Kochi to finalize the technical specification of the 37.5 m L_{OA} training vessel

Dr. S. Visnuvinayagam, Scientist
As Member

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

Dr. K.K. Prajith, Scientist
As Member

- Physical verification committee of MPEDA

Dr. Jesmi Debbarma, Scientist
As Member

- Assessment panel of experts of EIC and MPEDA

Dr. S. Remya, Scientist
As Member

- Assessment panel of experts for approval of seafood processing plants for EU
- Physical verification committee of MPEDA

- Technology assessment committee, EIA, Veraval
- Advisory committee,Veraval Fisheries College, GAU, Junagadh

Smt. V. Renuka, Scientist
As Member

- Assessment panel of experts for approval of seafood processing plants for EU
- Advisory Committee,Veraval Fisheries College, GAU, Junagadh
- Physical verification committee of MPEDA
- Technology Assessment Committee, EIA, Veraval

Shri C.G. Joshy, Scientist
As Member

- External examiner of SH College, Thevara, Kochi

Dr. P. Viji, Scientist
As Member

- Assessment panel of experts of EIC and MPEDA

Dr. P. K. Binsi, Scientist
As Member

- Subsidy Committee of MPEDA, Kochi
- Assessment panel of experts for approval of seafood processing plants for EU
- Research Advisory Committee of ICAR-CIFE, Mumbai for Masters and Ph.D. programme

Smt. U. Parvathy, Scientist
As Member

- Assessment panel of experts for approval of seafood processing plants for EU
- ICAR-CIFT and NETFISH-MPEDA consultancy project for assessmeny of impact of NETFISH training programmes

Shri G. Kamei, Scientist
As Member

- Physical verification committee of MPEDA

Shri S. Sreejith, Scientist
As Member

- Armed Forces Medical Research Committee

Smt. S.J. Laly, Scientist
As Member

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

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

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 for M.F.Sc. student thesis of KUFOS, Kochi
- Passing Board of M.F.Sc. of KUFOS, Kochi

Shri S. Chinnadurai, Scientist
As Member

- Assessment committee for technical personnel of ICAR-CMFRI, Kochi

Dr. S. Murali, 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. 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
- Editorial Board as Chief Editor, Science India, Kochi

Dr. B. Ganesan, Chief Technical Officer
As Member

- Institutional Animal Ethics Committee, School of Bio Sciences, MG University, Kottayam; M/s Arjuna Natural Extracts Ltd., Edayar, Kochi; M/s Pushpagiri College of Pharmacy, Thiruvalla; Confederation of Ayurvedic Renaisance Kerala Ltd., Thrissur; Amrita Institute of Medical Sciences and Research Centre, Kochi; St. Joseph's College of Pharmacy, Cherthala and Nehru College of Pharmacy, Pampady, Thrissur.

Shri C.R. Gokulan, Asst. Chief Technical Officer
As Member

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

Dr. Santhosh Alex, Asst. Chief Technical Officer
As Member

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

Shri P.S. Nobi, Technical Officer
As Member

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

Training and Capacity Building

Human resource development activities

During the period under report, a recommended by the Human Resources Deveopment Cell of the Institute staff of the Institute participated in various trainings programmes as listed below. 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. K.K. Asha	Proteomics: From protein purification to characterization	IIT, Mumbai (26 June - 1 July, 2017)
2.	Dr. Anuj Kumar	Presentation and persuation skills	New Delhi (15 May, 2017
3.	Dr. Pankaj Kishore Shri K.K. Anas	Stilbenes and steroids	EIA, Chennai (3-7 July, 2017)
4.	Smt. S.J. Laly Smt. E.R. Priya	Analysis of veterinary drug residues	EIA, Kochi (24-28 July, 2017)
5.	Shri K.A. Basha Shri R.K. Nadella	Application of Single Molecule Real Time (SMART) sequencing and bioinformatic analaysis	ICAR-NBFGR, Lucknow (25-26 July, 2017)
6.	Shri K.A. Basha	Application of bioinformatics in agricultural research and education	ICAR-NAARM, Hyderabad (14-23 September, 2017)
7.	Dr. K. Rejula	Impact assessment of agricultural research and technologies	ICAR-NAARM, Hyderabad (12-16 September, 2017)
8.	Dr. Saly N. Thomas	Priority setting, monitoring and evaluation	ICAR-NAARM, Hyderabad (6-11 October, 2017)
9.	Dr. L.N. Murthy	Analysis of veterinary drug residues	FSSAI, Mumbai (10-14 October, 2017)
10.	Dr. C.N. Ravishankar	The art of successful leadership and management	MDI, Gurgaon (1-3 November, 2017)
11.	Dr. S. Visnuvinayagam	Molecular techniques in shrimp health management	ICAR-CIFE, Mumbai (6-15 November, 2017)
12.	Smt. T. Muthulakshmi Smt. S.S. Greeshma	Next generation genomic sequencing techniques for beginners	ICAR-CMFRI, Kochi (7-8 November, 2017)
13.	Dr. Pankaj Kishore Shri Devananda Uchoi	Analysis of veterinary drug residues	ICAR-CIFT, Kochi (14-18 November, 2017)
14.	Shri K.K. Anas Smt. S.J. Laly	Doping substances in food supplement	NDTL, New Delhi (27-30 November, 2017)
15.	Smt. E.R. Priya	Advanced analytical solutions in dioxin analysis	CSIR-NIIST, Thiruvananthapuram (5 January, 2018)
16.	Dr. V.K. Sajesh Dr. K. Rejula	Enhancing farm income through entrepreneurship development in fishing and fish processing	ICAR-CIFT, Kochi (5-25 January, 2018)
17.	Smt. S.S. Greeshma	Marine nutrients for fighting malnutrition: Recent advances in marine biomolecules for human nutrition and healthcare	ICAR-CIFT, Kochi (1-21 February, 2018)

Sl. No.	Name(s) of participant(s)	Training attended	Venue and date
18.	Dr. V. Geethalakshmi	Big data analytics in agriculture	ICAR-NAARM, Hyderabad (8-9 February, 2018)
19.	Dr. Abhay Kumar	Molecular techniques in shrimp health management	ICAR-CIFE, Mumbai (24 February – 5 March, 2018)
20.	Dr. V. Murugadas Shri K.A. Basha Dr. T.K. Anupama Smt. T. Muthulakshmi Smt. E.R. Priya Smt. S.S. Greeshma	Antibiotic residue detection with the RIKILT SCAN Test	ICAR-CIFT, Kochi (26 February – 2 March, 2018)
21.	Shri V. Chandrasekar Shri P.N. Jha Shri S. Ezhil Nilavan	Writing and publishing skills for scientists	ICAR-CPCRI, Kasaragod (7-9 March, 2018)
Category - Technical			
22.	Smt. Anu Mary Jose	Chromatography technique for food analysis	IIFPT, Thanjavur (19-23 June, 2017)
23.	Dr. P.H. Dhiju Das Shri Rahul Ravindran Smt. V. Susmitha	Chromatographic techniques (GC & HPLC): An analytical approach in food analysis	CSIR-CFTRI, Mysuru (17-21 July, 2017)
24.	Smt. G. Remani Smt. V.C. Mary Shri M. Prasanna Kumar Shri P.D. Padmaraj Smt. Tessy Francis Shri Y.D. Kripalani Shri K.C. Anish Kumar Shri P. Suresh Shri G. Vinod Shri K. Ajeesh	Microbiological analysis of seafood	ICAR-CIFT, Kochi (1-7 August, 2017)
25.	Smt. U.P. Prinetha	Techniques in molecular biology and plant tissue sulture	KAU, Thrisur (23 October – 4 November, 2017)
26.	Smt. T. Silaja	J-Gate@CERA for southern region	ICAR-CMFRI, Kochi (15 December, 2017)
27.	Shri K. Ajeesh	Aquaculture nutrition and feed technology	ICAR-CIBA, Chennai (3-12 January, 2018)
28.	Shri G. Vinod Shri Ajith V. Chellappan	Food Safety Supervisor Training Programme	Kochi (26 January, 2018)
29.	Shri P.S. Nobi	Organizational behavior in government	ISTM, New Delhi (5-9 February, 2018)
30.	Shri Rakesh M. Raghavan Smt. P. Sruthi	Fish-preneurship for livelihood security: Scopes and opportunities	ICAR-CIFT, Kochi (24 February – 6 March, 2018)
31.	Shri P.D. Padmaraj Smt. Tessy Francis Shri N. Sunil Shri C.K. Suresh Shri K.D. Santhosh Shri P.A. Aneesh Shri K.A. Noby Varghese Smt. Vineetha Das	Enhancing the capabilities of Technical Personnel	ICAR-CIFT, Kochi (24 20-22 March, 2018)

Sl. No.	Name(s) of participant(s)	Training attended	Venue and date
	Shri V. Vipin Kumar Shri T. Jijoy Smt. U.P. Prinetha Smt. P. Sruthi Shri K.C. Anish Kumar Shri Ajith V. Chellappan Smt. Anu Mary Jose Smt. G. Archana Shri P. Suresh Smt. K. Reshmi Shri V.N. Sreejith		
Category - Adminsitrative			
32.	Shri K.S. Sreekumaran	General financial rules	ISTM, New Delhi (9-11 August, 2017)
33.	Shri P.P. Anil Kumar	Stress management	ISTM, New Delhi (28-31 August, 2017)
34.	Shri K.K. Sasi Smt. T.K. Shyma 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. N.R. Akhila Smt. A.R. Raji Shri P. Mani Smt. Jaya Das Smt. E. Jyothilakshmy 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 Kum. K.S. Sobha Kum. T. Deepa Shri P.P. George Smt. Subin George Smt. Suni Surendran Shri G.S. Sahoo Shri Deu Umesh Aroskar	Enhancing the capabilities of Administrative Personnel	ICAR-CIFT, Kochi (15-17 January, 2018)

Sl. No.	Name(s) of participant(s)	Training attended	Venue and date
Category - Skilled Support			
35.	Shri P.A. Sivan Shri P.V. Raju Shri A.V. Chandrasekharan Shri K.K. Karthikeyan Smt. U.K. Bhanumathy Shri P. Raghavan Shri T.M. Balan Shri V. Deepak Vin Smt. P.T. Mary Vinitha Shri K.R. Rajasaravanan Shri P.N. Nikhil Das Shri A. Vinod Shri K.S. Ajith Shri S.N. Dash Shri M.V. Rajan	Enhancing the capabilities of Skilled Support Staff	ICAR-CIFT, Kochi (15-17 March, 2018)

Trainings organized for various categories of employees

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

- Enhancing the capabilities of Administrative Personnel during 15-17 Janauary, 2018.
- Enhancing the capabilities of Skilled Support Staff during 15-17 March, 2018.
- Enhancing the capabilities of Technical Personnel during 20-22 March, 2018.

In the programme for Adminstrative Personnel the following were the lectures: (1). Creating supporting environs, (2). Auditing-An overview, (3). General management of administration, (4). Personality development, motivation, time management etc., (5). GST and its implications, (6). VII CPC-Basic features, and (7). Transparency in public procurement.

In the programme for Skilled Support Staff the following were the lectures: (1). Personality development, time management etc., (2). Inter-personnel relationship and motivation, (3). Nutrition and fitness, (4). Finance management for effective living, (5). Central Pay Commission, (6). Enterprise Resource Planning (ERP) (Theory and practical), and (7). Personal claims and advances.

In the programme for Skilled Support Staff the following were the lectures: (1). Personality development, time management, interpersonnel relationship etc., (2). Digital library usage, (3). Central Pay Commission, (4). Basics of laboratory saftey techniques, (5). Applications for cashless payments, (6). Basics of computer applications and Excell Prgramming (Theory and practical), (7). Effective English speaking, and (8). Maintenance and handling of laboratory equipments.

Prof. Edward Edezhath speaking to the administrative trainees

Participants and faculty of training for technical personnels

HRD fund allocation and utilization

The total fund allocated under HRD for the year 2017-18 was ₹ 3.00 Lakhs and the utilization is ₹ 3.45 Lakhs.

Visits Abroad

Dr. Ravishankar C.N., Director and **Dr. S.K. Panda,** Principal Scientist, Quality Assurance and Management Division, ICAR-CIFT, Kochi was part of Indian deleation to RIKILT Laboratories, The Netherlands to study the working of European Union Reference Laboratories during 2-6 October, 2017. Dr. S.K. Panda also atteneded the training on 'Risk assessment' at NVWA, The Netherlands during 4-6 Ocober, 2017.

Dr. S.K. Panda, Principal Scientist, Quality Assurance and Management Division, ICAR-CIFT, Kochi visited International Food Safety Training Laboratory (IFSTL), JIFSAN, University of Maryland, USA and Canadian Food Inspection Agency (CFIA) Headquarters, Ottawa during 10-19 April, 2017 to attend the Masters Training Programme on "Methods for the determination of drug residues in fish, meat and poultry". The visit to Canadian Food Inspection Agency at Ottawa was mostly focused on laboratory management and understanding the vast spectrum of operations carried out by the agency in monitoring and surveillance of food safety hazards as well as emergency operations carried out during food-borne outbreak, disaster management scenarios etc.

Dr. S.K. Panda (at *) at University of Meryland

Dr. Niladri Sekhar Chatterjee, Scientist, Biochemistry and Nutrition Division, ICAR-CIFT, Kochi completed SERB Overseas Post Doctoral Fellowship in Queens University, Belfast, U.K. The fellowship helped him in gaining substantial expertise in mass spectrometry-based metabolomics and subsequent data mining. During this fellowship Dr. Chatterjee gained expertise in processing and analyzing Big Data using high performance computation softwares such as Progenesis QI, XCMS, MZ Mine, SIMCA, Unscrambler etc. Identification of endogenous metabolites using mass spectrometry data and online database mining was another important skill learnt. Techniques of deconvolution of the spectra, identification of adducts and determination of accurate molecular mass were learnt. Databases such as Metlin, HMDB, Food DB, Kegg, Lipid Blast, Lipid Maps, Chemspider etc. were mined for possible identification of biomarkers. A new Ambient ionization Mass Spectrometry (AMS) technique named as Rapid Evaporation Ionisation Mass Spectrometry (REIMS) was learned. A new prototype software "Abstract Model Builder" was evaluated and optimized to process the data generated from REIMS experiments. Mass spectral databases were created, predictive models were developed and further successfully used in real time recognition of unknown shrimp samples. Techniques to process the REIMS data and subsequent identification of metabolites using general metabolomics software such as Progenesis QI was also learnt.

Dr. N.S. Chatterjee

Linkages/Partnerships

Collaboration with other institutes

Local Institutions in the area other than ICAR Institutes

- Goa Shipyard Ltd., Goa
- Cochin Shipyard Ltd., Kochi
- Marine Products Export Development Authority, Kochi
- Export Inspection Agency, Kochi, Visakhapatnam and Veraval

- Fishery Survey of India
- National Institute of Oceanography, Goa and 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, Bihar, Manipur, Tripura, Meghalaya and Arunachal Pradesh

National Institutes and Agricultural Universities

- Agricultural Universities
- Ministry of Agriculture
- Ministry of Food Processing Industries
- Department of Ocean Development
- Department of Biotechnology
- Department of Science and Technology
- Department of Electronics
- Indian Institute of Technology, Chennai and Kharagpur
- 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 Science, Gitam Deemed to be University
- Dr. V.S. Krishna Govt. PG College, Visakhapatnam
- 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
- College of Fisheries, Mangaluru
- ICAR-National Bureau of Fish Genetic Resources Research Centre, Kochi
- INCOIS, Hyderabad
- Andhra University, Visakhapatnam

- Amity University, Noida
- JNTU, Hyderabad
- Sri Venkateswara Veterinary University, Tirupati
- State Institite of Fisheries Technlogy, Kakinada
- P.S.G. College of Arts and Science, Coimbatore
- Annamalai University, Annamalai Nagar
- Bharathiyar University, Coimbatore
- College of Fisheries, Veraval, Gujarat
- Junagadh Agricultural University, Junaadh, Gujarat
- Kamadhenu University, Gandhi Nagar, Gujarat
- Christ 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
- Matsya Mahila Vedi, Chellanam
- Alleppey Diocesan Charitable and Social Welfare Society, Alappuzha
- Vanitha Matsya Thozilali Bank, Neendakara
- Kerala Industrial and Technical Consultancy Organization (KITCO)
- Kerala State Women's Development Corporation Ltd., Thiruvananthapuram
- Chellanam Panchayat SC/ST Co-operative Society Ltd., Kochi
- Development Action through Self Help Network (DARSHN)
- Agency for Development of Aquaculture in Kerala (ADAK)
- Chellanam-Kandakadavu Fishermen Development and Welfare Co-operative Society, Kochi
- Karnataka Fisheries Development Corporation, Bengaluru
- Gandhi Smaraka Seva Kendram, Alappuzha
- Kottappuram Integrated Development Society (KIDS), Kodungalloor
- MS Swaminathan Research Foundation, Chennai
- District Youth Fisheries Welfare Association, Visakhapatnam

Consultancies taken up (Also please see Section on ABI at Page No. 83)

- Descaling machine technology was successfully transferred to Malawi (Africa).
- In collaboration with KVK, Kumarakom, an electrical dryer of 10 kg capacity has been designed based on consultancy.
- Collaboration with IISc, Bangalore as part of the project "Feasibility study on coastal reservoir concept to impound Netravati river flood waters: A sustainable strategy for water resource development for Mangalore and Bangalore".
- Process for manufacturing of ornamental fish feed developed by Drs. K.N. Mohanta, S. Subramanian, G.B. Sreekanth and N. Manju Lekshmi has been commercialized by ICAR-CCARI, Old Goa, for the benefit of fisheries farmers and agri-entrepreneurs.
- Design and technical specification of 21.0 m L_{OA} tuna long liner cum gillnetter was provided to the Department of Fisheries, Government of Kerala.
- Technical specification and general arrangement drawing of a search and rescue boat for the SAFF, Kanyakuamari, Tamil Nadu was provided.
- Evaluated M/s Aurofish Chilled Tuna Processing Facility at Vaithikuppam, Puducherry as consultancy work for BOBP-IGO and prepared a detailed SWOT report.
- Revamping of clam processing unit at Muhamma Panchayath in collaboration with District Panchayath, Alappuzha and District Industries Centre, Alappuzha.
- Consultancy with M/s Zest, Manjeri for dried fishery products and fishery waste management.

Technical guidance imparted

- To Alleppey Diocesan Charitable and Social Welfare Society, Alappuzha for 10 Kg electrical dryer.
- To Self Employed Women's Association (SEWA), Elamkunnappuzha, Ernakulam for 10 Kg electrical dryer.
- To Shri Ratan Kummi Yumnam for 10 Kg electrical dryer.
- To Self Help Group, Kadamakkudy, Ernakulam for 10 Kg electrical dryer.
- To Shri Anish Mathew, Kottayam for 20 Kg electrical dryer.
- To M/s Santhom Mart and Food Court, Mundamveli, Ernakulam for hygienic and refrigeration enabled mobile fish vending kiosk.
- To Smt. Seena Shahul, M/s Sha Cold Storage and Fish Centre, Tripunithura for hygienic and refrigeration enabled mobile fish vending kiosk.
- To Kavalam Panchayath, Alappuzha for assessing the training and technical needs related to fish processing.

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 of ICAR-CIFT and test reports were sent to the concerned. Fishing gear materials and accessories such as synthetic netting materials (webbing, twine and yarn), ropes, floats etc. and fishing craft materials such as wood, FRP, steel etc. supplied by government and private agencies.

Past year in the life of ICAR-CIFT

Events

Visit of Union Minister of State for Agriculture and Farmers Welfare: Shri Sudarshan Bhagat, Hon'ble Union Minister of State for Agriculture and Farmers Welfare, Govt. of India visited ICAR-CIFT, Kochi on 5 May, 2017 to review the activities of the Institute. He also made a short interaction with stakeholders comprising of fishermen, women SHG members and fish processors with regard to their problems in harvesting and post harvesting sectors in fisheries. The Minister also released some newly developed fish products namely; Collagen peptide biscuits, Seaweed Nutridrink, Calcium and iron fortified fish soup powder and an E-Book entitled "Mechanized Fishing Vessels of India".

Shri Sudarshan Bhagat addressing the staff

Release of 'Nutridrink'

Visit of Director General, ICAR: Dr. T. Mohapatra, Secretary, DARE and DG, ICAR, New Delhi visited Mumbai Research Centre of ICAR-CIFT on 12 June, 2017 along with Dr. Gopal Krishna, Director and Vice Chancellor of Deemed to be University, ICAR-CIFE, Mumbai. Later, Dr. Mohapatra interacted with the Scientists and other staff regarding various activities of the Centre. He also visited the laboratories, office premises and suggested to improve the quality of research output. Dr. T. Mohapatra also visited the Visakhapatnam Centre on 7 November, 2017. He visited the laboratories and interacted with the scientists. Later, he addressed the staff of the Research Centres of CIFT and CMFRI and stressed that scientists and staff should work on mission mode and cater to the needs of the region by working in collaboration with the state governments for the effective dissemination of research outcome to the stakeholders.

Dr. Mohapatra inspecting solar dryer at Mumbai

Dr. Mohapatra addressing at Visakhapatnam

Launching of Mobile Application for Fisheries Technology: In an effort to leverage the potential of Information and Communication Technologies for disseminating the research outputs to public, ICAR-CIFT, Kochi has developed a Mobile App, which will provide quick access to information related to harvest and post harvest aspects in fisheries. The application was launched by Dr. J.K. Jena, Deputy Director General (Fisheries), ICAR, New Delhi at a function held at ICAR-CIFT on 25 November, 2017. The App provides information on harvest and post harvest technologies including quality assurance and management,

biochemistry and nutrition, microbiology and engineering aspects. The information related to various trainings and other programmes of ICAR-CIFT are also available in the application. The application can be freely downloaded from the Google play store.

Visit of Secretary, Animal Husbandry, Dairying and Fisheries: Shri Devendra Choudhary, IAS, Secretary, Department of Animal Husbandry, Dairying and Fisheries (AHDF), Govt. of India accompanied by Dr. S. Karthikeyan, IAS, Director, Department of Fisheries, Govt. of Kerala visited ICAR-CIFT, Kochi on 22 July, 2017.

Shri Devendra Choudary addressing the staff

Releasing of Book on e-Procurement: E-procurement is one the most important programmes introduced by Government of India to bring in efficiency, economy and transparency in public procurement. ICAR-CIFT, which always addresses the changing procurement practices and technology, is one of the first Institutes to fully encash the benefit of e-procurement which is one of the important IT tools for ensuring a transparent system of procurement of goods, works and services. Based on the experience gained by the implementation, a manual on "Systematic Implementation of Government E-procurement" was brought out by ICAR-CIFT for the benefit of users engaged in procurement of goods and services. The book, first in the series of administrative training manuals planned by ICAR-CIFT was released by Dr. J.K. Jena, DDG (Fisheries Science), ICAR, New Delhi on 25 November, 2017.

Installation of Rain Water Harvesting System: A rain water harvesting system of 2000 litres capacity with three-layer filtration mechanism was installed in the pilot plant premises at the Head Quarters. The System was opened by Dr. J.K. Jena, DDG (Fisheries Science) on 25 November, 2017.

Inauguration of rain water harvesting system

Handing Over of Electrical Dryer: The ICAR-CIFT, Kochi in collaboration with Kerala University of Fisheries and Ocean Studies (KUFOS), Kochi handed over a dryer to a fisherwomen group of Alleppey Diocesan Charitable and Social Welfare Society (ADC&SWS) at Andhakaranazhi, Cherthala, Kerala, on 23 October, 2017. The fish dryer was distributed with a formal MoU signed by ICAR-CIFT, KUFOS and ADC&SWS. The programme was followed by a one day training programme on pre-processing of prawns for drying and demonstration of operation of dryer.

Exchange of MoU for fish dryer distribution

Launching of Refrigeration-Enabled Fish Vending Kiosk: ICAR-CIFT, Kochi has developed a refrigeration-enabled fish vending kiosk to improve the unhygienic handling and marketing practices of fisherfolks. The special feature of the kiosk is its fish storage-cum-display facility and a well-insulated refrigeration system. This kiosk is found to be favourable and affordable to small scale and retail fish vendors for investment on refrigeration-enabled fish vending kiosk developed by ICAR-CIFT. The kiosk was launched by ICAR-CIFT at M/s Santhom Mart and Food Court, Mundamveli, Kochi on 16 December, 2017. The first unit of the kiosk was inaugurated

Shri K.J. Maxi inaugurating the kiosk

Smt. Chandrika Devi inaugurating the kiosk

by Shri K.J. Maxi, Member of Legislative Assembly, Kochi, Ernakulam in the presence of Dr. Ravishankar C.N., Director, ICAR-CIFT, Kochi.

Another unit of the kiosk was launched at M/s Sha Cold Storage and Fish Centre at Pavankulangara Junction, Puthiyakavu, Ernakulam on 2 January, 2018 by Smt. Chandrika Devi, Municipal Chairperson, Tripunithra, Ernakulam.

Signing of MoA with M/s Cochin Shipyard Ltd.: In association with the Central Sector Scheme on Blue Revolution and Make in India, ICAR-CIFT, Kochi and M/s Cochin Shipyard Limited (CSL) has joined hands for a collaborative programme, for the design and construction of commercial fishing vessels adhering to international standards. In continuation to this, the construction has started with plate cutting ceremony at Cochin Shipyard Ltd. on 29 January, 2018. Deatails given on Page No. 86.

Plate cutting ceremony of 22.5 m L_{OA} long liner cum gillnetter

Meetings

Meeting on Antibiotic Residues: A two days programme on 'Scoping mission on detection methods: Present and future for antibiotic residues', was jointly organized by FSSAI, New Delhi, ICAR-CIFT, Kochi and RIKILT, Netherlands during 2-3 May, 2017 at ICAR-CIFT, Kochi. Dr. Teena and Dr. Mariel from RIKILT, Netherlands made presentations on antibiotic residue detection methods including screening methods and various aspects of validation and accreditation. Dr. Reena Shaheen, FSSAI Director and Dr. N. Bhaskar, Advisor (QA), FSSAI were present during the programme. Scientists from various Divisions and representatives from EIA, Kochi attended the programme.

Meeting in progress

Stakeholders Meet to Promote Fisheries in Andaman and Nicobar Islands: A Stakeholders Meet on "Development of tuna fisheries in Andaman and Nicobar Islands" was held at ICAR-CIFT, Kochi on 8 July, 2017. The event was organized by Andaman & Nicobar Administration and ICAR-CIARI, Port Blair in association with ICAR-CIFT, Kochi and ICAR-CMFRI, Kochi. The Meeting was presided over by Shri Anindo Mazumdar, IAS, Chief Secretary, A&N Administration. Presentations were made by Dr. S. Dam Roy, Director, ICAR-CIARI, Port Blair, Dr. Mohan Joseph Modayil, Former Member, ASRB and Former Director, ICAR-CMFRI, Kochi and Dr. Ravishankar C.N., Director,

Interactive session in progress

ICAR-CIFT, Kochi. The interactive session was attended by more than 130 stakeholders comprising of investors, fish-processors, entrepreneurs, progressive fishermen from different coastal states namely Gujarat, Tamil Nadu, Andhra Pradesh, Karnataka, Kerala etc. along with officials and scientists from A&N Administration, line departments of Kerala, MPEDA, MATSYAFED, ANIIDCO, NABARD, NIPHAT, ICAR-CIFT and ICAR-CMFRI.

Training on Fabrication of 40 mm Square Mesh Codends: A training cum demonstration programme on 'Fabrication of 40 mm square mesh codends for trawls/dolnet fishing gear' was organized by ICAR-CIFT in collaboration with State Fisheries Department, Govt. of Maharashtra, at Thane and Raigad districts of Maharashtra during 21-22 July, 2017. Duing the programme a lecture on "Demonstration and promotion of bycatch reduction through use of square mesh" was given followed by hands-on training to fabricate/ convert square mesh from diamond mesh for the benefit of 100 fishermen.

Feed The Future-India Triangular Training: A training programme on "Recent trends in harvest and post harvest technologies in fisheries" was conducted at ICAR-CIFT, Kochi during 12-26 September, 2017. The programme is the 11th in the series of the 'Feed the Future India Triangular Training (FTT-ITT) programme', a triangular cooperation between India, US and Africa for adapting technological advances and innovative solutions to address Global Food Security. This Indo-US joint initiative is funded by USAID, India representing US Government and coordinated by National Institute of Agricultural Extension Management (MANAGE), Hyderabad under the aegis of Ministry of Agriculture & Farmers Welfare, Govt. of India. Twenty two executives representing eight member countries *viz.*, Afghanistan, Ghana, Kenya, Liberia, Malawi, Mongolia, Sudan and Uganda participated in the programme.

Participants and faculty of the training programme

Inauguration of FTF international training programme

Dr. P. Rajendran, VC, KAU delivering the inaugural address

Entrepreneurial Skill Imparted to Unemployed Rural Youths: As a part of Govt. of India's Skill Development Programme followed by the initiatives taken by Andaman & Nicobar Administration, Port Blair, ICAR-CIFT, Kochi conducted a skill-based in-house training programme on 'Post harvest technology for preservation and value addition of marine resources' for the unemployed rural youths of the A&N Islands during 16-21 August, 2017. The programme sponsored by Directorate of Industries, Andaman & Nicobar Administration, Port Blair was attended by 15 selected rural youths along with two officers, Shri Sindhupathi Raja, Industries Promotion Officer and Shri R. Janak Rao, Laboratory In-Charge from Dept. of Industry, A&N Administration.

Dignitaries on the dais during inaugural programme

Training Programme on Microbiological Examination of Seafood: ICAR sponsored training programme on "Microbiological examination of seafood" was organized at ICAR-CIFT, Kochi during 1-7 August, 2017. The programme was inaugurated by Prof. A. Ramachandran, Vice Chancellor, KUFOS, Kochi which was attended by 21 participants from different parts of the country representing Universities and leading research institutes of ICAR that included one each from Andhra Pradesh, Karnataka, Gujarat, Maharashtra and rest

17 participants were from Kerala. The training programme constituted theory classes by experts in the field, followed by practical demonstrations. The programme concluded on 7 August, 2017 with a plenary session in which feedback was obtained from the trainees. The participants were also presented with certificates.

Prof. A. Ramachandran delivering the inaugural address

International Training under Dr. C.V. Raman Fellowship: Dr. Osama Abbas Muhieldeen, Associate Professor and HOD, Department of Agricultural Engineering, Gezria University, Sudan carrierd out three months training and research in Fishing Technology Division under Dr. C.V. Raman International Fellowship for African Researchers during 27 November, 2017 to 27 February, 2018. Apart from the training he has carried out a project work on trammel net fishing.

Practical session for Dr. Osama Abbas Muhieldeen in progress

Live Webcasting of Hon'ble PM's Address: ICAR-CIFT, Kochi arranged live webcasting of Hon'ble Prime Minister's address to farmers, agricultural scientists and other stakeholders on 17 March, 2018 on the eve of the Krishi Unnathi Mela organized at IARI, Pusa, New Delhi during 16-18 March, 2018. About 100 stakeholders comprising of fishers from Thoppumpady, Mulavukad, Perumbalam and Chembu; fish processors, entrepreneurs from different parts of the state along with more than 300 ICAR-CIFT personnel attended the Live Webcast programme. In addition, Stakeholders-Scientists Interface was also organized to discuss about the potential deliverables of ICAR-CIFT technologies, which can be utilized for the development of the fisheries sector and livelihood security of the small scale fisher community. Later the stakeholders were taken around the different demonstration units of Institute including fish processing pilot plants, net mending workshop, Fishing Technology and Engineering Museum and ATIC to expose them to the ICAR-CIFT technologies. A training programme for clam fishers from Perumabalam was also organized as part of the programme where they were trained on production of value added products from clam meat.

Institutional TOT Programmes

Technology on value added product development from fish have been demonstrated at Kadamakkudy village in Ernakulam district of Kerala; at Mangamaripeta village in Visakhapatnam district of Andhra Pradesh and Veraval in Gir Somnath district of Gujarat under the Institute project entitled 'Evolving SMART EDP module for livelihood security of small scale fisherfolk through fish-preneurship' in which input support system was provided to the beneficiaries through bilateral signing of MOU between the community (Second party) and ICAR-CIFT (First party).

Input distribution programme at Kochi

Input distribution at Mangamaripeta, Visakhapatnam

Activities under NEH Component

ICAR-CIFT organized technology demonstration-cum-training programmes on 'Value added product development from fishes' at Arunachal Pradesh (KVK, Roing), Assam (Dept. of Fisheries, Govt. of Assam), Manipur (Department of Fisheries, Manipur) and Meghalaya (ICAR, RC-NEH, Barapani). Under these programmes three mini fish processing units were established at these places for imparting hands on training to stakeholders on developing value added fish products. Also demonstration of fishing using coracles was conducted at Rukmo village, Lower Dibang Valley, Arunachal Pradesh. Besides canoes and coracles were distributed to the community for improved fishing in the lakes and reservoirs.

Activities under TSP (STC) Component

- One-day training-cum-demonstration Programme on 'FRP coracles' for the tribal fisherfolk on 15 May, 2017 in Bhutnal village of Vijayapura district in Karnataka.
- One-day training-cum demonstration programme on'FRP coracles' for the tribal fishers on 17 May, 2017 at Vani Vilasa Sagara dam site in Hiriyur in Chitradurg district in Karnataka.
- Training-cum-demonstration on 'Hygienic handling and value addition of fish' at Village Digad, in Ambegaon Tehsil of Pune in Maharashtra during 30-31 May, 2017.
- A training cum demonstration programme on 'Responsible fishing' on 3 March 2018 at Vazhachal, Chalakudy, Thrissur.
- Training cum demonstration programme on 'Harvesting technologies' at Kanjirappuzha, Mannarkkad in Palakkad district of Kerala.
- Technology demonstration programme on 'Improved gillnets' at Aliyar dam, Pollachi in Coimbatore district of Tamil Nadu.
- Technology demonstration programme on 'Fishing and value added product development' at Peruvannamuzhy village, Koyilandi in Kozhikode, Kerala.

Distribution of FRP canoes and coracles to tribal fisherfolk at Digad, Pune

Shri Innocent, Hon. MP, Chalakudy addressing the fishermen at Vazhachal, Kerala

ICAR-CIFT Extends Help in Search and Rescue Operation in Ockhi Affected Areas: ICAR-CIFT Research Vessel Matsyakumari-II was associated with the search and rescue operations carried out in connection with the Cyclone Ockhi duing 10-18 December, 2017. Two officials from the Enforcement Wing of the Fisheries Department, Govt. of Kerala along with two fishermen from Pozhiyoor were also onboard the vessel. The vessels were equipped to conduct search at 140 nautical mile north of Alappuzha for 11 days. The Institute also completed a study on the impact of Ockhi in marine fisheries and submitted report to Dept. of Fisheries, Govt. of Kerala.

Stakeholder's Meeting: Visakhapatnam Research Centre of ICAR-CIFT organized Stakeholder's meetings at Visakhapatnam, Kakinada, Machilipatnam and Nizamapatnam during 16-17 February, 2018 and 20-21 February, 2018 to formulate strategies for deep sea resource exploitation at Bay of Bangal.

Celebrations

Diamond Jubilee Foundation Day Celebrations: The ICAR-CIFT at its Head Quarters at Kochi and Research Centres at Visakhapatnam, Veraval and Mumbai celebrated its Diamond Jubilee Foundation Day on 28 and 29 April, 2017.

At ICAR-CIFT, Kochi the function was inaugurated by Shri Pinarayi Vijayan, Chief Minister of Kerala with gracious presence of Smt. J. Mercykutty Amma, Minister of Fisheries, Harbour Engineering and Cashew Industry, Govt. of Kerala; Adv. V.S. Sunil Kumar, Minister for Agriculture; Dr. T. Mohapatra, Secretary, DARE, GoI & Director General, ICAR, New Delhi and other galaxy of dignitaries on the dais which included Smt. Soumini Jain, Mayor of Cochin Municipal Corporation, Shri K.J. Maxi, MLA, Kochi and Shri Hibi Eden, MLA, Ernakulam. On the occasion, the Chief Minister launched the brand logo of ICAR-CIFT named 'ciftec' for popularization of ICAR-CIFT products under the unique brand name. During the function, a number of ICAR-CIFT publications, Pictorial Memoir and Souvenir were also released. The programme was also attended by Directors of different ICAR institutes like CIFE, Mumbai; NBFGR, Lucknow; CIFRI, Barackpore; CIBA, Chennai; CTCRI, Thiruvanthapurum; CPCRI, Kasargod; IISR, Calicut; CMFRI, Kochi; Director of Research of KUFOS and CUSAT along with Former DDG (Fy.) Dr. K. Gopakumar, Former ASRB Member Dr. Mohan J. Modayil and retired and serving staff of ICAR-CIFT.

Inauguration of Diamond Jubilee celebrations by Hon'ble Chief Minister

Director explaining the technologies to the dignitaries

Prof. K.P. Sudheer, IIT, Madras & Adjunct Professor, Purdue University, USA gave a scientific talk on, "Problems and prospects of water management in India" at ICAR-CIFT, Kochi on 24 April, 2017.

On 25 April, 2017, an ICAR-CIFT-Seafood Industry Interface Meet was held at the Institute as part of the business incubation drive designed for the fisheries sector, to promote entrepreneurship with the help of latest scientific breakthroughs and R&D facilities. The event included exclusive technical sessions featuring the technological assets of the Institute and panel discussions. Several grass root entrepreneurs, start-up companies, exporters and importers, personals from R&D institutes and academia attended the event.

Prof. K.P. Sudheer giving lecture (Also seen are Dr. Suseela Mathew and Dr. Ravishankar C.N.)

Interface meet in progress

A stakeholder workshop on "Ring seine fishing" was held on 26 April, 2017. Dr. Ravishankar C.N., Director, ICAR-CIFT inaugurated the Workshop, followed by technical session, chaired by Shri C.D. George, Senior Manager, MATSYAFED. Lectures on "Present status and standardization of ring seine" and "Present status and standardization of ring seine crafts" were conducted in the technical session which was followed by group discussion with fishermen representing different fishermen societies in Kerala.

The Institute was kept open for the general public on 27 April, 2017. The activities and achievements of the Institute were displayed in the exhibition and explained to the visitors. The Institute laboratories were also kept open. Large number of students and general public utilized the opportunity to get acquainted with the activities of the Institute.

A painting competition for school students was conducted on 28 April, 2017. In the afternoon a quiz competition for college students was also conducted. The winners were given away with certificates and cash prizes.

At the Visakhapatnam Research Centre, the Guest for the inaugural function held on 29 April, 2017 was Shri V. Padmanabham, President, Seafood Exporters Association of India. Two books entitled, "Technologies developed by ICAR-CIFT, Visakhapatnam" and "Scientific publications of ICAR-CIFT, Visakhapatnam" were also released on the occasion. Representatives from different fisheries sectors including Central (FSI, CIFNET, NIFPHTT, IWST, CMFRI), State Govt. officials, academicians from Andhra University, representatives of boat operators associations, seafood entrepreneurs, fisherwomen, NGOs and retired staff of ICAR-CIFT participated in the meeting. The meeting was followed by an Open House, where the fishing technology, fish processing and microbiology laboratories of the research centre was open to the public, to create awareness among the stakeholders and public, on the activities and technologies developed at the Centre. Students, fishers, officials and general public visited the laboratories.

Releasing of the book

At the Veraval Research Centre, Shri Lakham Bhai Bhensala, a leading fish processor and President of Fish Exporters Association of Gujarat was the Chief Guest of the function held on 29 April, 2017. Dr. S.M. Zofair, Dean Incharge, College of Fisheries, Veraval and Shri Mohamed Koya, Scientist Incharge, Veraval Centre of ICAR-CMFRI were the Guest of Honours. During the programme some of the leading exporters like Shri Kenny Thomas, Shri Piyus Fofandi and Shri Karsan Bhai expressed their views on the work and services of ICAR-CIFT. The function was attended by most of the fish processors of Veraval and Porbandar. Deputy Director and Additional Director of Export Inspection Agency (EIA), and Additional Director, Marine Product Export Development Authority (MPEDA), Veraval also graced the occasion. The retired staff of VRC CIFT were the special invitees for the programme who were honoured and felicitated. During the programme three brochures were released by the dignitaries.

At the Mumbai Research Centre the celebrations were held on 28 April, 2017 which was inaugurated by Dr. Sasidhar, Scientific Officer, BARC, Mumbai. The highlight of diamond jubilee celebration was honouring of the retired staff of the Centre. An open day was also conducted for exhibiting the ICAR-CIFT technologies and activities. Children from IES Navi Mumbai High School, fisherfolk and entrepreneurs from Vashi actively participated in the programme. A quiz competition for school children was also conducted and prizes were distributed to the winners.

Anti Terrorism Day: The Institute celebrated 'Anti-Terrorism Day' on 20 May, 2017. The staff of the Institute assembled together and took Anti Terrorism Day Pledge.

National Sadbhavana Diwas: 'National Sadbhavana Diwas' was celebrated at the Institute on 18 August, 2017 in connection with 'Communal Harmony Fortnight'. The staff assembled together and took Sadbhavana Day Pledge.

Vigilance Awareness Week: Vigilance Awareness Week was celebrated at the Institute during 30 October to 4 November, 2017. The observance of the week commenced with a pledge administered by the Director to all staff members on 30 October, 2017. As part of the celebration Dr. Mathew Jolly, Additional Director General, National Academy for Custom, Excise and Narcotics, Kochi delivered a talk on 3 November, 2017.

National Unity Day: 'Rashtriya Ekta Diwas' (National Unity Day) was celebrated at the Institute during 31 October to 4 November, 2017 with a pledge administered by the Director to all staff member.

National Technology Day: The Day was celebrated on 11 and 12 May, 2017 at ICAR-CIFT, Kochi. The inaugural session presided over by Dr. Ravishankar C.N., Director, ICAR-CIFT was followed by a scientific talk on

Release of publication (L to R: Dr. V. Geethalakshmi, Dr. Manoj P. Samuel, Dr. Ravishankar, C.N. and Dr. R.S. Rajeev)

Training in progress

'Advanced uses of polymers and special chemicals with focus on space science application' by Dr. R.S. Rajeev, Scientist Engineer from Vikram Sarabhai Space Centre (ISRO), Thiruvananthapuram. A publication on 'Fish drying and processing technologies' was also released on the occasion. Apart from the Institute staff members, students from Kadamakudy Vocational Higher Secondary School, St. Alberts College and St. Theresas College participated in the programme.

A two-day training programme was also conducted for fisherwomen from Kadamakudy village on 'Fish drying and processing technologies'. The participants were trained in hygienic processing and drying of fishes using solar dryers. ICAR-CIFT has fabricated solar dryers with electricity, LPG and biomass backup which can handle bulk quantities of fish for drying.

'Swatch Pakhwada': As part of the 'Swatch Pakhwada' celebrations during 16-31 May, 2017, an awareness programme on 'Hygienic handling of fish' was done at Kadamakudy village, Ernakulam on 16 May, 2017. Around 15 fisherfolk participated in the programme. The objectives of Swachh Bharat Mission was explained to the fishers by Dr. Sindhu, Principal, Vocational Higher Secondary School, Kadamakudy. Importance of hygiene and sanitation at work place was stressed by Dr. V. Geethalakshmi, Principal Scientist. Dr. A.K. Mohanthy, HOD, EIS presided over the programme and emphasized on the need for youngsters in carrying forward the message of cleanliness and sanitation at home and work place.

Another awareness drive on 'Cleanliness at fish markets' was conducted at Polakkandam fish market, Kochi on 23 May, 2017. A demonstration of ICAR-CIFT fish de-scaler machine was also conducted on the occasion.

Awareness programme at Kadamakudy village

Shri C.R. Gokulan, Asst. Chief Tech. Officer demonstrating fish de-scaler machine

World Environment Day Celebrations: The Veraval Centre celebrated "World Environment Day" on 5 June, 2017. Shri Jagdish Bhai Fofandi, President, Veraval-Patan Joint Municipality, the Chief Guest of the programme administered the oath of keeping environment clean and being responsible for the environment to all the staff of ICAR-CIFT and ICAR-CMFRI. The inaugural function concluded with the address of Dr. D. Divu, Scientist Incharge of Veraval Regional Station of ICAR-CMFRI which was followed by planting of tree saplings outside the office premises and finally the staff of ICAR-CIFT and ICAR-CMFRI jointly went for a

Dr. Suseela Mathew planting a sapling at Kochi

Tree planting at Visakhapatnam

march to create awareness towards environment protection among the people. The ICAR-CIFT, Kochi and the Visakhapatnam Research Centre also celebrated World Environment Day on 6 June, 2017 by organizing plantation drive.

International Yoga Day Celebrations

International Day of Yoga was celebrated on the 21 June, 2017 at ICAR-CIFT Head Quarters in Kochi and at its Research Centres at Veraval, Visakhapatnam and Mumbai.

At ICAR-CIFT, Kochi the Yoga Day Celebrations commenced with a formal meeting presided over by Dr. Ravishankar C.N., Director, ICAR-CIFT. The Chief Guest of the day Shri Kaithapram Vasudevan Nampoothiri, Chairman, Patanjali Yoga Research and Training Centre, Kochi delivered a talk on "The importance of yoga in our daily life" which was followed by a Mass Yoga Performance of staff members based on the Common Yoga Protocol of the Ministry of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homeopathy (AYUSH), New Delhi under his mentorship.

Address by Dr. Ravishankar C.N. (On the dais are: Dr. J. Bindu, Smt. Lalithambika Mohandas, Shri Kaithapram Vasudevan Nampoothiri and Shri P.J. Davis)

Mass Yoga performance in progress

At the Visakhapatnam Research Centre, the Scientists and staff of the Centre participated in the Yoga walk organized on 18 June, 2017 by the Yoga Department, Andhra University, Visakhapatnam on the RK Beach Road. The Centre celebrated the Day on 21 June, 2017. A Yoga session was organized at CIFT-CMFRI complex on the forenoon and all the staff participated enthusiastically. Yoga trainer, Shri Prasanna from Yoga Village, Andhra University explained the significance of Yoga for leading a healthy life and demonstrated various 'Asanas'.

At the Veraval Research Centre, the five-day programme was inaugurated on 17 June, 2017 by Dr. A.K. Jha, Scientist Incharge of the Centre. Two short films on Yoga and a cinematographic compilation of previous year's Yoga Day activities at the Centre were also presented. On 19 June, 2017, a poster designing competition was done on the theme "Yoga keliye hamara yogdaan". A theory session on Yoga was held on 20 June, 2017. Shri M. Thakar Abhay Kumar, Shree Somanth Sanskrit University, Veraval was the resource person of the session. On 21 June, 2017, practical session was held on the Common Yoga Protocol by AYUSH. Afternoon, a quiz competition was conducted on the theme Yoga and general health.

Yoga session in progress at Veraval

Yoga session in progress at Mumbai

At the Mumbai Research Centre the Chief Guest of the celebrations on 21 June, 2017 was Smt. Rekha Chatterjee, a professional Yoga teacher. Demonstration on different Yoga techniques like 'Asanas' and breathing exercises were made and the benefits of each practice for health as well as for curing different diseases like migraine, arthritis, diabetes, blood pressure, hormonal problems etc. were detailed.

World Antimicrobial Resistance Awareness Week: ICAR-CIFT, Kochi observed World Antimicrobial Resistance Awareness Week sponsored by FAO in collaboration with USAID and Government of India during 13-19 November, 2017. The programme was inaugurated by Dr. Ravishankar C.N., Director, ICAR-CIFT, Kochi on 13 November, 2017. Prof. (Dr). V. Anil Kumar, Clinical Additional Professor, Department of Microbiology, Amrita Institute of Medical Sciences, Kochi delivered a talk on "Antimicrobial resistance (AMR) and its implications on human health" on 15 November, 2017. On 16 November, 2017, a class on 'Antimicrobial resistance and the role of individuals in reducing the spread through hand hygiene, cough and sneeze hygiene' was held followed by distribution of the awareness kit and tee shirts sponsored by FAO.

On 17 November, 2017, Dr. M.M. Prasad, HOD, MFB, ICAR-CIFT delivered a talk on 'Antimicrobial resistances in fisheries sector and controlling measures such as probiotics, phages and CRISPR' to the Post Graduate Students of Fisheries and Aquaculture Division, St. Albert's College, Kochi. Dr. G.K. Sivaraman, Principal Scientist delivered another talk on 'Basic hygienic practices in controlling of AMR'. After the talks all the students and teaching staff were administered 'Antimicrobial resistance prevention and control pledge'.

On 18 November 2017, the following talks were delivered to the 11th Standard Students of Kendriya Vidyalaya, Port Trust, Kochi:

- Discovery of antibiotic penicillin by Alexander Fleming - Dr. M.M. Prasad, HOD, MFB
- Antibiotics and antimicrobial resistances – Dr. Toms C. Joseph, Principal Scientist
- Basic hygienic practices for controlling AMR – Dr. V. Murugadas, Scientist

Visakhapatnam Research Centre observed Antimicrobial Resistance Awareness Week during 13-19 November, 2017. In this connection, Dr. B. Madhusudana Rao, Principal Scientist delivered a talk on 'Antimicrobial resistance and its impact on human Health' to the staff of the Centre on 14 November, 2017.

Dr. Ravishankar C.N. inaugurating the programme

Prof. Anil Kumar delivering the talk

Science Promotion Week: As part of the Science Promotion Week-2017, a presentation on 'Indian Council of Agricultural Research-Central Institute of Fisheries Technology - Contribution to science' was conducted at Kendriya Vidyalaya, Ernakulam on 14 November, 2017. In addition, the products developed by the Institute and posters explaining the research activities of ICAR-CIFT were also exhibited. The talks highlighted on ICAR-CIFT's initiatives like, fuel efficient and energy saving fishing vessels, value added products, fish waste utilization, packaging and preservation, quality management, solar drier, extension and consultancy programmes.

Dr. P. Jeyanthi, Scientist delivering the lecture

Agricultural Education Day: ICAR-CIFT celebrated National Agricultural Education Day on 4 December, 2017 which was attended by more than 100 students from Kendriya Vidyalaya No. 2, Naval Base and Kendriya Vidyalaya, INS Dhronacharya. Dr. Saly N. Thomas, Principal Scientist talked on various methods of fishing including responsible fishing techniques. Dr. Manoj P. Samuel, HOD, Engg. delivered a talk and interacted with the students on water conservation and management aspects. Dr. A.K. Mohanty, HOD, EIS gave an overview about higher education opportunities in agriculture and allied subjects and its career prospects. Later, the students visited various laboratories of the institute and were also appraised about the activities of pilot processing plant and net fabrication unit.

Dr. Suseela Mathew, Director Incharge inaugurating the programme

Students visiting fishing net fabrication facility

Quami Ekta Week: Quami Ekta Week was observed during 19-25 November, 2017 and Flag Day on 24 November, 2017 at the Institute. The staff of the Institute took National Integration Pledge on 24 November, 2017.

Constitution Day: Constitution Day was celebrated on 27 November, 2017. The staff of the Institute took Constitution Day Pledge.

National Science Day: ICAR-CIFT, Kochi and the Veraval Research Centre of ICAR-CIFT celebrated 'National Science Day' on 28 February, 2018. At Kochi the Day coincided with the valedictory function of the three months International Training in Fishing Technology under Dr. C.V. Raman International Fellowship for African Researchers. On the occasion Dr. V.P.N. Nampoori, Emeritus Professor, International School of Photonics, CUSAT, Kochi delivered a lecture on Sir C.V. Raman and his inspiring life and work. In the function certificate was issued to Dr. Abbas Muhieldeen Osama, Associate Professor, Gezira University, Sudan who joined the Institute on 27 November, 2017 in the Fishing

Dr. V.P.N. Napoori delivering the lecture. Also seen are Dr. Ravishankar C.N. and Dr. Leela Edwin

Technology Division. Apart from the training he has carried out a project work on trammel net fishing. At Veraval Research Centre various activities, including quiz and oral presentations by the scientists of ICAR-CIFT and ICAR-CMFRI were organized.

International Women's Day: ICAR-CIFT celebrated International Women's Day on 8 March, 2018. Smt. Roopa George, entrepreneur-restaurateur, accomplished Bharatnatyam dancer and Veena exponent and a brand ambassador for Kottapuram Integrated Development Society (KIDS) that promotes the traditional Kerala art of screw pine woven mats was the Chief Guest of the day. As part of the celebrations, a home-made video celebrating the women staff, past and present since the inception of ICAR-CIFT was made and screened which was well received. Also a video showing the courage and grit of women fighter pilots of Indian Air Force and the circum-navigation around the globe of Officers belonging to Indian Navy who are braving the rough and unpredictable weather were screened. Women staff of ICAR-CIFT put up a stellar show by enacting a traditional dance drama based on 'Bhoothapaatttu' which glorifies the courage of a mother and the sacrifices the mother makes to get back her son from the 'Bhootham'.

Smt. Roopa George being felicitated by Director Incharge

Enacting the dance drama

The Veraval Research Centre of ICAR-CIFT also celebrated the International Women's Day on 8 March, 2018. The Chief Guest of the function was Dr. Nimisha Makhansa, a leading Gynecologist of Veraval and the special invitee was Dr. K.M. Swapna, Assistant Director, EIA, Veraval while Smt. Shikha Rahangdale, Scientist, VRC of ICAR-CMFRI was the special guest.

Dr. Nimisha Makhansa delivering the Chief Guest's address

Awards and Recognitions

Best Annual Report Award for ICAR-CIFT: ICAR-CIFT, Kochi has been awarded the 'Best Annual Report Award 2016-17 for Large Institute Category' of all the ICAR Institutes in the country. The award was received by Dr. Ravishankar C.N., Director from Shri Radha Mohan Singh, Hon'ble Union Minister of Agriculture and Farmers Welfare during the ICAR Directors and Vice Chancellors Meet held at New Delhi on 8 March, 2018.

Dr. Ravishankar C.N. receiving the award from Shri Radha Mohan Singh

Indian Agribusiness Excellence Award for ICAR-CIFT: ICAR-CIFT, Kochi bagged the 'Indian Agribusiness Excellence Award' for its outstanding leadership and tireless efforts in backward linkage with farmers and forward linkage with industry. The award instituted by Global Agri Systems Pvt. Ltd., New Delhi was received

by Dr. Ravishankar C.N., Director, ICAR-CIFT in a function held at Bengaluru on 28 August, 2017.

SKOCH Evergreen Platinum Award for ICAR-CIFT: The ICAR-CIFT, Kochi has been awarded the SKOCH Evergreen Platinum Award and Order-of-Merit for its initiatives on "Green, Clean and Affordable Energy: Multi-Purpose Solar Conversion System". The award was received by Dr. Manoj P. Samuel, Head, Engineering Division of ICAR-CIFT in a function held at the Constitution Club of India, New Delhi on 10 March, 2018.

SKOCH Award for Agri Business Incubation Centre of ICAR-CIFT: The Agri Business Incubation Centre of ICAR-CIFT, Kochi has bagged the SKOCH Order of Merit Award-2017 for qualifying amongst the top 30 Transformational Innovation Projects in India which was presented at the 50th SKOCH Summit held at the Constitution Club of India, New Delhi on 20 December, 2017. On selecting, the Award Committee in its recommendations has highlighted the contribution of Agri Business Incubation Centre of ICAR-CIFT in translating the research results generated in R&D to the field of fisheries and other allied sectors.

ICAR-CIFT Conferred with Wiley Library Award: ICAR-CIFT, Kochi received the Wiley Library Award for Highest Usage of Wiley Journals in 2017 within CeRA Consortium (Fisheries and Aquaculture Institutes). The award was received by Dr. Suseela Mathew, Scientist-in-Charge (Library) and Smt. T. Silaja, Assistant Chief Technical Officer at Wiley Library Award function held at New Delhi on 20 December, 2017.

ICAR-CIFT Designated as Content Partner of National Digital Library of India: ICAR-CIFT, Kochi is designated as a content partner of National Digital Library of India for its generous contribution of contents. The Certificate of Content Contribution to integrate the Institute contents with National Digital Library of India was received by Smt. T. Silaja, ACTO and the Nodal Person of ICAR-CIFT during National Digital Library Partners Meet held at IIT, Kharagpur on 8 February, 2018.

Dr. Ginson Joseph, a former Research Scholar, ICAR-CIFT, Kochi has been awarded Jawaharlal Nehru Award for P.G Outstanding Doctoral Thesis Research in Agricultural and Allied Sciences, 2016 in Fisheries Science category. The topic of his research was "Optimization of high pressure processing parameters for Indian white prawn (*Fenneropenaeus indicus*) and its shelf life evaluation during chilled storage". The work has been carried out in the Fish Processing Division of the Institute under the guidance of Dr. J. Bindu, Principal Scientist. Dr. Ginson Jospeh received the

Dr. Manoj P. Samuel (Extreme left) receiving the award

Dr. George Ninan, Principal Scientist and SIC, ABI receiving the SKOCH Award

Dr. Suseela Mathew and Smt. T. Silaja receiving the Wiley Library Award and Smt. Silaja receiving the certificate od NDLI

Dr. Ginson Joseph receiving the award

award from Shri Radha Mohan Singh, Hon'ble Minister for Agriculture and Farmers Welfare during the ICAR Foundation Day celebrations held at New Delhi on 17 July, 2017.

Dr. Nikita Gopal, Principal Scientist, ICAR-CIFT, Kochi received the Asian Fisheries Society Certificate of Appreciation in recognition of contributions as an Inaugural Officer of the Gender in Aquaculture and Fisheries Section of the Asian Fisheries Society.

Smt. U. Parvathy, Scientist, Mumbai Research Centre of ICAR-CIFT received the Young Scientist Award for presentation of the paper entitled "Protein hydrolysate from yellowfin tuna (*Thunnus albacares*) red meat for oxidative and structural stabilization of microencapsulated fish oil" authored by Parvathy, U., Binsi, P.K., Jeyakumari, A., George Ninan, Zynudheen, A.A. and Ravishankar, C.N. The paper was presented at the 11th Indian Fisheries and Aquaculture Forum on 'Fostering innovations in fisheries and aquaculture: Focus on sustainability and safety' held at Kochi during 21-24 November, 2017.

Dr. N. Manju Lekshi, Scientist, ICAR-CIFT, Kochi received the Young Scientist Award for presentation of the paper entitled "Economic evaluation and ecological characterization of semi-enclosed and open water system of Goa, India" by Manju Lekshmi, N., Sreekanth, G.B., Singh, N.P., Vennila, A., Ratheesh Kumar, R. and Pandey, P.K. at the 11th Indian Fisheries and Aquaculture Forum on 'Fostering innovations in fisheries and aquaculture: Focus on sustainability and safety' held at Kochi during 21-24 November, 2017.

Smt. U. Parvathy and Dr. N. Manju Lekshmi receiving the award from Dr. J.K. Jena, DDG (FS), ICAR, New Delhi

The team comprising of **M.P. Remesan, K.A. Sayana, V.R. Madhu, P. Pravin and Leela Edwin** received the Best Paper Award in the session, Fishing Systems for Sustainable Fisheries for their paper "Development of low drag trawls for energy efficient fishing" presented at the 11th Indian Fisheries and Aquaculture Forum on 'Fostering innovations in fisheries and aquaculture: Focus on sustainability and safety' held at Kochi during 21-24 November, 2017.

The team comprising of **Praveena Raj, K. Elavarasan, C.S. Tejpal, Anuj Kumar, K. Satheesh Kumar and S.K. Panda** received the Best Paper Award in the session, Adding Value to Fish: Avenues in Fish Processing and Packaging for their paper "Improved utilization of sardine head waste: Preparation and characterization of protein hydrolysate" presented at the 11th Indian Fisheries and Aquaculture Forum on 'Fostering innovations in fisheries and aquaculture: Focus on sustainability and safety' held at Kochi during 21-24 November, 2017.

The team comprising of **M.V. Baiju, V. Vipin Kumar, M.P. Remesan and Leela Edwin,** received the Best Poster Award for their poster entitled "Solar powered fishing boat for inland waters" presented at the 11th Indian Fisheries and Aquaculture Forum on 'Fostering innovations in fisheries and aquaculture: Focus on sustainability and safety' held at Kochi during 21-24 November, 2017.

The team comprising of **K.M. Mrudula, P.K. Sajeenamol, Jiswin Joseph, M.V. Neelima, J. Bindu, S. Sreejith, V.K. Sajesh and Nikita Gopal** received the second prize (poster) in the session Gender in fisheries and aquaculture for their poster on "Traditional fish recipes of fisher households and their significance" presented at the 11th Indian Fisheries and Aquaculture Forum on 'Fostering innovations in fisheries and aquaculture: Focus on sustainability and safety' held at Kochi during 21-24 November, 2017.

The team comprising of **N. Manju Lekshmi, G. Archana, Saly N. Thomas and Leela Edwin** received the second prize (poster) in the session Gender in Fisheries and Aquaculture for their poster on "Rural women participation in pre and post harvest operations of stake net (estuarine set bag) along Aroor fishing village, Alappuzha, Kerala" presented at the 11th Indian Fisheries and Aquaculture Forum on 'Fostering innovations in fisheries and aquaculture: Focus on sustainability and safety' held at Kochi during 21-24 November, 2017.

Smt. E.R. Priya, Scientist, ICAR-CIFT, Kochi received the 'Dr. Ravindran Memorial Award for Best Paper Presentation in Fisheries Science' at the 27th Swadeshi Science Congress on 'Science and technology for societal development' held at Amrita Viswa Vidyapeetham, Amrita University, Kollam during 7-9 November, 2017. She presented the paper titled, "Rapid detection kits for chemical contaminants in fish" by E.R. Priya, S.J. Laly, S.K. Panda, K. Ashok Kumar and C.N. Ravishankar.

Dr. A.K. Jha, Scientist, Veraval RC of ICAR-CIFT received the Best Oral Presentation Award for the research paper titled "Preparation and characterization of seaweed extract-based biodegradable nano-composite film" and 2nd prize for the presentation on "Nutritional significance of some seaweed resources of Saurashtra coast" in 10th National Science Symposium on 'Recent trends in science and technology', organized by Christ College, Rajkot on 11 February, 2018.

Dr. S. Remya, Scientist, Veraval RC of ICAR-CIFT received the Best Poster Presentation Award for the research paper titled 'Intelligent freshness indicators and chitosan-based active antimicrobial film for smart packaging application of fish' for the research paper titled 'Fish packaging application of poly lactic acid (PLA)-based biodegradable active films' in the 10th National Science Symposium on 'Recent trends in science and technology', organized by Christ College, Rajkot on 11 February, 2018.

Smt. V. Renuka, Scientist, Veraval RC of ICAR-CIFT received Best Oral Presentation Award for her work entitled "Antioxidant and functional property of jawala protein hydrolysates (JPH) using RSM" in the 10th National Science Symposium on 'Recent trends in science and technology' organized by Christ college, Rajkot on 11 February 2018.

Dr. A.K. Jha, Dr. S. Remya and Smt. V. Renuka receiving the award

Dr. K.K. Prajith, Scientist, Veraval RC of ICAR-CIFT received Best Oral Presentation Award (2nd position) for his paper entitled "Off bottom trawl (OBT) for conservation of biodiversity by reducing bycatch in trawl fishery" by Prajith, K.K, Kamei, G. and Madhu, V.R. during 10th National Science Symposium on 'Recent trends in science and technology' organized by Christ College, Rajkot on 11 February, 2018.

Dr. N.S. Chatterjee, Scientist, Biochemistry and Nutrition Division, ICAR-CIFT, Kochi received the Best Poster Presentation Award for the paper entitled, "Shrimp fraud: Authentication of species, geographical origin and harvesting method by high resolution spectrometry based metabolomics" by Niladri S. Chatterjee, Oliver P. Chevallier, Ewa Wielogorska, Connor Black and Christopher T. Elliot presented at the 5th Annual Conference of AOAC International held at New Delhi during 28 February-1 March, 2018.

Shri K.R. Rajasaravanan, Skilled Support Staff, ICAR-CIFT, Kochi became the winner in Carroms (Single) in the ICAR-Inter Zonal Sports Tournament held at ICAR-IARI, New Delhi during 25-29 April, 2017.

Shri K.R. Rajasaravanan, Skilled Support Staff, ICAR-CIFT, Kochi became the winner in Carroms (Single) in the ICAR-Zonal Sports Tournament held at ICAR-SBI, Coimbatore during, October, 2017. **Shri K.D. Santhosh,** Tech. Asst. was the Runner Up in Shuttle Badminton (Singles) tournament, while

Shri Rajasaravanan receiving honours at ICAR-Zonal Sports Tournament

Shri K.V. Mathai, PA was the Runner up in Chess (Men). **Dr. P. Jeyanthi,** Scientist bagged second position in 200 m sprint and shot put and third position in 100 m sprint and long jump.

Post Graduate Studies

Kum. Jesmi Debbarma, Scientist, Visakhapatnam Research Centre of ICAR-CFT was awarded Ph.D. degree for her thesis entitled "Development of fish sausage from *Pangasius hypophthalmus* fortified with seaweed dietary fibre" from ICAR-CIFE, Mumbai (Deemed to be University). Kum. Jesmi worked under the guidance of Dr. L. Narasimha Murthy, Principal Scientist, Fish Processing Division and Scientist Incharge, ICAR-CIFT, Mumbai Research Centre.

Smt. S. Remya, Scientist, Veraval Research Centre of ICAR-CIFT was awarded Ph.D. degree for her thesis entitled "Development of active packaging for shelf life extension of fish stored in chilled condition" from ICAR-CIFE, Mumbai (Deemed to be University). Smt. Remya worked under the guidance of Dr. C.N. Ravishankar, Director, ICAR-CIFT, Kochi.

Smt. P. Jeyanthi, Scientist, Extension, Information and Statistics Division, ICAR-CIFT, Kochi was awarded Ph.D. in Agriculture (Agricultural Economics) for the thesis entitled "Supply chain analysis of marine fish marketing system in Kerala" under the guidance of Dr. K. Jesy Thomas, Professor and Head, Agricultural Economics Division from Kerala Agricultural University, Vellanikkara, Thrissur.

Dr. V. Murugadas, Scientist, Microbiology, Fermentation and Biotechnology Division, ICAR-CIFT, Kochi was awarded Ph.D. of Cochin Univeersity of Science and Technology, Kochi for his thesis entitled, "Molecular diversity and source tracking of methicllin-resistant *Staphylococcus aureus* prevalent in seafood". He carried out his research under the guidance of Dr. K.V. Lalitha, Principal Scientist (Retd.), Microbiology, Fermentaion and Biotechnology Division, ICAR-CIFT, Kochi.

Shri Abhay Kumar, Scientist, Microbiology, Fermentation and Biotechnology Division, ICAR-CIFT, Kochi was awarded Ph.D. of ICAR-CIFE, Mumbai (Deemed to be University) for his thesis entitled, "Establishment of embryonic stem like cell culture from *Carassius auratus* (Linnaeus, 1758)". He carried out his research under the guidance of Dr. Gayatri Tripathi, Principal Scientist, AEHM Division, ICAR-CIFE, Mumbai.

Smt. N. Manju Lekshmi, Scientist, Fishing Technology Division, ICAR-CIFT, Kochi was awarded Ph.D. of ICAR-CIFE, Mumbai (Deemed to be University) for her thesis entitled, "Ecological and economic impacts of aquaculture in coastal waters of Goa". She carried out her research under the guidance of Dr. P.K. Pandey, Dean, Agarthala University of Fisheries.

Kum. H. Mandakini Devi, Scientist, Fish Processing Division, ICAR-CIFT, Kochi was awarded Ph.D. of ICAR-CIFE, Mumbai (Deemed to be University) for her thesis entitled, "Development of food packaging film using gelatin extracted from surimi refiner discharge". She carried out her research under the guidance of Dr. A.K. Balange, Senior Scientist, FRHPHM Division, ICAR-CIFE, Mumbai.

Important Visitors

- Shri Pinarayi Vijayan, Chief Minister, Smt. J. Mercykutty Amma, Minister of Fisheries, Harbour Engineering and Cashew Industry, Adv. V.S. Sunil Kumar, Minister for Agriculture, Govt. of Kerala; Dr. T. Mohapatra, Secretary, DARE, GoI & Director General, ICAR, New Delhi, Smt. Soumini Jain, Mayor of Cochin Municipal Corporation, Shri K.J. Maxi, MLA, Kochi and Shri Hibi Eden, MLA, Ernakulam (Kochi on 29 April, 2017).
- Shri Sudarshan Bhagat, Union Minister of State for Agriculture and Farmers Welfare, Govt. of India (Kochi on 5 May, 2017).
- Dr. T. Mohapatra, Secretary, DARE and DG, ICAR, New Delhi and Dr. Gopal Krishna, Director and VC of ICAR-CIFE, Mumbai (Deemed to be University) (Mumbai on 12 June, 2017).
- Shri Anindo Mazumdar, IAS, Chief Secretary, A&N Administration, Dr. S. Dam Roy, Director, ICAR-CIARI, Port Blair, Dr. Mohan Joseph Modayil, Former Member, ASRB and Former Director, ICAR-CMFRI, Kochi (Kochi on 8 July, 2017).

Dr. N.S. Rathod at Kochi

Shri Devendra Chaudhary, IAS at Kochi

- Shri Devendra Choudhary, IAS, Secretary, DAHDF, Govt. of India and Dr. S. Karthikeyan, IAS, Director, Department of Fisheries, Govt. of Kerala (Kochi on 22 July, 2017).
- Prof. A. Ramachandran, Vice Chancellor, KUFOS, Kochi (Kochi on 1 August, 2017).
- Dr. Sanu Jacob, Joint Director, EIA (Mumbai on 22 August, 2017).
- Dr. P. Rajendran, Vice Chancellor, KAU, Thrissur (Kochi on 12 September, 2017).
- Dr. T. Mohapatra, Secretary, DARE and DG, ICAR, New Delhi (Visakhapatnam on 7 November, 2017).
- Dr. J.K. Jena, DDG (Fy.), ICAR, New Delhi (Kochi on 25 November, 2017).
- Dr. Narendra Sing Rathod, DDG (Agrl. Education), ICAR, New Delhi (Kochi on 19 February, 2018).

Invited Talks

Technical Talks

- Shri K.U.K. Menon, Noted Caligraphist on "Personality improvement through graphological analysis" on 5 August, 2017.
- Dr. Praveen Jacob, CMO, Alpha Natural Nutrition, Bengaluru on "Dietary management of diabetes and Coronary Vascular Disease (CVD)" on 14 August, 2017.
- Shri A.M. Dara, Sub Inspector of Police, Cyber Cell, Kochi on "Cyber securities" on 9 February, 2018.

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.

Revenue generation by ATIC (2017-18)

Particulars	Income generated (₹)
Revenue - Publications	1,32,071
Revenue - Product Sales	12,550
Testing/Diagnostic services	39,01,588

ATIC visitors (2017-18)

Particulars	Number of stakeholders
Students visited	2219
Faculties visited	181
Technologists visited	10
Fisheries officials visited	75
Fishermen visited	83
Stakeholders benefited through testing	636
Stakeholders benefited through telephone enquiry	377
Stakeholders benefited through technical bulletins distribution	250
Enquiries/letters replied	142

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 and the report to PMO. 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 to review the progress achieved in the ongoing research projects of the Institute during 2017-18 and to discuss the research project proposals for the year 2018-19. The Institute Research Project Document for the year 2018-19 was compiled and brought out for discussion at the Meeting. The House discussed in detail the ongoing research projects, besides completed projects and 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: ICAR-CIFT Newsletter and Fish Tech Reporter were published during the period. Besides, the Institute Annual Report 2016-17 and Research Highlights 2016-17 (both bilingual) were also brought out. The Annual Report won the 'Best Annual Report Award 2016-17 for Large Institute Category' of all the ICAR Institutes in the country.

Other technical matters: The Cell continued to answer queries on various technical matters received from other organizations and individuals. The queries received by the CTO, PME Cell in the additional capacity of Public Relations Officer, as well as from the feedback option in the Institute Website were attended to. Further, materials for various publications like ICAR News/ICAR Reporter, Agrinews, Fishing Chimes, MPEDA Newsletter, Seafood News, Aqua International, Sea Queen, ICAR Web page etc. were forwarded regularly for publication. The publicity related and extension-oriented activities of the Institute are being regularly presented in the monthly meetings of the Inter Media Publicity Co-ordination Committee of Ministry of Information and Broadcasting, Govt. of India. Besides, the PME Cell functions as the nodal point for releasing Press Releases and Reports.

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: (1). Assessment Committee - 5 times, (2). Career Advancement Committee - Once, and (3). Modified ACP Committee - 2 times.

Cases considered by the Departmental Promotion Committee

Category	Promotion	Declaration of probation	Granting MACP
Scientific	1	-	-
Technical	24	1	-
Administrative	6	1	1
Supporting	-	-	6
Auxiliary	-	-	1

Official Language Implementation

Hindi Chethana Mass: Hindi Chethana Mass was celebrated at the Institute during 10 August to 14 September, 2017. Different competitions like Precis writing, General knowledge, Extempore speech, Poster presentation, News reading, Memory test, Act 3(3) of OL, Singing, Anthakshari and street play were conducted among the staff members during the period. The valedictory function of Chethana Mass was held on 14 September, 2017. Dr. Ravishankar C.N., Director, ICAR-CIFT presided over the meeting. The Chief Guest, Shri Sudhanshu Sekhar Jha, IRS, Commissioner of Income Tax (Appeals), Kochi spoke about the origin of Hindi Language, its present form and importance. He also released a book titled, "Karyalayeen Dwibhashik Tippaniyam". Later he gave away the prizes for the winners. Shri Paras Nath Jha, Scientist, Fishing Technology Division bagged the 'Rajbhasha Prathibha Puraskar' and the FT Division was adjudged as the Best Division. Earlier, Dr. Suseela Mathew, HOD, B&N welcomed the gathering. Dr. P. Shankar, Senior Tech. Officer read the ICAR Director General's appeal. Dr. J. Renuka, Deputy Director (OL) proposed vote of thanks. A cultural programmme followed the Session in which solo song, group song, single dance, group dance and street play were enacted. International trainees from Liberia, Mr. Victor F. Nah and Ms Beatrice Newland also performed.

Hindi week was also celebrated at the Mumbai Research Centre during 13-19 September, 2017.

Shri P.N. Jha receiving the Rajbhasha Prathibha Puraskar

Fishing Technology Division receiving the Best Division Award

Cultural programme in progress

Hindi week celebrations at Mumbai

Inspection of Hindi Implementation by Parliament Committee: The Second Sub Committee on Parliament on Official Language inspected the implementation of Hindi at Mumbai Research Centre of ICAR-CIFT. The inspection held on 21 February, 2018 was chaired by Dr. Prasanna Kumar Patsani, MP (Lok Sabha). The other members present were Shri Vivek Gupta, MP (Rajya Sabha), Shri Laxmi Narayan Yadav, MP (Lok Sabha) and Shri S.S. Rana, Secretary, Dr. Satyendra Singh, Senior Research Author, Shri Vikas Verma, Hindi Officer, Shri Kiran Pal Singh, Senior Translator and Smt. Neerja, Research Assistant. ICAR-CIFT was represented by Dr. P. Pravin, ADG (M.Fy.), ICAR, New Delhi, Smt. Seema Chopra, Director (OL), ICAR, Shri Manoj Kumar Singh, Assistant Chief Technical Officer, ICAR, Dr. Ravishankar C.N., Director, ICAR-CIFT, Dr. L.N. Murthy, Scientist Incharge, Mumbai Research Centre of ICAR-CIFT, Dr. J. Renuka, Deputy Director (OL), Dr. Santhosh Alex, Assistant Chief Technical Officer, Dr. P. Shankar, Senior Technical Officer and Shri A.N. Agawane, Assistant.

Parliament Official Language Committee at Mumbai

Hindi Workshop: A one day Hindi Workshop was conducted at ICAR-CIFT, Kochi on 16 March, 2018 for the benefit of Scientists of the Institute. Shri Ramesh Prabhu, Chief Official Language Superintendent, HPCL, Kochi was the resource person of the Workshop. Thirty four Scientists took part in the Workshop. The Scientists were trained in the use of Unicode in Computers and also language usage in mobiles.

Library

Library is playing a vital role in providing services to support the information needs of the scientific community of the Institute. The Library is well equipped with modern facilities and resources in the form of online databases, CD-ROMs, DVDs, books, e-journals, e-standards, theses, reports etc. During the period under report, Library acquired 26 books. Online databases *viz.*, ASFA (Aquatic Science and Fisheries Abstracts) and Indian Standards on DVD 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: Digitization of ICAR-CIFT publications and putting them in open digital repository is an important activity of the Library. During the period 1150 documents have been digitized and added to the repository. At present the ICAR-CIFT Digital Repository holds 3374 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 112 articles under DDR (Document Delivery Request) facility of CeRA.

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 Inter-library Loan Programme, with more than 90 member libraries from more than 25 countries offering materials to other member libraries *via*. inter-library 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. 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 generous contribution of 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, Email, Video Conferencing and other computer related facilities. AKMU also

periodically updates Institute Website and Personnel Management Information System Network (PERMISnet) of the employees of the Institute. AKMU provides internet connectivity to nearly 250 systems through LAN and wifi connectivity to nearly 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 round the clock for the employees of the Institute.

In the last financial year, AKMU has organized inhouse training programmes on ICAR ERP system for the Scientific, Technical, Administrative and Skilled Support Staff of ICAR-CIFT in which different modules like Employee self service, Creation of ICAR-CIFT Projects, Budget integration and Purchase requisition application were introduced to the staff.

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 acts 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 the overall research activities and achievements of the Institute and acts as an interface between Institute and end-users. The contents of the Institute Website are periodically updated. The information on training programmes, recruitments of temporary staff, tender notices and other circulars of the Institute are periodically uploaded in the Institute Website for better transparency of the working conditions. ICAR-CIFT has IP-based video conferencing facility. It is being operated and maintained effectively by the AKMU. This facility is being used for monitoring and evaluating research programmes in the Research Centres **of** the Institute and also other organizations.

AKMU is maintaining and updating of Personnel Management Information System Network (PERMISnet-II) of ICAR at the Institute. It contains personal, professional and referential attributes of personnel along with information on plan-wise cadre strength and institutional parameters for different categories of the staff. The information is periodically updated. As per the provision given, the Institute provided user name and password to the Regional Centres to update the information in PERMISnet on periodical basis.

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 the stakeholders. Further, AKMU provides input to the Knowledge Management Portal developed by ICAR by updating details of Institute, higher authorities contact information, information on sophisticated analytical instrumentation facility available and online transaction details of the Institute.

NABL Activities

The Chemical, Biological and Mechanical laboratories of ICAR-CIFT, Kochi are accredited to ISO/IEC: 17025:2005 by NABL for the field of testing from the year 2005 onwards. Dr. A.A. Zynudheen, Principal Scientist and HOD Incharge, Quality Assurance and Management Division serves as the Quality Manager and


NABL
National Accreditation Board for Testing and Calibration Laboratories
CERTIFICATE OF ACCREDITATION
ICAR-CENTRAL INSTITUTE OF FISHERIES TECHNOLOGY
Matsyapuri P.O., Willingdon Island, Cochin, Kerala
CHEMICAL TESTING


NABL
National Accreditation Board for Testing and Calibration Laboratories
CERTIFICATE OF ACCREDITATION
ICAR-CENTRAL INSTITUTE OF FISHERIES TECHNOLOGY
Matsyapuri P.O., Willingdon Island, Cochin, Kerala
BIOLOGICAL TESTING


NABL
National Accreditation Board for Testing and Calibration Laboratories
CERTIFICATE OF ACCREDITATION
ICAR-CENTRAL INSTITUTE OF FISHERIES TECHNOLOGY
Matsyapuri P.O., Willingdon Island, Cochin, Kerala
MECHANICAL TESTING

Dr. S.K. Panda, Principal Scientist serves as the Technical Manager of NABL in the Institute. Out of 106 NABL recommended scope for testing of the Institute, 83 parameters comes under Chemical, 17 parameters in Biological and 6 parameters in Mechanical field. ILC programmes were conducted for chemical and biological parameters in water and fish matrix and also for mechanical parameters. Participated in three Proficiency Test programmes this year, which included chemical parameters in water and fish and biological parameters in fish. The laboratory conducted internal audits at planned intervals to conform the requirements of the management system and documents. Desktop surveillance of the laboratories was carried out and the report sent to NABL, New Delhi for continuous compliance of the accreditation.

NABL accreditation ISO/IEC 17025:2005 standard was revised to ISO/IEC 17025:2017 and as part of this Dr. A.A. Zynudheen, HOD Incharge, QAM and Smt. P.K. Shyma, Asst. Chief Technical Officer attended a National Conclave on Laboratories "Laboratories: Striving towards excellence amidst challenges and opportunities" during 23-24 January, 2018 at Ahmedabad. ICAR-CIFT has undertaken consultancy programmes with ICAR-IISR, Kozhikode and ICAR-CIFA, Bhubaneswar for getting NABL accreditation for their laboratories.

During the year 2017-18, a total of 1635 samples including NABL, Non-NABL samples were analyzed and total revenue of ₹ 44.79 lakhs was realized.

Committees

Quinqennial Review Team

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

Members

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

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

Research Advisory Committee

Chairman: Dr. Bhaskaran Manimaran, Former Vice Chancellor, TNFU, Nagapattinam

Members

1. Dr. B. Hanumanthappa, Professor, College of Fisheries, Mangaluru
2. Dr. Sajan George, Former Dean, KUFOS, Kochi
3. Dr. Sreenath Dixit, Director, ATARI, Bengaluru
4. Dr. K.S.M.S. Raghava Rao, Head, Food Engineering, CSIR-CFTRI, Mysuru
5. Shri P.P. Surendran, DGM, Matsyafed, Thiruvananthapuram
6. Dr. P. Pravin, Asst. Director General (M. Fy.), ICAR, New Delhi
7. Dr. Ravishankar C.N., Director, ICAR-CIFT

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

Institute Management Committee

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

Members

1. Shri P. Sahadevan, Joint Director of Fisheries, Govt. of Kerala
2. Shri H.S. Veerappa Gowda, Director of Fisheries, Govt. of Karnataka

3. Dr. G. Sugumar, Dean, CFRI, Thoothukudy
4. Dr. Rani Palaniswami, ICAR-CIFRI Regional Centre, Kochi
5. Dr. S.V. Alavandi, HOD, ICAR-CIBA, Chennai
6. Dr. S. Kalavathy, Principal Scientist ICAR-CPCRI Regional Station, Kayamkulam
7. Dr. K.V. Rajendran, HOD, ICAR-CIFE, Mumbai
8. Assistant Director General (M. Fy.), ICAR, New Delhi
9. Assistant Finance and Accounts Officer, ICAR-CPCRI, Kasaragod

Member Secretary: Shri P.J. Davis, Senior Administrative Officer, ICAR-CIFT

Grievance Cell

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

Members

1. Dr. Suseela Mathew, Principal Scientist & HOD, B&N
2. Shri P.J. Davis, Senior Administrative Officer
3. Shri P.P. Anil Kumar, Assistant 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 Clerk
7. Shri P. Raghavan, Skilled Support Staff
8. Shri M.V. Rajan, Auxillary Staff

Member Secretary: Shri T. Viswanathan, Assistant Administrative Officer, ICAR-CIFT

Institute Joint Staff Council

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

Members (Official side)

1. Dr. Suseela Mathew, Principal Scientist & HOD, B&N
2. Dr. A.A. Zynudheen, Principal Scientist & HOD I/c, QAM
3. Dr. M.P. Remesan, Principal Scientist
4. Smt. M.J. Christina Joseph, Administrative Officer
5. Shri K.S. Sreekumaran, Finance & Accounts Officer

Secretary (Official Side)

Shri P.J. Davis, Senior Administrative Officer

Members (Staff Side)

1. Shri G. Vinod, Technician
2. Shri K.B. Sabukuttan, Assistant Administrative Officer
4. Shri P.K. Somasekharan Nair, Assistant
5. Shri K.K. Karthikeyan, Skilled Support Staff
6. Shri P.N. Nikhil Das, Skilled Support Staff

Secretary (Staff Side)

Shri P.S. Nobi, Technical Officer

On-going Research Projects

Institute projects

Sl. No	Name of Project	Principal Investigator	Location of Project	Co-Investigators	
1.	Investigations on fish behaviour 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. Chinnadurai Shri R.K. Renjith Shri P.N. Jha Dr. R. Raghu Prakash Dr. U. Sreedhar Dr. K.K. Prajith Shri G. Kamei
2.	Design, development and standardization of deep sea fishing vessel and gear systems for commercial operation	Shri M.V. Baiju	Kochi, Visakhapatnam & Veraval	Kochi Visakhapatnam Veraval	Dr. Saly N. Thomas Dr. M.P. Remesan Shri P.N. Jha Shri R.K. Renjith Dr. R. Raghu Prakash Dr. U. Sreedhar Dr. K.K. Prajith
3.	Marine biomolecules - Characterization and utilization for neutraceutical, biomedical and industrial applications	Dr. K.K. Asha	Kochi, Visakhapatnam & Veraval	Kochi Visakhapatnam Veraval	Dr. Suseela Mathew Dr. R. Anandan Dr. George Ninan Dr. Femeena Hassan Dr. S.K. Panda Dr. C.O. Mohan Shri C.G. Joshy Dr. N.S. Chatterjee Shri C.S. Tejpal Smt. Lekshmi R.G. Kumar Shri K.K. Anas Dr. Raja Swaminathan (ICAR-NBFGR, Kochi) Dr. B. Madhusudana Rao Dr. Jesmi Debbarma Dr. A.K. Jha
4.	Modeling studies for estimation of revenue-based capacity and valuation of selected fishing systems and fish supply chain analysis	Dr. P. Jeyanthi	Kochi & Veraval	Kochi Veraval	Dr. A.K. Mohanty Dr. Nikita Gopal Dr. V. Geethalakshmi Shri V. Radhakrishnan Nair Shri V. Chandrasekar Dr. V.K. Sajesh Shri G. Kamei

Sl. No	Name of Project	Principal Investigator	Location of Project	Co-Investigators	
5.	An assessment of the impact of S&T outputs of ICAR-CIFT on the socio-economic fabric of fisheries stakeholders	Dr. S. Ashaletha	Kochi	Kochi	Dr. A.K. Mohanty Dr. V. Geethalakshmi Shri V. Radhakrishnan Nair Shri V. Chandrasekar Dr. V.K. Sajesh Dr. K. Rejula
6.	Molecular heterogeneity and bioprospecting of aquatic and fish bacteria for novel molecules and genes	Dr. Toms C. Joseph	Kochi, Visakhapatnam, Mumbai & Thiruvanantha-puram	Kochi Visakhapatnam Mumbai Thiruvanantha-puram	Dr. M.M. Prasad Dr. G.K. Sivaraman Dr. K.K. Asha Shri V. Radhakrishnan Nair Dr. V. Murugadas Shri C.G. Joshy Shri K.A. Basha Shri R.K. Nadella Smt. S.S. Greeshma Smt. T. Muthulakshmi Dr. Abhay Kumar Shri S. Ezhil Nilavan Dr. M.A. Pradeep (ICAR-CMFRI, Kochi) Dr. Raja Swaminathan (ICAR-NBFGR, Kochi) Dr. B. Madhusudana Rao Dr. S. Visnuvinayagam Dr. E. Sreekumar (RGCBT, Thiruvananthapuram) Dr. R. Ajaykumar (RGCBT, Thiruvananthapuram) Dr. Santhosh Mundayoor (RGCBT, Thiruvananthapuram)
7.	Quality improvement of Indian fishing fleet and engineering interventions in post harvest sector	Shri M. Nasser	Kochi	Kochi	Dr. Manoj P. Samuel Dr. S. Ashaletha Dr. V. Geethalakshmi Dr. S. Murali Dr. D.S. Aniesrani Delfiya Smt. P.V. Alfiya
8.	Service life enhancement of fishing materials through application of nano particles and its impact on environment	Dr. P. Muhamed Ashraf	Kochi	Kochi	Dr. Leela Edwin Dr. Saly N. Thomas Shri S. Chinnadurai Dr. N. Manju Lekshmi
9.	Assessing environmental aspects of fish, fishery products and effects of chemical hazards	Dr. G.K. Sivaraman	Veraval, Kochi & Mumbai	Veraval Kochi	Dr. A.K. Jha Smt. V. Renuka Dr. S. Remya Dr. M.M. Prasad Shri R.K. Nadella Shri K.A. Basha

Sl. No	Name of Project	Principal Investigator	Location of Project	Co-Investigators	
				Mumbai	Dr. L.N. Murthy Dr. S. Visnuvinayagam Dr. A. Jeyakumari Smt. U. Parvathy
10.	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
11.	Optimization of harvesting techniques for mesopelagics 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
12.	Development of region and species specific pots/traps	Dr. K.K. Prajith	Veraval, Kochi & Visakhapatnam	Veraval Kochi Visakhapatnam	Shri G. Kamei Dr. S. Remya Dr. D. Divu (ICAR-CMFRI) Dr. M.P. Remesan Shri S. Chinnadurai Dr. N. Manju Lekshmi Dr. U. Sreedhar
13.	Technological interventions for enhancing utilization of secondary raw materials of aquatic origin	Dr. A.A. Zynudheen	Kochi, Mumbai & Veraval	Kochi Mumbai Veraval	Dr. S.K. Panda Dr. P.K. Binsi Shri C.G. Joshy Dr. 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. Parvathy Smt. V. Renuka
14.	Interventions in processing and preservation of commercial and unconventional fishery resources	Dr. George Ninan	Kochi, Mumbai & Visakhapatnam	Kochi	Dr. A.A. Zynudheen Dr. J. Bindu Dr. C.O. Mohan Dr. P.K. Binsi Smt. S.J. Laly Shri C.G. Joshy Dr. H. Mandakini Devi

Sl. No	Name of Project	Principal Investigator	Location of Project	Co-Investigators	
					Shri Devananda Uchoi Dr. Anuj Kumar Dr. K. Elavarasan Kum. Rehana Raj Smt. S.S. Greeshma Smt. K.R. Sreelakshmi
				Mumbai	Dr. A. Jeyakumari Smt. U. Parvathy
				Visakhapatnam	Dr. P. Viji
15.	Biodegradable packaging materials for fish and fishery products	Dr. J. Bindu	Kochi, Veraval & Visakhapatnam	Kochi	Shri S. Sreejith Shri K. Sathish Kumar Dr. T.K. Anupama Smt. K. Sarika Smt. E.R. Priya
				Veraval	Dr. S. Remya Smt. V. Renuka
				Visakhapatnam	Dr. Jesmi Debbarma
16.	Development of processing protocols for emerging farmed fishery resources	Dr. P.K. Binsi	Kochi, Viaskhapatnam & Mumbai	Kochi	Dr. 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 Kum. Rehana Raj
				Visakhapatnam Mumbai	Dr. S. Murali Dr. P. Viji Dr. A. Jeyakumari Smt. U. Parvathy
17.	Development of active and intelligent packaging system for fish and shellfishes	Dr. C.O. Mohan	Kochi, Veraval & Mumbai	Kochi	Dr. Ravishankar C.N. Dr. K. Ashok Kumar Dr. P. Muhamed Ashraf Dr. S.K. Panda Shri C.G. Joshy Dr. Anuj Kumar Dr. K. Elavarasan Dr. Pankaj Kishore Smt. K.R. Sreelakshmi Dr. K. Nagalakshmi
				Veraval Mumbai	Dr. S. Remya Dr. S. Visnuvinayagam
18.	Economic evaluation of resource use efficiency and management of reservoir ecosystem	Dr. V. Geethalakshmi	Kochi	Kochi	Dr. Nikita Gopal Dr. Femeena Hassan Dr. P. Jeyanthi Shri V. Chandrasekar

Sl. No	Name of Project	Principal Investigator	Location of Project	Co-Investigators	
19.	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
20.	Design and development of tools and technologies for energy and water use optimization in fish processing industries	Dr. Manoj P. Samuel	Kochi & Visakhapatnam	Kochi Visakhapatnam	Dr. K. Ashok Kumar Dr. George Ninan Shri C.G. Joshy Dr. S. Murali Dr. D.S. Aniesrani Delfiya Smt. P.V. Alfiya Dr. K. Rejula Dr. Jesmi Debbarma
21.	Fishing technological interventions for sustainable marine ecosystem services along the east coast of India	Dr. R. Raghu Prakash	Visakhapatnam & Kochi	Visakhapatnam Kochi	Dr. G. Rajeswari (Till 30 June, 2017) Dr. U. Sreedhar Dr. Jesmi Debbarma Shri M.V. Baiju Dr. V.R. Madhu Dr. P. Jeyanthi
22.	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 Mumabi	Dr. Toms C. Joseph Dr. G.K. Sivaraman Shri V. Radhakrishnan Nair Dr. V. Murugadas Shri C.G. Joshy Shri K.A. Basha Shri R.K. Nadella Smt. S.S. Greeshma Smt. T. Muthulakshmi Dr. Abhay Kumar Shri S. Ezhil Nilavan Dr. B. Madhusudana Rao Dr. S. Visnuvinayagam
23.	Evolving SMART EDP module for livelihood security of small scale fisherfolk through fish-preneurship	Dr. A.K. Mohanty	Kochi, Visakhapatnam, Veraval & Mumbai	Kochi Visakhapatnam Veraval Mumbai	Dr. S. Ashaletha Dr. George Ninan Dr. M.V. Sajeev Dr. P. Jeyanthi Dr. V.K. Sajesh Dr. K. Rejula Dr. P. Viji Dr. S. Remya Dr. L.N. Murthy
24.	Seaweeds of Indian coast as source of bioactive compounds for developing nutraceuticals/ functional foods	Dr. Suseela Mathew	Kochi	Kochi	Dr. R. Anandan Dr. V. Geethalakshmi Dr. K.K. Asha Dr. N.S. Chatterjee Dr. Anuj Kumar Dr. H. Mandakini Devi Dr. T.K. Anupama Shri C.S. Tejpal

Sl. No	Name of Project	Principal Investigator	Location of Project	Co-Investigators	
				Veraval Visakhapatnam	Shri K.K. Anas Smt. Lekshmi R.G. Kumar Smt. V.A. Minimol Dr. A.K. Jha Dr. Jesmi Debbarma
25.	Developing a rapid detection kit for formaldehyde contamination in seafood	Smt. S.J. Laly	Kochi	Kochi	Dr. S.K. Panda Smt. E.R. Priya
26.	Development of moisture soaker sachets/pads from aquatic weed Water hyacinth (*Eichhornia crassipes*) using super absorbant polymers for fish packaging application	Shri S. Sreejith	Kochi	Kochi	Dr. P. Muhamed Ashraf Smt. K. Sarika
27.	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
Indian Council of Agricultural Research (ICAR) Projects					
28.	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* Shri A.C. Praveen* Smt. P.R. Sudha* Smt. E.B. Lovely* Dr. B. Madhusudana Rao Dr. L.N. Murthy
29.	Nutrient profiling and evaluation of fish as a dietary component	Dr. Suseela Mathew	Kochi, Veraval & Mumbai	Kochi Veraval Mumbai	Dr. R. Anandan Dr. G.K. Sivaraman Dr. K.K. Asha Dr. N.S. Chatterjee Shri C.S. Tejpal Smt. Lekshmi R.G. Kumar Shri K.K. Anas Smt. Divya K. Vijayan* Smt. R. Jayarani* Dr. A.K. Jha Smt. V. Renuka Dr. A. Jeyakumari

Sl. No	Name of Project	Principal Investigator	Location of Project	Co-Investigators	
30.	All India Network project on Fish health	Dr. K. Ashok Kumar	Kochi	Kochi	Dr. S.K. Panda Smt. S.J. Laly
National Agricultural Science Fund (NASF) Project					
31.	Green fishing systems for tropical seas	Dr. Leela Edwin	Kochi, Goa, Pune & Mumbai	Kochi Goa Pune Mumbai	Dr. Saly N. Thomas Dr. M.P. Remesan Shri M.V. Baiju Dr. V.R. Madhu Shri P.S. Muhammed Sherif* Smt. K.A. Sayana* Smt. Leena Raphael* Shri P.K. Mahato* Smt. Jolsna Jeevan* Shri H. Unnikrishnan* Shri S. Vinayak Karma* Shri K.R. Harikrishnan* Shri B.K. Upadhyay Shri Ashok Naik Shri Sanjay V. Raut Shri Kishore Darda Kum. Margot Wunnikvan Shri Rakesh Gaikwad
Department of Biotechnology (DBT) Projects					
32.	Genetic diversity of *Clostridium botulinum* in seafoods and development of Lateral Flow Immuno Assay (LFIA) for toxinotyping	Dr. Tom C. Joseph	Kochi	Kochi	Shri P.V. Arun Jyothi* Kum. Athira Vidyadharan*
33.	Evaluating cost and benefits of prophylactic health products and novel alternatives on small holder aquaculture farms in Asia and Africa	Dr. Toms C. Joseph	Kochi	Kochi	Shri K.S. Bibin Das* Smt. T.R. Lakshmi* Shri Chandra Rao*
Department of Science and Technology (DST) Project					
34.	Development of clam cluster an clam processing facility at Perumbalam village, Thycatuserry block, Cherthala taluk, Alappuzha	Dr. Nikita Gopal	Kochi	Kochi	Dr. J. Bindu Shri V. Chandrasekar Shri S. Sreejith Smt. K.H. Sreedevi* Shri James J. Pulikottil*

Sl. No	Name of Project	Principal Investigator	Location of Project	Co-Investigators	
Indian National Centre for Ocean Information (INCOIS) Projects					
35.	Retrieval of phytoplankton and associated optical constituents based on long term bio-optical studies	Dr. P. Muhamed Ashraf	Kochi	Kochi	Smt. P. Minu* Smt. V.P. Souda*
36.	Indigenous traditional knowledge (ITKs) in marine fisheries sector of Kerala: Documentation and analysis	Dr. Nikita Gopal	Kochi	Kochi	Dr. J. Bindu Dr. V.K. Sajesh Shri S. Sreejith Kum. Diana Benjamin* Kum. T.A. Alfreeda* Kum. M.V. Neelima* Shri Jiswin Jose* Kum. K.M. Mrudula* Kum Sumisha Velloth (Vijnana Bharati, New Delhi)*
National Fisheries Development Board (NFDB) Project					
37.	National surveillance programme for aquatic animal diseases	Dr. V. Murugadas	Kochi	Kochi	Dr. Toms C. Joseph Dr. S. Ashaletha Shri K.A. Basha Shri P.G. Akhil Nath* Shri P. Shaheer*
ICAR-National Fellow Project					
38.	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*
Export Inspection Council of India (EICI) Project					
39.	Preparation of pictorial guidelines based on freshness ratings for the species of fishes exported to European Union	Dr. S.K. Panda	Kochi, Visakhapatnam, Veraval & Mumbai	Kochi Visakhapatnam Veraval Mumbai	Dr. S.K. Panda Dr. Pankaj Kishore Dr. B. Madhusudana Rao Dr. A.K. Jha Dr. L.N. Murthy
Food and Agricultural Organization (FAO) Project					
40.	Assessment of food loss from selected gillnet and trammel net fisheries in India	Dr. Saly N. Thomas	Kochi, Veraval & Kakinada	Kochi Veraval Kakinada	Dr. Leela Edwin Shri S. Chinnadurai Dr. K.K. Prajith Dr. V. Salarama (ICM, Kakinada)

Sl. No	Name of Project	Principal Investigator	Location of Project	Co-Investigators	
Bangalore Water Supply and Sewage Board (BWSSB) Project					
41.	Feasibility study on coastal reservoir concept to impound Netravati river flood waters: A sustainable strategy for water resource development for Mangaluru and Bengaluru	Dr. T.G. Sitaram, IISc., Bengaluru	Bengaluru & Kochi	Kochi	Dr. Manoj P. Samuel Dr. M.V. Sajeev Dr. S. Murali
* Research Fellow					

List of Personnel in ICAR-CIFT

(As on 31st March, 2018)

Managerial Personnel

Director: Dr. Ravishankar C.N.

Heads of Division

Biochemistry and Nutrition Division	:	Dr. Suseela Mathew, Principal Scientist
Fish Processing Division	:	Dr. K. Ashok Kumar, Principal Scientist
Microbiology, Fermentation & Biotechnology Division	:	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 Assurance and Management Division I/c	:	Dr. A.A. Zynudheen, Principal Scientist

Visakhapatnam Research Centre	:	Dr. R. Raghu Prakash, Principal Scientist
Mumbai Research Centre	:	Dr. L.N. Murthy, Principal Scientist
Veraval Research Centre	:	Dr. A.K. Jha, Scientist

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

Other Personnel

Headquarters, Cochin

Scientific Personnel

Principal Scientist

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

Senior Scientist

1. Shri M.V. Baiju
2. Dr. M.V. Sajeev
3. Dr. C.O. Mohan

Scientist

1. Shri V. Radhakrishnan Nair
2. Dr. P. Jeyanthi
3. Dr. P.K. Binsi
4. Shri V. Chandrasekar
5. Shri C.G. Joshy
6. Dr. V. Murugadas
7. Dr. K. Nagalakshmi
8. Dr. N.S. Chatterjee
9. Dr. V.K. Sajesh
10. Smt. S.J. Laly
11. Dr. N. Manju Lekshmi
12. Shri K.A. Basha
13. Shri R.K. Nadella
14. Shri S. Sreejith
15. Dr. T.K. Anupama
16. Dr. H. Mandakini Devi
17. Dr. Pankaj Kishore
18. Dr. Anuj Kumar
19. Smt. K.R. Sreelakshmi
20. Smt. Lekshmi R.G. Kumar
21. Smt. E.R. Priya
22. Shri R.K. Renjith
23. Smt. K. Sarika
24. Shri P.N. Jha
25. Dr. K. Elavarasan
26. Shri S. Chinnadurai
27. Smt. T. Muthulakshmi
28. Shri C.S. Tejpal
29. Smt. S.S. Greeshma
30. Shri Devananda Uchoi
31. Dr. K. Rejula
32. Shri K. Sathish Kumar
33. Dr. Abhay Kumar
34. Shri K.K. Anas
35. Shri S. Ezhil Nilavan
36. Smt. V.S. Minimol
37. Dr. S. Murali
38. Smt. PV. Alfiya
39. Dr. D.S. Aniesrani Delfiya
40. Kum. Rehana Raj

Technical Personnel

Chief Technical Officer

1. Dr. A.R.S. Menon
2. Dr. B. Ganesan

Assistant Chief Technical Officer

1. Shri C.R. Gokulan
2. Smt. P.K. Shyma
3. Dr. M. Baiju
4. Smt. T. Silaja
5. Shri T.V. Bhaskaran
6. Smt. M. Rekha
7. Smt. K.K. Kala
8. Shri Sibasis Guha
9. Shri K.D. Jos
10. Dr. Santhosh Alex

Senior Technical Officer

1. Shri P.S. Babu
2. Shri G. Omanakuttan Nair
3. Smt. G. Remani
4. Dr. P. Shankar
5. Smt. K.G. Sasikala

Technical Officer

1. Shri K.B. Thampi Pillai
2. Smt V.C. Mary
3. Shri V.N. Dileepkumar
4. Shri C. Subash Chandran Nair
5. Shri Aravind S. Kalangutkar
6. Shri P.S. Nobi
7. Smt. K.S. Mythri
8. Smt. P.K. Geetha
9. Shri Sajith K. Jose
10. Shri P.V. Sajeevan
11. Smt. P.A. Jaya
12. Shri V.K. Siddique
13. Shri T.B. Assisse Francis
14. Shri G. Gopakumar
15. Smt. N. Lekha
16. Shri K.S. Babu
17. Shri P. Bhaskaran
18. Smt. Bindu Joseph
19. Shri T.P. Saju
20. Smt. N.C. Shyla

Senior Technical Assistant

1. Shri P.D. Padmaraj
2. Smt. Tessy Francis
3. Shri P.S. Sunil Kumar
4. Shri N. Sunil
5. Shri K.V. Mohanan
6. Shri C.K. Suresh
7. Shri K. Dinesh Prabhu
8. Shri K.D. Santhosh

Technical Assistant

1. Shri P.A. Aneesh
2. Shri K.A. Noby Varghese
3. Shri V. Vipin Kumar
4. Smt. Vineetha Das
5. Shri T. Jijoy
6. Smt. V. Sushmitha
7. Smt. P. Sruthi
8. Shri Rahul Ravindran
9. Smt. U.P. Prinetha
10. Shri Rakesh M. Raghavan
11. Dr. P.H. Dhiju Das

Senior Technician

1. Shri K.C. Anish Kumar
2. Shri G. Vinod
3. Shri Ajith V. Chellappan
4. Shri K. Ajeesh
5. Shri M.T. Udayakumar
6. Smt. Anu Mary Jose
7. Smt. G. Archana
8. Smt. P.J. Mary
9. Shri P. Suresh
10. Smt. K. Reshmi
11. Shri V.N. Sreejith
12. Shri K. Nakulan

Administrative Personnel

Deputy Director (Official Language)

1. Dr. J. Renuka

Adminstrative Officer

1. Smt. M.J. Christina Joseph

Assistant Administrative Officer

1. Shri P. Krishna Kumar
2. Shri T. Viswanathan
3. Shri K.B. Sabukuttan
4. Shri M.N. Vinodh Kumar
5. Smt. T.D. Usheem

Assistant Finance & Accounts Officer

1. Shri P.P. Anil Kumar

Private Secretary

1. Smt. S. Kamalamma
2. Smt. N. Leena

Assistant

1. Shri K.K. Sasi
2. Smt. T.K. Shyma
3. Smt. V.S. Aleyamma
4. Smt. G.N. Sarada
5. Shri C.K. Sukumaran
6. Smt. V.K. Raji
7. Smt. K. Renuka
8. Shri K. Das
9. Shri P.K. Somasekharan Nair
10. Smt. G. Surya
11. Smt. Nilina Elais
12. Smt. N.R. Akhila
13. Smt. A.R. Raji
14. Shri P. Mani
15. Smt. Jaya Das
16. Smt. E. Jyothilakshmy

17. Smt. P.R. Mini
18. Shri T.N. Shaji
19. Shri Santhosh Mohan
20. Smt. Shiji John
21. Shri T.R. Syam Prasad

Personal Assistant

1. Shri K.V. Mathai
2. Shri R.D. Goswami
3. Smt. Anitha K. John

Upper Division Clerk

1. Shri P.G. David
2. Smt. K.V. Suseela
3. Shri T.D. Bijoy
4. Smt. K.S. Sobha
5. Kum. T. Deepa

Lower Division Clerk

1. Shri P.P. George
2. Smt. Subin George
3. Smt. Suni Surendran
4. Shri Deu Umesh Aroskar
5. Shri G.S. Sahoo

Supporting Personnel

Skilled Support Staff

1. Shri P.A. Sivan
2. Shri P.V. Raju
3. Shri A.V. Chandrasekharan
4. Shri K.K. Karthikeyan
5. Smt. U.K. Bhanumathy
6. Shri T.K. Rajappan
7. Smt. P.T. Mary Vinitha
8. Shri O.P. Radhakrishnan
9. Shri S.N. Dash
10. Shri P. Raghavan
11. Shri T.M. Balan
12. Shri V. Deepak Vin
13. Shri K.R. Rajasaravanan
14. Shri K. Thinakaran
15. Shri P.N. Nikhil Das
16. Shri A. Vinod
17. Shri K.S. Ajith

Auxiliary Staff

1. Shri M.V. Rajan

Visakhapatnam Research Centre

Scientific Personnel

Principal Scientist

1. Dr. U. Sreedhar
2. Dr. B. Madhusudana Rao

Scientist

1. Dr. P. Viji
2. Dr. Jesmi Debbarma

Technical Personnel

Chief Technical Officer

1. Dr. M.S. Kumar

Senior Technical Officer

1. Dr. Ancy Sebastian

Technical Officer

1. Shri A.K. Naik
2. Shri Damodar Rout
3. Shri P. Radhakrishna
4. Shri H.S. Bag

Senior Technical Assistant

1. Shri M. Prasanna Kumar

Technician

1. Shri G. Bhushanam

Administrative Personnel

Upper Division Clerk

1. Shri D.L. Pattanaik

Lower Division Clerk

1. Shri Amit Vengraj
2. Shri Ramesh Mirdha

Supporting Personnel

Skilled Support Staff

1. Shri Jaisingh Oram
2. Shri T.N. Banchoor
3. Shri Sanyasi Ganik
4. Shri M.S. Prabhakara Rao
5. Smt. Gyana Netri Nag
6. Smt. Nalla Naveena
7. Shri S.K. Mehar
8. Shri Kedar Meher
9. Shri Lalit Oram
10. Shri G.B. Mahanandia

Veraval Research Centre

Scientific Personnel

Scientist

1. Dr. K.K. Prajith
2. Dr. S. Remya
3. Smt. V. Renuka
4. Shri G. Kamei

Technical Personnel

Senior Technical Assistant

1. Shri H.V. Pungera
2. Shri S.H. Ummer Bhai
3. Shri G. Kingsely

Technical Assistant

1. Kum. Nimmy S. Kumar

Senior Technician

1. Shri J.B. Malmadi
2. Shri Y.D. Kriplani

Administrative Personnel

Assistant Administrative Officer

1. Shri M.M. Damodara

Assistant

1. Shri D.P. Parmar

Upper Division Clerk

1. Shri M. Arockia Shaji

Supporting Personnel

Skilled Support Staff

1. Shri D.K. Viram
2. Shri R.N. Gosai
3. Shri A.M. Vala
4. Shri M.K. Kana
5. Smt. Harshaban A. Joshi
6. Smt. Pushpaben P. Chudasama
7. Smt. Motiben K. Fofandi
8. Shri N.K. Masani
9. Shri P. Ramakrishna

Auxiliary Staff

1. Shri J.K. Khodidas
2. Smt. Veena Sreedhar Narkar

Mumbai Research Centre

Scientific Personnel

Scientist

1. Dr. S. Visnuvinayagam
2. Dr. A. Jeyakumari
3. Smt. U. Parvathy

Technical Personnel

Assistant Chief Technical Officer

1. Smt. Sangeetha D. Gaikwad
2. Smt. Triveni G. Adiga

Technical Assistant

1. Smt. Priyanka Ajay Nakhawa

Senior Technician

1. Shri T.A. Waghmare

Administrative Personnel

Assistant

1. Shri A.N. Agawane

Supporting Personnel

Skilled Support Staff

1. Shri V.S. Salvi
2. Smt. Priyanka P. Bait

Individual curiosity, often working without practical ends in mind, has always been a driving force for innovation

Frederick Seitz

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