ICAR - CIFT

# ANNUAL REPORT 2023


**ICAR - CENTRAL INSTITUTE OF FISHERIES TECHNOLOGY**

(DARE, Ministry of Agriculture & Farmer's Welfare, Govt.of India)

Willingdon Island, Matsyapuri P. O., Kochi - 682029, Kerala, India



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# Annual Report
# 2023

**ICAR-Central Institute of Fisheries Technology**
(DARE, Ministry of Agriculture and Farmers Welfare, Govt. of India)
Willingdon Island, Kochi - 682 029
ISO/IEC 17025:2017 NABL Accredited & ISO 9001:2015 certified

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**ICAR-CIFT COVER**


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# निदेशक के डेस्क से

भाकृअनुप-केमाप्रौसं 67 वर्षों की समर्पित सेवा के लिए अनुसंधान और विकास-उन्मुख हस्तक्षेपों के माध्यम से देश के सामाजिक-आर्थिक विकास और खाद्य सुरक्षा में योगदान देना जारी रखा है। मैं संस्थान की वार्षिक रिपोर्ट 2023 प्रस्तुत करना एक बड़ा सम्मान मानता हूं, जिसमें जनवरी से दिसंबर 2023 की अवधि के दौरान अनुसंधान आउटपुट और संबंधित उपलब्धियों का विवरण है। एक प्रमुख अनुसंधान संस्थान के रूप में, भाकृअनुप-केमाप्रौसं ने मत्स्यन और मत्स्य प्रसंस्करण उद्योगों के साथ मिलकर कार्य किया है, ताकि उनके विकास को बढ़ावा देने के लिए अनुसंधान, विस्तार और अन्य संबंधित गतिविधियाँ की जा सकें।

वर्ष के दौरान संस्थान में 39 संस्थानवित्त पोषित अनुसंधान परियोजनाएं और 26 बाह्य वित्त पोषित परियोजनाएं संचालित थीं। इन परियोजनाओं के माध्यम से, संस्थान का उद्देश्य विभिन्न हितधारकों जैसे छोटे उद्यमियों, मछुआरों और निर्यातकों की ज़रूरतों को पूरा करना था। बाहरी वित्तपोषित परियोजनाओं को राष्ट्रीय एजेंसियों और अंतर्राष्ट्रीय वित्त पोषण निकायों द्वारा समर्थित किया गया, जिसमें नॉर्वेजियन यूनिवर्सिटी ऑफ़ साइंस एंड टेक्नोलॉजी, रॉयल अकादमी ऑफ़ इंजीनियरिंग-यूके, इंटरनेशनल राइस रिसर्च इंस्टीट्यूट और वर्ल्डफ़िश शामिल हैं।

इस वर्ष अनुसंधान और अन्य गतिविधियों में वृद्धि देखी गई, जिसमें प्रग्रहण और पश्च प्रग्रहण की प्रौद्योगिकियों में उन्नति, उद्योग भागीदारों के साथ कई महत्वपूर्ण समझौता ज्ञापनों पर हस्ताक्षर, प्रौद्योगिकी हस्तांतरण, उत्पाद विकास इत्यादि शामिल है। इस अवधि के दौरान, परामर्श परियोजनाओं, सहयोगी अनुसंधान, अनुबंध सेवाओं और अनुबंध अनुसंधान के माध्यम से 25 प्रौद्योगिकी हस्तांतरण निष्पादित किए गए हैं। अंतर्राष्ट्रीय और राष्ट्रीय पीरसमीक्षित पत्रिकाओं में पांडुलिपियों के रूप में प्रकाशित वैज्ञानिक उपलब्धियाँ संस्थान के योगदान को दर्शाती हैं। इसके अलावा, संस्थान के वैज्ञानिकों ने विभिन्न वैज्ञानिक मंचों पर कई विचार-विमर्शों में सक्रिय रूप से भाग लिया। संस्थान ने पेटेंट, कॉपीराइट और परिकल्पन पंजीकरण के मामले में भी महत्वपूर्ण उपलब्धियाँ हासिल कीं, और भाकृअनुप संस्थान रैंकिंग में चौथा स्थान प्राप्त किया है।

भाकृअनुप-केमाप्रौसं प्रग्रहण और पश्च प्रग्रहण की प्रौद्योगिकी में किफायती स्वदेशी और नवीन प्रौद्योगिकियों को उपलब्ध कराने के लिए प्रतिबद्ध है। उपलब्धियों में से एक

मत्स्यन प्रौद्योगिकी के क्षेत्र में उल्लेखनीय भारत के विभिन्न समुद्री राज्यों में CIFT-V आकार स्लॉटेड ओटर बोर्ड का व्यापक रूप से लोकप्रिय होना था, जिसका उद्देश्य ट्रॉल प्रचालन की लागत को कम करना था। एक अन्य प्रमुख गतिविधि सीआइएफटी-एमपीईडीएटेड का विकास और कार्यान्वयन था, जो अंतर्राष्ट्रीय मानकों का अनुपालन करता है। जाल की पकड़ दक्षता में सुधार के लिए रणनीतियाँ, नैनो-प्रौद्योगिकी दृष्टिकोणों के माध्यम से मत्स्यन गियर और यान सामग्री के स्थायित्व को बढ़ाना, समुद्री स्तनपायी घटनाओं का दस्तावेजीकरण, एफआरपी कूड़े के परिवर्तन के लिए आशाजनक प्रौद्योगिकी रिपोर्ट के तहत अवधि के दौरान किए गए शोध के कुछ दिलचस्प क्षेत्र हैं।

पश्च प्रग्रहण के क्षेत्र में, अनुसंधान प्रयासों में बाजरा को शामिल करते हुए नए उत्पाद विकसित करने, मत्स्य अपशिष्ट से निकाले गए जैवसक्रिय यौगिकों को खाद्य उत्पादों में एकीकृत करने, खाने के लिए तैयार समुद्री खाद्य उत्पादों में नवीनता लाने, स्मार्ट और बुद्धिमान संवेष्टन प्रणाली परिकल्पना और झींगे के जल रहित परिवहन की पद्धति के खोज पर ध्यान केंद्रित किया गया। कुछ नए उत्पादों में स्पिरुलिना हाइड्रोलिसेट्स और कोलेजन पेप्टाइड से एक एंटीऑक्सीडेंट ड्रिंक, समुद्री शैवाल के साथ ग्लूटेन-मुक्त बाजरा कुकीज़, प्रलेपित उत्पादों के लिए बाजरा-आधारित बैटर फॉर्मूलेशन, कोलेजन पेप्टाइड फोर्टिफाइड सूप क्यूब्स, ब्लड क्लैम (सौराष्ट तट का एक अप्रयुक्त संसाधन) से पकाने के लिए तैयार कटलेट और शुष्क कैट फिश से स्मोक्ड उत्पाद शामिल हैं। भाकृअनुप-केमाप्रौसं मात्स्यिकी क्षेत्र के लिए ऊर्जा-कार्यक्षम पश्च प्रग्रहण की मशीनरी के परिकल्पन करने के लिए प्रतिबद्ध है। मत्स्य की गुणवत्ता और ताज़गी के गैर-विनाशकारी मूल्यांकन के लिए एक पोर्टेबल युक्ति, एक सौर प्रशीतित कियोस्क का बेहतर परिकल्पन और पायलट स्केल इंफ्रा रेड शुष्कक का निष्पादन मूल्यांकन पिछले वर्ष की कुछ उन्नतियाँ थीं। मानव पोषण के लिए समुद्री-व्युत्पन्न जैव सक्रिय अणुओं की जैव-पूर्वेक्षण भाकृअनुप-केमाप्रौसं की एक प्रमुख गतिविधि है। पिछले वर्ष, काइटोसन की जैव-सक्रियता को बढ़ाने के लिए प्रक्रियाओं को मानकीकृत किया गया, जिसमें रमनोलिपिड नैनोकणों के साथ ग्राफ्टिंग, काइटोसन-जिलेटिन प्रोटीन हाइड्रोलाइज़ेट का उपयोग करके पिकरिंग इमल्शन विकसित करना, और काइटोसन-जिलेटिन -लिग्निन हाइड्रोजेल का सृजन करना शामिल है। जैव सक्रिय यौगिकों के स्रोत के रूप में समुद्री शैवाल की खोज संस्थान की एक सतत गतिविधि है। इस प्रयास के एक भाग के रूप में, चयनित भूरे समुद्री शैवालों की पोषण संबंधी रूपरेखा तैयार करने, तथा इन समुद्री शैवालों से जैवसक्रिय यौगिक निकालने के लिए सुपरक्रिटिकल द्रव निष्कर्षण, एंजाइम-सहायता प्राप्त निष्कर्षण, तथा दबावयुक्त निष्कर्षण विधियों सहित विभिन्न निष्कर्षण विधियों के अनुकूलन पर ध्यान केंद्रित किया गया है।

भाकृअनुप-केमाप्रौसं घरेलू और निर्यात दोनों बाजारों के लिए समुद्री खाद्य पदार्थों की सुरक्षा सुनिश्चित करने में महत्वपूर्ण भूमिका निभाता है। इस संबंध में, हाइपोक्सैंथिन सामग्री के लिए एक त्वरित परीक्षण पद्धति, विकृत करने वाले जीवाणु की तेजी से पहचान के लिए एक रंगमिति परख और मत्स्य में बीएचए और बीएचटी निर्धारित करने के लिए यूपीएलसी पद्धतियों को विकसित करने की दिशा में अनुसंधान को उन्मुख किया गया। भाकृअनुप-केमाप्रौसं द्वारा विकसित मत्स्य और मत्स्य उत्पादों के लिए विश्लेषण के तरीकों पर एक मैनुअल देश भर के हितधारकों को लाभान्वित करने के लिए एफएसएसएआई द्वारा जारी की गई। इसके अलावा, सार्वजनिक हित के लिए, मत्स्य और मत्स्य उत्पादों से संबंधित एफएसएसएआइ मानकों के संग्रह को प्रदर्शित करने के लिए 'Food-'O'-Copoeia' नामक एक वेबसाइट बनाई गई। मानव रोगजनक के लिए जलीय पर्यावरण और मत्स्य विक्रय परिसर की निगरानी भाकृअनुप-केमाप्रौसं में अनुसंधान का एक और प्रमुख क्षेत्र है। खुदरा बाजारों से एकत्र किए गए मत्स्य नमूनों में *वी. वल्नीफिकस* और टीडीएच सकारात्मक संभावित रोगजनक *वी. पैराहेमोलिटिकस* की व्यापकता और विब्रियो प्रजाति में संयुग्मी ट्रांसपोजेबल तत्व के एसए-क्सटी इंटीग्रेज जीन की उपस्थिति के महत्वपूर्ण निष्कर्ष पाए गए। रोगाणुरोधी प्रतिरोधी जीवाणु को लक्षित करने वाले बैक्टीरियोफेज पर शोध से आशाजनक परिणाम प्राप्त हुए। *ऑरेंटियोचाइट्रियम* प्रजाति में ओमेगा 3 वसा अम्ल की प्रचुरता इन कमजोर जीवाणु से बायोमॉलीक्यूल्स के निष्कर्षण के अवसर प्रदान करती है।

प्रौद्योगिकी प्रसार और हितधारकों द्वारा प्रौद्योगिकी अपनाने का मूल्यांकन संस्थान के निष्पादन के प्रमुख संकेतकों के रूप में मापा जाता है। भाकृअनुप-केमाप्रौसं की सफल प्रौद्योगिकियों की निगरानी और प्रभाव मूल्यांकन के लिए एक व्यापक डैशबोर्ड विकसित और मूल्यांकित किया गया। इसके अलावा, मत्स्यन की गतिविधियों के आर्थिक जोखिमों के मॉडलिंग पर शोध, समुद्री मात्स्यिकी में पश्च प्रग्रहण नुकसान का आकलन और ऑनलाइन मत्स्य वेंडिंग प्लेटफार्मों का भूनिर्माण सामाजिक-आर्थिक अनुसंधान के प्रगतिशील क्षेत्रों में से हैं। क्षमता निर्माण गतिविधियों को सबसे अधिक महत्व देते हुए, भाकृअनुप-केमाप्रौसं ने मात्स्यिकी क्षेत्र के सभी हितधारकों को लाभान्वित करने वाले कई प्रशिक्षण सह निदर्शन कार्यक्रम आयोजित किए हैं। इसके अलावा, संस्थान ने कमजोर आबादी को सशक्त बनाने के लिए एससी-एसपी, टीएसपी और एनईएच सहित भारत सरकार के प्रमुख कार्यक्रमों में सक्रिय रूप से योगदान दिया है।

मुझे सभी हितधारकों, सरकारी संगठनों और वित्त पोषण एजेंसियों के प्रति हार्दिक आभार व्यक्त करते हुए गर्व हो रहा है, जिन्होंने हमारी यात्रा के दौरान हमें अपना अटूट समर्थन दिया है। मैं भाकृअनुप के विषय वस्तु प्रभाग द्वारा दिए गए मार्गदर्शन और समर्थन के लिए अत्यंत आभारी हूं। संस्थान के वैज्ञानिकों और कर्मचारियों के समर्पित प्रयासों का विशेष उल्लेख किया जाना चाहिए, और मैं संस्थान के अधिदेश के सभी पहलुओं में उनके अमूल्य योगदान को निष्ठा से स्वीकार करता हूं।

# From the Director's Desk

With 67 years of dedicated service, ICAR-CIFT continues to contribute to the nation's socio-economic development and food security through research and development-oriented interventions. I consider it a great honor to present the Institute's Annual Report 2023, which chronicles the research output and related achievements during the period January to December 2023. As a premier research institute, ICAR-CIFT undertook research, extension, and other related activities in harmony with the fishing and fish processing industries to foster their development.

During the year, there were 39 institute-funded research projects and 26 externally funded projects, in operation in the institute. Through these projects, the institute aimed to address the needs of various stakeholders viz., small entrepreneurs, fishermen, and exporters. The externally funded projects were supported by national agencies and also international funding bodies including the Norwegian University of Science and Technology, Royal Academy of Engineering-UK, International Rice Research Institute, and WorldFish.

The year witnessed a flurry of research and other activities including advancements in harvest and post-harvest technologies, the signing of several important MoUs with industry partners, technology transfers, product development, and more. During this period, 25 technology transfers have been executed through Consultancy Projects, Collaborative Research, Contract Services, and Contract Research. The scientific achievements published as manuscripts in international and national peer-reviewed journals reflect the institute's contributions. Further, scientists from the institute actively participated in numerous deliberations across various scientific forums. The institute also achieved significant milestones in terms of patents, copyrights, and design registrations, and achieved 4$^{th}$ place in the ICAR institute ranking.

ICAR-CIFT is committed to provide affordable indigenous & innovative technologies in harvest and post-harvest technology. One of the notable achievements in the fishing technology domain was the widespread popularisation of the

CIFT-V form slotted otter boards in various maritime states of India, aimed at reducing the cost of trawl operations. Another highlighted activity was the development and implementation of CIFT-MPEDA-TED, which complies with international standards. Strategies for improving the catch efficiency of traps, enhancing the durability of fishing gear & craft material through nano-technological approaches, documentation of marine mammal incidence, promising technologies for FRP litter transformation are some of the interesting areas of research carried out during the period under report.

In the post-harvest domain, research efforts were focused on developing novel products incorporating millets, integrating bioactive compounds extracted from fish waste into food products, innovative ready-to-eat seafood products, designing smart & intelligent packaging systems and exploring methods for waterless transportation of shrimp. Some of the novel products included an antioxidant drink from spirulina hydrolysates and collagen peptide, gluten-free millet cookies with seaweed, millet-based batter formulation for coated products, collagen peptide fortified soup cubes, ready-to-cook cutlets from blood clam (an untapped resource of Sourashtra coast) and smoked products from Arid cat fish. ICAR-CIFT is committed to designing energy-efficient post-harvest machineries for the fisheries sector. A portable device for non-destructive evaluation of fish quality and freshness, an improved design of a solar refrigerated kiosk and performance evaluation of pilot scale Infrared dryer were a few of the advancements made in the last year. Bioprospecting marine-derived bioactive molecules for human nutrition is a prime activity of ICAR-CIFT. In the past year, processes were standardized for enhancing the bioactivity of chitosan through grafting with rhamnolipid nanoparticles, developing pickering emulsions using chitosan-gelatin protein hydrolysate, and creating chitosan-gelatin-lignin hydrogels. Exploration of seaweeds as a source of bioactive compounds is a continuous activity of the institute. As a part of this effort, the focus has been on conducting nutritional profiling of selected brown seaweeds and optimizing various extraction methods, including supercritical fluid extraction, enzyme-assisted extraction, and pressurized extraction methods, to extract bioactive compounds from these seaweeds.

ICAR-CIFT plays a crucial role in ensuring the safety of seafood intended for both domestic and export markets. In this regard, research was oriented towards developing a rapid test method for hypoxanthine content, a colorimetric assay for rapid identification of spoilage bacteria and UPLC methods for determining BHA and BHT in fish. A manual on Methods of Analysis for Fish and Fish Products developed by ICAR-CIFT was released by FSSAI to benefit stakeholders across the country. Furthermore, for public interest, a website named 'Food-'O'-Copoeia' was created to showcase a collection of FSSAI standards pertaining to fish and fish products. Monitoring the aquatic environment and fish vending premises for human pathogen is another key area of research at ICAR-CIFT. Prevalence of *V. vulnificus* and tdh positive potentially pathogenic *V. parahaemolyticus* and presence of SXT integrase gene of conjugative transposable element in *Vibrio sp.* in fish samples collected from retail markets were important findings. Research on bacteriophages targeting antimicrobial-resistant bacteria yielded promising results. The abundance of omega 3 fatty acids in *Aurantiochytrium* sp. gives opportunities for extraction of biomolecules from these undermined bacteria.

Technology dissemination and assessment of technology adoption by the stakeholders are measured as key indicators of the Institute's performance. A comprehensive dashboard for the monitoring and impact assessment of successful technologies of ICAR-CIFT was developed and evaluated. Besides, research on modelling of economic risks of fishing activities, assessment of post-harvest losses in marine fisheries and landscaping of online fish vending platforms are among the progressing areas of socio-economics research. While giving foremost importance to capacity building activities, ICAR-CIFT has organized numerous training cum demonstration programs benefiting stakeholders throughout the fisheries sector spectrum. Also, the institute has actively contributed to the Govt. of India's flagship programmes including SCSP, TSP and NEH for empowering the weaker populations.

I am privileged to extend my heartfelt gratitude to all stakeholders, government organizations, and funding agencies for their unwavering support throughout our journey. I greatly acknowledge the guidance and support offered by the subject matter division of ICAR. The dedicated efforts of the scientists and staff of the institute deserve special mention, and I sincerely acknowledge their priceless contributions across all aspects of the Institute's mandate.

# महत्वपूर्ण उपलब्धियाँ

- भारतीय जल में अपनाने के लिए CIFT-MPEDA-TED को अंतर्राष्ट्रीय मानकों के साथ विकसित, मानकीकृत और गोता-मूल्यांकित किया गया
- डीजल की खपत, $CO_2$ उत्सर्जन और ट्रॉलिंग की परिचालन लागत को कम करने के लिए भारत के विभिन्न राज्यों में ईंधन कार्यक्षम CIFT-VSOB को विकसित और लोकप्रिय किया गया
- नैनो कार्बन डॉट-ग्रेफीन मिश्रण को जलीय कृषि पिंजरे के जालों में जैव प्रदूषण को कम करने में सक्षम पाया गया
- लकड़ी के संरक्षण के लिए नैनो कॉपर, क्रोम और बोरॉन (सीसीबी) विकसित की गई
- कृत्रिम प्रकाश से जाल में रीफ मत्स्यों की पकड़ दर में सुधार पाया गया
- पीले फनेल प्रवेश द्वार वाले जालों की पकड़ क्षमता हरे और काले रंग के फनेल प्रवेश द्वारों की तुलना में बेहतर थी
- हाइड्रोक्सीपाटाइट नैनो सिल्वर कम्पोजिट (HAP-Ag) में उत्कृष्ट जैवनाशी गतिविधि पाई गई
- परित्यक्त एफआरपी यानों को घर के पिछवाड़े में जलाने से होने वाले रासायनिक उत्सर्जन के प्रभाव का पता लगाया गया
- महाराष्ट्र में मोरबे और बारवी जलाशय तथा केरल में चुलियार और मालमपुष़ा जलाशयों में मत्स्यन की प्रणालियों के परिकल्पन और तकनीकी विवरण का दस्तावेजीकरण किया गया
- जलाशय में मत्स्यन के लिए फ्रेम क्लोम जाल (पॉलियामाइड मोनोफिलामेंट) का परिकल्पन तैयार किया गया
- समुद्री पर्यावरण में परित्यक्त एफआरपी मत्स्यन यानों और उनके मलबे के परिमाणीकरण के लिए एक कार्यप्रणाली को मानकीकृत किया गया
- ड्राइव प्रणाली के माध्यम से डीजल इंजन और ट्रांसमिशन गियर के साथ एक प्रणोदन प्रणाली तैयार की गई
- विभिन्न मत्स्यन प्रणालियों के एलसीए को पूरा किया गया और भारत के लक्षद्वीप सहित पूर्वी और पश्चिमी तट पर वस्तुसूची/ऊर्जा उपयोग/कार्बन उत्सर्जन पर द्वितीयक जानकारी के साथ आंकड़ों को मान्य किया गया
- मछुआरों द्वारा अपनाए गए स्वदेशी समुद्री स्तनपायी शमन उपायों का दस्तावेजीकरण 8 समुद्री राज्यों के 100 स्थानों से किया गया
- दूर कोच्चि मत्स्यन मैदानों में 64 बार देखे गए बोर्ड पर के अवलोकन से दर्ज किए गए समुद्री स्तनधारी थे *टर्सिओप्स एडुनकस* (इंडो-पैसिफिक बॉटलनोज़), *सूसा प्लंबिया* (हिंद महासागर हंपबैक डॉल्फिन), *ग्रैम्पस ग्रिसियस* (रिसो डॉल्फिन) और व्हेल (*बालानोप्टेरा* प्रजाति)।
- शुष्कित मत्स्य और बटन मशरूम की भंडारण स्थिरता को बढ़ाने के लिए खाद्य प्रलेपन और फिल्म उपयुक्त पाई गई
- स्पिरुलिना हाइड्रोलाइज़ेट और मत्स्य स्केल कोलेजन पेप्टाइड से एंटीऑक्सीडेंट पेय विकसित किया गया
- झींगा कवच प्रोटीन का उपयोग करके एंटीऑक्सीडेंट से समृद्ध चारा विकसित किया गया
- स्क्विड त्वचा और मेलेनिन मुक्त स्याही के निचोड़ को संयोजित करने से जैव आधार फिल्म की कार्यक्षमता में वृद्धि हुई

- सोने के नैनोकणों का संश्लेषण और कैपिंग एजेंट के रूप में काइटोसन का उपयोग करके उसका लक्षण वर्णन किया गया
- सम-सहसंबद्ध त्रुटि संरचना के तहत डी-इष्टतम अवरुद्ध द्वितीय क्रम प्रतिक्रिया सतह प्रतिगमन मॉडल विकसित किया गया
- मत्स्य की त्वचा के चमड़े के उत्पादन के लिए वनस्पति टैनिंग प्रक्रिया को मान-ाकीकृत किया गया
- समुद्री शैवाल और बाजरे के संयोजन से मूल्य वर्धित उत्पाद विकसित किए गए
- मत्स्य कोलेजन पेप्टाइड से समृद्ध सूप क्यूब्स विकसित किए गए
- कटलहड्डी चूर्ण के संयोजन से कैल्शियम समृद्ध सफेद ब्रेड विकसित किया गया
- उद्यमियों और हितधारकों का समर्थन करने के लिए वेब आधारित प्रौद्योगिकी सूचना प्रणाली (TIS) विकसित की गई
- जलीय प्रजातियों के जल रहित परिवहन के लिए एक प्रोटोटाइप विकसित किया गया
- कोट्टायम शैली के 'झींगा रोस्ट' के लिए खाने के तैयार प्रक्रिया की स्थिति को रिट ॉर्टेबल पाउच में तैयार किया गया
- खाने के लिए तैयार गोवा स्टाइल चिकन ज़ाकौटी की निधानी आयु 9 महीने से ज़्यादा पाई गई
- 3D प्रिंटिंग का उपयोग करके आइस बॉक्स के लिए ताज़गी सूचक धारक को परिकल्पित और संरचित किया गया और IP संरक्षण के लिए आवेदन दायर किया गया
- मत्स्य में हाइपोक्सैंथिन मात्रा का तेज परीक्षण को विकसित किया गया
- मत्स्य को विकृत करने वाले जीवाणु की तेजी से पहचान के लिए एक रंगमिति परख विकसित की गई
- मत्स्यों के तापमान के दुरुपयोग के दौरान हाइपोक्सैंथिन तेजी से संचय हुआ और सामान्य तापमान में छह घंटे के भंडारण के बाद 50 मिलीग्राम/किलोग्राम से अधिक हो गया
- व्यावसायिक रूप से महत्वपूर्ण भूरे समुद्री शैवाल, हरे समुद्री शैवाल और लाल समुद्री शैवाल की व्यापक मेटाबोलाइट प्रोफ़ाइल का प्रदर्शन किया गया और यौगिक एनोटेशन के साथ मास स्पेक्ट्रल डेटाबेस सृजित किया गया
- तरल क्रोमैटोग्राफी QTRAP मास स्पेक्ट्रोमेट्री का उपयोग करके तलछट के नमूनों में 38 एंटीबायोटिक दवाओं के लिए बहु-अवशेष पहचान विधि को अनुकूलित किया गया
- मत्स्य और मत्स्य उत्पादों में एस्कॉर्बिक अम्ल के निर्धारण के लिए UPLC विधि विकसित की गई, साथ ही ब्यूट इलेटेड हाइड्रॉक्सीएनिसोल (BHA) और ब्यूटाइलेटेड हाइड्रॉक्सीटोल्यूइन (BHT) का भी निर्धारण किया गया।
- टेंडेम मास स्पेक्ट्रोमेट्री और तरल क्रोमैट ोग्राफी का उपयोग करके, मत्स्य में क्लोट्रिमेज़ोल अवशेषों को रिकवरी, मैटि क्स प्रभाव, स्थिरता, विशिष्टता, चयन-ात्मकता, संवेदनशीलता, कैरी-ओवर, रैखिकता, सटीकता और परिशुद्धता के संदर्भ में EU2021/808 में उल्लिखित दिशानिर्देशों के अनुपालन में मान्य किया गया।
- नमूनों (n=1460) में क्लोट्रिमेज़ोल, फ्लोरफेनिकॉल और इसके अमाइन, इमामेक्टिन, ऑक्सीटेट्रासाइक्लिन, एन्-ारोफ्लोक्सासिन (एनरोफ्लोक्सासिन और सिप्रोफ्लोक्सासिन के योग के रूप में) और ऑक्सोलिनिक अम्ल जैसे का दवा अवशेष को अकलित किया गया
- मत्स्य और मत्स्य उत्पादों के विश्लेषण के तरीकों के लिए FSSAI मैनुअल तैयार किया गया और इसे FSSAI द्वारा अधिसूचित किया गया
- मत्स्य और मत्स्य उत्पादों के लिए Food-'O'-Copoeia विकसित किया गया और यह ऑनलाइन प्लेटफॉर्म पर उपलब्ध है
- REIMS हाई रेजोल्यूशन मास स्पेक्ट्रोमीटर, और वास्तविक समय प्रजातियों के लिए केमोमेट्रिक्स मॉडलिंग और व्यावसायिक रूप से महत्वपूर्ण झींगा प्रजातियों की भौगोलिक उत्पत्ति प्रमाणीकरण के आधार पर एक तीव्र विश्लेषणात्मक विधि विकसित की गई
- समुद्री खाद्य पदार्थों से प्राप्त ES-BL-उत्पादक *E. कोली* उपभेदों में से 85% से अधिक में सीटाइलपाइरिडिनि-ियम क्लोराइड के प्रति सह-प्रतिरोध पाया गया
- केरल के त्रिशूर और आलप्पुषा जिले के जलीय कृषि तालाबों में *वी. वल्न-ीफिकस* का प्रचलन 11% था, जबकि एरणाकुलम क्षेत्रों के खुदरा मत्स्य बाजारों में यह 3% था
- दो खुदरा समुद्री खाद्य पदार्थों के नमूनों से टीडीएच पॉजिटिव संभावित रोगजनक वी. पैराहेमोलिटिकस उपभेदों को वियुक्त किया गया
- संयुग्मी ट्रांसपोज़ेबल तत्व के SXT इंट ीग्रेज जीन को पांच विब्रियो प्रजातियों में पाया गया
- ऑरेंटियोचाइट्रियम प्रजाति M 54 में ओमेगा-3 और ओमेगा-6 पॉलीअन-ासेचुरेटेड फैटी एसिड की उपस्थिति देखी गई और 8.3 ग्राम/लीटर शुष्क कोशिका भार का बायोमास उत्पन्न किया गया
- बहु होस्ट समृद्ध MRSA-लाइसेट स्पॉट के *होस्ट* श्रेणी विश्लेषण के लिए एक संशोधित प्रक्रिया विकसित की गई
- समृद्ध फेज लाइसेट्स 90% MRSA होस्ट को नष्ट करने में सक्षम थे और MSSA होस्ट के 71% परीक्षण किए गए
- व्यापक होस्ट रेंज बैक्टीरियोफेज के डाउनस्ट्रीम वियुक्ति और लक्षण वर्णन के लिए एक तेज़ विधि विकसित की गई
- MRSA और MSSA फेज के लिए पिनहेड आकार की पट्टिका से परिभाषित पट्टिका प्राप्त करने के लिए प्रोटोकॉल मानकीकृत किए गए
- CH-GPH नैनोकण परिसरों के संश्लेषण के लिए प्रोटोकॉल को मान-ाकीकृत किया गया
- काइटोसन-जिलेटिन-लिग्निन हाइड्रोजेल की तैयारी के लिए एक विधि विकसित की गई
- काइटोसन और एल्गिनेट से तैयार किए गए रमनोलिपिड नैनोकणों का संश्लेषण विकसित किया गया

- बायोएक्टिव पेप्टाइड्स के साथ बायो-पॉलिमर कोटेड नैनोलिपोसोम तैयार किया गया
- काइटोसन-जिलेटिन प्रोटीन हाइड्रोलाइज़ेट (CHI-GPH) नैनोकॉम्प्लेक्स और मत्स्य तेल का उपयोग करके पिकरिंग इमल्शन तैयार किया गया
- लिपोफिलिक यौगिकों के लिए वितरण प्रणाली के रूप में पॉलीमराइज़्ड व्हे प्रोटीन के विकास के लिए एक पद्धति तैयार की गई
- पिकरिंग इमल्शन स्टेबलाइज़र के रूप में स्व-संयोजन किए गए काइटोसन के विकास के लिए एक पद्धति तैयार की गई
- विकसित कर्क्यूमिन-आधारित पूरक *मैक्रोब्रैकियम रोसेनबर्गी* के वृद्धि प्रदर्शन को बेहतर बनाना पाया गया
- न्यूट्रास्युटिकल एजेंट के रूप में स्क्वैलीन से भरी सोडियम एल्गिनेट बीड्स के निर्माण के लिए एक प्रौद्योगिकी विकसित की गई
- विभिन्न ट्यूना प्रसंस्करण अंशों की वसा अम्ल प्रोफाइलिंग की गई
- डिब्बाबंद टूना त्वचा अंशों से ओमेगा-3 PUFA प्राप्त करने के लिए सुपरक्रिटिकल द्रव-आधारित निष्कर्षण प्रोटोकॉल विकसित किया गया
- मेघालय (रीभोई और पश्चिमी गारो हिल्स) में मत्स्य खरीद और उपभोग व्यवहार पर अध्ययन किए गए
- मंडपम तट से चयनित भूरे समुद्री शैवाल की पोषण और वसा अम्ल प्रोफाइलिंग निर्धारित की गई
- भूरे समुद्री शैवाल से फ़्लोरोटेनिन प्राप्त करने के लिए सुपरक्रिटिकल द्रव निष्कर्षण प्रोटोकॉल विकसित किया गया
- भूरे समुद्री शैवाल से बायोएक्टिव प्राप्त करने के लिए एक एंजाइम सहायता प्राप्त निष्कर्षण पद्धति विकसित की गई
- भूरे समुद्री शैवाल से बायोएक्टिव प्राप्त करने के लिए एक दबावयुक्त निष्कर्षण पद्धति विकसित की गई
- ऑनलाइन मत्स्य विक्रय का रणनीतिक परिदृश्य तथा ऑनलाइन मत्स्य खरीद के लिए चालकों और बाधाओं का एक वैचारिक मॉडल भी बनाया गया
- भाकृअनुप-केमाप्रौसं में सफल प्रौद्योगिकियों की निगरानी और प्रभाव आकलन के लिए पहचाने गए प्रमुख संकेतकों का उपयोग करके एक व्यापक डैशबोर्ड विकसित किया गया
- समुद्री मात्स्यिकी में पश्च प्रग्रहण में होने वाले नुकसान का आकलन करने के लिए अनौपचारिक मत्स्य क्षति आकलन पद्धति का उपयोग किया गया
- आर्थिक जोखिमों के मॉडलिंग के लिए, आंकड़े इंगित करते हैं कि एक दिन के मत्स्यन में लगे मछुआरों को आर्थिक जोखिमों का अधिक खतरा होता है क्योंकि तूफान और चक्रवातों के लिए मौसम की चेतावनी प्रत्येक घटना के दौरान कम से कम 4 दिनों के लिए मत्स्यन के परिचालन को प्रतिबंधित करती है
- झींगा और क्लैम का उपयोग करके सौर सुरंग शुष्कक का निष्पादन और तकनीकी-आर्थिक विश्लेषण किया गया
- पायलट स्केल आईआर शुष्कक का निष्पादन मूल्यांकन किया गया
- विभिन्न सिफ्ट शुष्कक में क्लैम और सोल मत्स्य के शुष्कन और गुणवत्ता विशेषताओं का मूल्यांकन किया गया
- मत्स्य विक्रय के लिए बेहतर सौर प्रशीतित कियोस्क के लिए परिकल्प तैयार किया गया
- झींगा शुष्कन के लिए गैसीफायर हीट बैकअप के साथ बहुउद्देश्यीय सौर तापीय रूपांतरण प्रणाली के प्रोटोटाइप का विकास और मूल्यांकन किया गया
- मत्स्य की गुणवत्ता और ताज़गी के गैर-विनाशकारी मूल्यांकन के लिए एक पोर्टेबल युक्ति विकसित की गई
- NAS फिशरिस, अरूर, कोच्चि में समुद्री खाद्य प्रसंस्करण में अमोनिया/कार्बन डाइऑक्साइड (प्राकृतिक रेफ्रिजरेंट) कैस्केड रेफ्रिजरेशन की स्थापना की गई
- फिनफिश जलकृषि प्रणाली से प्राप्त हेटरोट्रॉफिक जीवाणु के टेट्रासाइक्लिन प्रतिरोध का निर्धारण किया गया
- शुष्कित मत्स्य के लिए यूवी प्रकाश उपचार ने भंडारण के दौरान जीवाणु और फफूंदों की वृद्धि और रासायनिक विकृति को काफी हद तक नियंत्रित किया
- माही माही मत्स्य फिलेट फ्रेम अपशिष्ट से मत्स्य सॉस विकसित किया गया
- प्रलेपित मत्स्य उत्पाद के लिए बाजरा आधारित बैटर फॉर्मूलेशन विकसित किया गया
- आंध्र प्रदेश और ओडिशा राज्यों की मौजूदा ट्रॉल प्रणालियों और ट्रॉल मत्स्यन में चुनौतियों पर सर्वेक्षण किया गया
- *ई. कोली*, कोगुलेज़ नकारात्मक स्टैफिलोकोसी (CoNS) और *विब्रियो* प्रजाति को *पेनियस वन्नामेई* झींगा और तालाब के पानी से वियुक्त किया गया, जिसमें रोगाणुरोधी प्रतिरोध का समान प्रतिमान दिखा
- सौराष्ट्र तट पर पाई जाने वाली शार्क और गिटार मत्स्य सहित इलास्मोब्रांच में भारी धातुओं के संदर्भ में खतरे की पहचान और स्वास्थ्य जोखिम का मूल्यांकन किया गया।
- सौराष्ट्र तट की कम मूल्य वाली एरिएड कैट फिश (*एरियस डुसुमिएरी*) के मूल्य संवर्धन के लिए पद्धति को मानकीकृत किया गया
- सौराष्ट्र तट पर उत्पन्न स्क्विड अपशिष्ट के उपयोग के लिए स्क्विड पेन से β-काइटिन के निष्कर्षण की पद्धति को अनुकूलित किया गया
- रक्त क्लैम एक्सुडेट (सीबीई) चूर्ण को विकसित किया गया
- पकाने के लिए तैयार (RTC) रक्त क्लैम कटलेट के लिए मानकीकृत नुस्खा

# Significant Achievements

- Developed, standardized and dive-evaluated CIFT-MPEDA-TED with international standards for adoption in Indian waters
- Developed and popularised the fuel efficient CIFT-VSOB in different States of India to reduce diesel consumption, $CO_2$ emission and operational cost of trawling
- Nano-carbon dot-graphene composite was found to reduce biofouling in aquaculture cage nets
- Developed nano CCB for wood protection in the marine environment
- Artificial lights are found to improve the catch rates of reef fish in traps
- Traps with yellow funnel entrance had better catching efficiency compared to the green and black coloured funnels
- Hydroxyapatite nano silver composite (HAP-Ag) was found to have excellent biocidal activity
- Impact of chemical emissions from backyard burning of abandoned FRP boats determined
- Edible coating and films were found suitable for enhancing the storage stability of dried fish and button mushrooms
- Antioxidant drink from Spirulina hydrolysate and fish scale collagen peptide was developed
- A methodology was standardized for the quantification of abandoned FRP fishing boats and their debris in the marine environment
- Designed a propulsion system with diesel engine and transmission gear through Z drive system
- LCA of various fishing systems were completed and data validated with secondary information on inventories/ energy use/carbon emission along the east and west coast including Lakshadweep Island of India
- Design and technical details of fishing systems in Morbe and Barvi reservoir in Maharashtra and Chulliar and Malampuzha reservoirs in Kerala were documented
- Designed frame gillnets (polyamide monofilament) for reservoir fishing
- Indigenous marine mammal mitigation measures followed by the fishers were documented from 100 locations of 8 maritime States
- The marine mammals recorded from onboard observations of 64 sightings of the fishing grounds off Kochi were *Tursiops aduncus* (Indo-Pacific bottlenose), *Sousa plumbea* (Indian Ocean humpback dolphin), *Grampus griseus* (Risso dolphin), and whale (*Balaenoptera* sp.)
- Feed enriched with antioxidant using shrimp shell protein was developed

- Incorporation of extracts from squid skin and melanin free ink enhanced functionality of biobased film
- Synthesised the gold nano-particles and characterization using chitosan as capping agent was done
- Developed D-optimal blocked second order response surface regression model under equi-correlated error structure
- Vegetable tanning process for production of fish skin leather was standardised
- Seaweed and millet incorporated value added products were developed
- Soup cubes enriched with fish collagen peptide was developed
- White bread fortified with calcium by incorporating cuttlebone powder was developed
- Web based technology information system (TIS) to support entrepreneurs and stakeholders was developed
- Developed a prototype for waterless transportation of aquatic species
- Optimized process conditions for Kottayam style shrimp roast in ready to eat form in retortable pouch
- Shelf life of ready to eat Goan style Chicken Xacauti was found to be more than 9 months
- Designed and fabricated freshness indicator holder for ice box using 3D printing and filed for IP protection
- Rapid testing of hypoxanthine content in fish was developed
- A colorimetric assay for rapid identification of spoilage bacteria in fish was developed
- Hypoxanthine accumulated rapidly during temperature abuse of fishes and exceeded 50 mg/kg after six hours of storage in room temperature
- Comprehensive metabolite profile of commercially important brown seaweed, green seaweed and red seaweed performed and mass spectral database created with compound annotation
- Multi-residue detection method for 38 antibiotics in sediment samples using Liquid chromatography QTRAP mass spectrometry were optimized
- UPLC method was developed for determination of ascorbic acid in fish and fish products with simultaneous determination of butylated hydroxyanisole (BHA) and butylated hydroxytoluene (BHT)
- Using tandem mass spectrometry and liquid chromatography, the Clotrimazole residue in fish was validated in terms of recovery, matrix effect, stability, specificity, selectivity, sensitivity, carry-over, linearity, accuracy, and precision in compliance with the guidelines outlined in EU2021/808
- Estimated drug residues such as Clotrimazole, Florfenicol and its amine, Emamectin, Oxytetracycline, Enrofloxacin (as sum of Enrofloxacin and ciprofloxacin) and Oxolinic acid in samples (n=1460)
- FSSAI Manual of Methods of Analysis for Fish and Fish Products were prepared and notified by FSSAI
- Food-'O'-Copoeia was developed for fish and fish products and the same is available in online platform
- A rapid analytical method was developed based on REIMS High resolution mass spectrometer, and chemometrics modelling for real time species and geographical origin authentication of commercially important shrimp species
- Co-resistance to Cetylpyridinium chloride was found in more than 85% of ESBL-producing *E. coli* strains from seafood
- The prevalence of *V. vulnificus* in aquaculture ponds of Thrissur and Alappuzha district of Kerala was 11% while it was 3% in the retail fish markets of Ernakulam regions
- tdh positive potentially pathogenic *V. parahaemolyticus* strains were isolated from two retail seafood samples
- The SXT integrase gene of conjugative transposable element was detected in five *Vibrio* sp.
- The *Aurantiochytrium* sp. M54 exhibited the presence of omega-3 and omega-6 polyunsaturated fatty acids and produced biomass of 8.3g/l of dry cell weight
- A modified process for host range analysis of multiple host's enriched MRSA-lysate spots was developed
- The enriched phage lysates were able to lyse 90% of the MRSA hosts and 71% of the MSSA hosts tested
- A faster method was developed for downstream isolation and characterization of broad host range bacteriophages
- Standardized protocol for obtaining defined plaques from pinhead sized plaque for MRSA and MSSA phages
- Protocol for the synthesis of CH-GPH nanoparticle complexes was standardized

- A method for the preparation of Chitosan-Gelatin-Lignin Hydrogels was developed
- Synthesis of rhamnolipid nanoparticles grafted chitosan and alginate was developed
- Bio-polymer coated nanoliposome with bioactive peptides was prepared
- Pickering emulsions was prepared using chitosan-gelatin protein hydrolysate (CHI-GPH) nanocomplexes and fish oil
- A methodology was designed for development of polymerized whey protein as a delivery system for lipophilic compounds
- A methodology was designed for development of self assembled chitosan as a pickering emulsion stabilizer
- Developed curcumin-based supplement was found to improve the growth performance of *Macrobrachium rosenbergii*
- A technology was developed for fabrication of sodium alginate beads loaded with squalene as a nutraceutical agent
- Fatty acid profiling of different tuna processing fractions was carried out
- Supercritical fluid-based extraction protocol was developed for recovering omega-3 PUFA from canned tuna skin fractions
- Studies on fish purchase and consumption behaviour in Meghalaya (Ri-Bhoi and West Garo Hills) were carried out
- Nutritional and fatty acid profiling of selected brown seaweeds from Mandapam coast were determined
- Supercritical fluid extraction protocol for obtaining phlorotannin from brown seaweed was developed
- Developed an enzyme assisted extraction method for obtaining bioactives from brown seaweed
- Developed a pressurized extraction method for obtaining bioactives from brown seaweed
- Strategic landscape of online fish vending and a conceptual model of drivers and barriers to online fish purchase was also created
- A comprehensive dashboard for the monitoring and impact assessment of successful technologies at ICAR-CIFT was developed using identified key indicators
- Informal Fish Loss Assessment Method was used to assess post-harvest losses in marine fisheries
- For modelling economic risks, data indicates that fishermen engaged in single-day fishing are more prone to economic risks as weather warnings for storms and cyclones restrict fishing operations for a minimum of 4 days during each occurrence
- Performance and techno-economic analysis of solar tunnel dryer was carried out using shrimp and clam
- Performance evaluation of pilot scale IR dryer was carried out
- Drying and quality characteristics of clam and sole fish in various CIFT dryers were evaluated
- Prepared design for improved solar refrigerated kiosk for fish vending
- Developed and evaluated performance of a prototype of multi-purpose solar thermal conversion system with a gasifier heat backup for shrimp drying
- Developed a portable device for non-destructive evaluation of fish quality and freshness
- Established ammonia/carbon dioxide (natural refrigerant) cascade refrigeration in seafood processing at NAS Fisheries, Aroor, Kochi.
- Determined the tetracycline resistance of heterotrophic bacteria recovered from finfish aquaculture system
- UV light treatment for dried fish significantly controlled the bacterial and mould growth and chemical spoilage during storage
- Developed fish sauce from *Mahi mahi* fish fillet frame waste
- Developed millet-based batter formulation for coated fish product
- Survey on existing trawl systems of Andhra Pradesh and Odisha states and the challenges in trawl fishing was conducted
- *E. coli*, coagulase negative Staphylococci (CoNS) and *Vibrio* spp. isolated from *Penaeus vannamei* shrimp and from pond water showed similar pattern of antimicrobial resistance.
- Hazard identification and health risk in terms of heavy metals were evaluated in elasmobranch including shark and guitar fish landed at Saurashtra coast
- Standardized method for value addition to low value Ariid cat fish (*Arius dussumieri*) of Saurashtra coast
- Optimized the method for extraction of β-chitin from squid pen for the utilization of squid waste generated along Saurashtra coast
- Developed Blood Clam Exudate (CBE) powder
- Standardized recipe for Ready to Cook (RTC) Blood clam cutlet

# The Institute

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

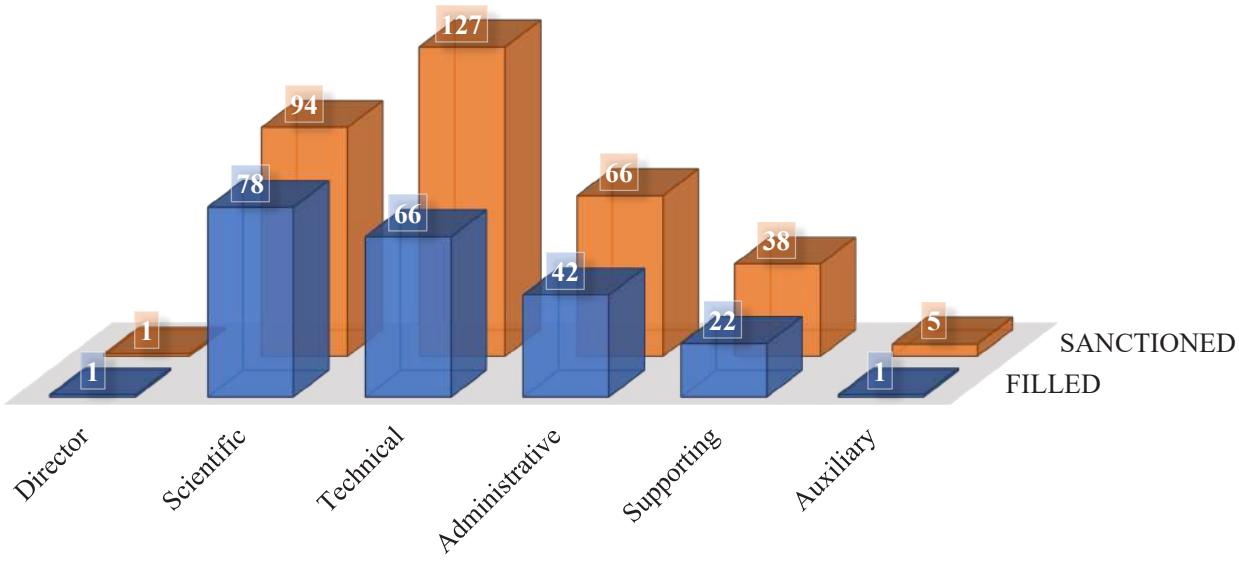
The Institute is the only national centre in the country where research in all disciplines relating to fishing and fish processing is undertaken. Research Centres function at Visakhapatnam (Andhra Pradesh), Veraval (Gujarat) and Mumbai (Maharashtra).

## 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

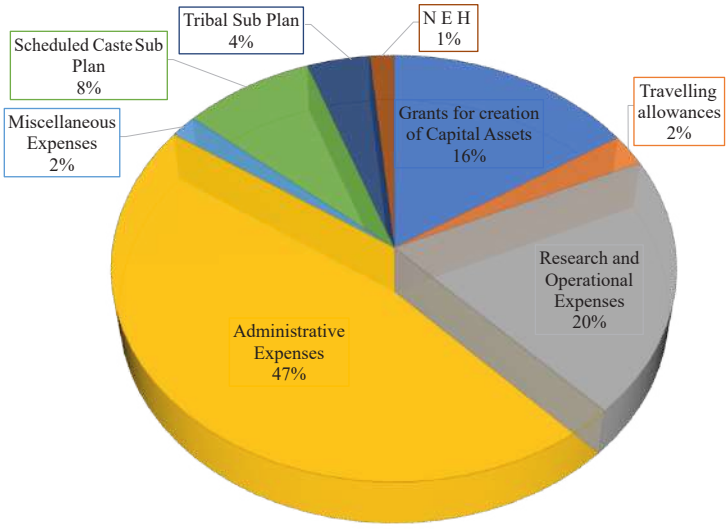
- Basic and strategic research in fishing and processing, bioactive compounds and food safety.
- Design and develop energy efficient fishing systems for responsible fishing and sustainable management.
- Development of implements and machinery for fishing and fish processing.
- Consultancy services, human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




# Staff Position

ICAR-CIFT has a total staff strength of 330. Of the total staff, 28.5% are scientific personal, 38.5% technical, 20% administrative, 11.5% supporting staff and the rest auxiliary staff. Of the sanctioned positions in different categories, 83% of the scientific, 52% of the technical, 64% of the administrative, 58% of supporting and 20% of the auxiliary staff are in position.

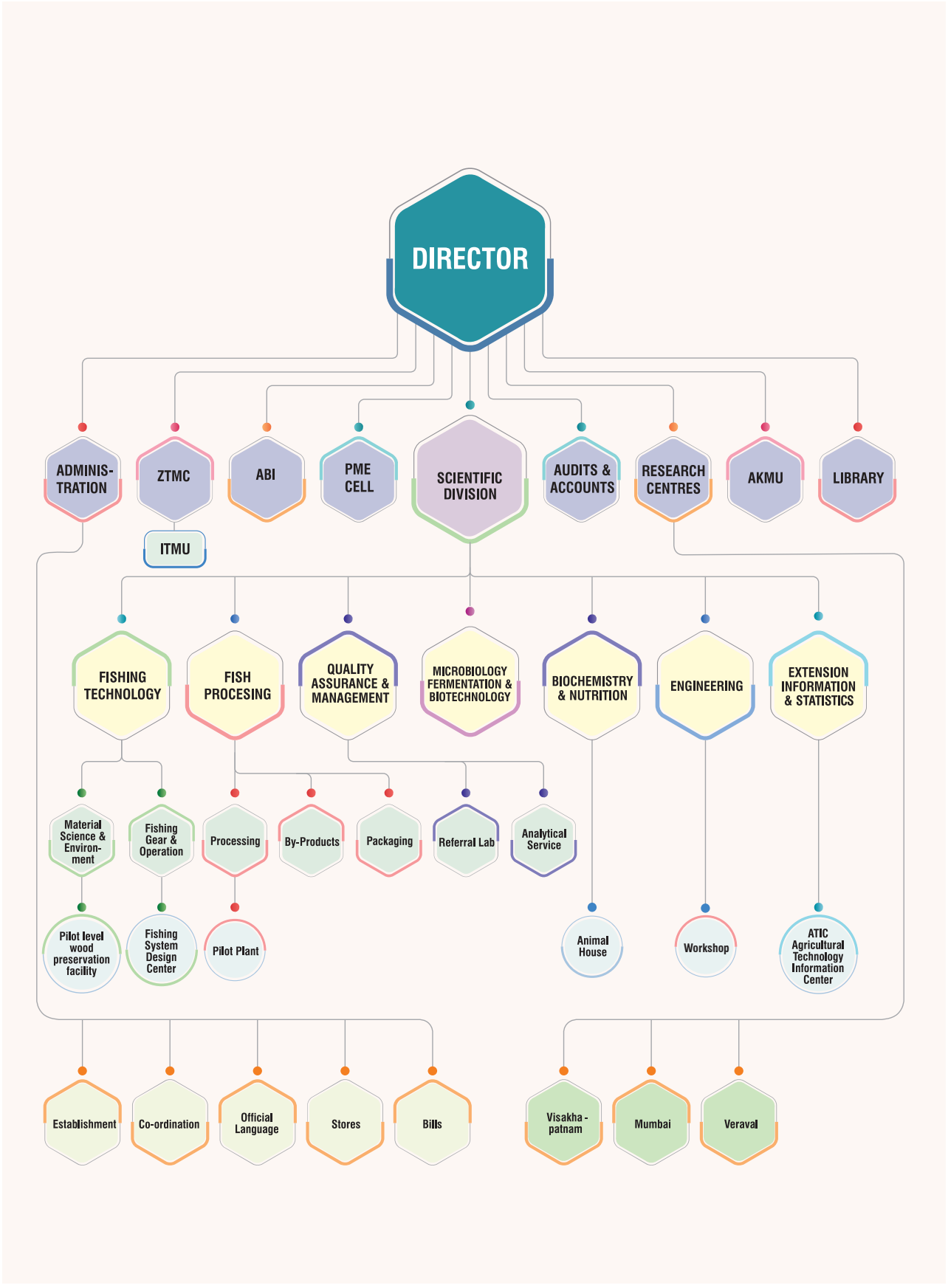
*Head wise budget allocation for the year 2023-24*




**Excluding Estt. Charges and Pension Benefits*

# Budget Allocation and Expenditure

During the reporting period of 2022-23, ICAR-CIFT effectively utilized the allocated budget fund of rupees 5409 Lakhs, achieving 100% utilization.


DIRECTOR
ADMINIS-TRATION
ZTMC
ITMU
ABI
PME CELL
SCIENTIFIC DIVISION
AUDITS & ACCOUNTS
RESEARCH CENTRES
AKMU
LIBRARY
FISHING TECHNOLOGY
FISH PROCESING
QUALITY ASSURANCE & MANAGEMENT
MICROBIOLOGY FERMENTATION & BIOTECHNOLOGY
BIOCHEMISTRY & NUTRITION
ENGINEERING
EXTENSION INFORMATION & STATISTICS
Material Science & Environ-ment
Fishing Gear & Operation
Processing
By-Products
Packaging
Referral Lab
Analytical Service
Pilot level wood preservation facility
Fishing System Design Center
Pilot Plant
Animal House
Workshop
ATIC Agricultural Technology Information Center
Establishment
Co-ordination
Official Language
Stores
Bills
Visakha-patnam
Mumbai
Veraval

# Fishing Technology Division

## Institute Projects

1. *Studies on resource and energy conservation in trawl systems*
2. *Studies on fish behaviour as an input for developing responsible fishing systems*
3. *Designing Responsible Fishing Systems: Integrating fish morphology and behavioural responses to fishing stimuli*
4. *Investigation of environmental burdens associated with selected small-scale fishing systems, value-added fishery product/aquaculture system of India using LCA approach*
5. *Development of nano sensors for precision aquaculture and technologies to protect fishing materials*
6. *Technological interventions for improvement of the fishing system in selected water bodies of India*
7. *Fishing material debris assessment and studies on its degradation and aquatic faunal intakes*

## Most Significant Achievements

- *Indigenous marine mammal mitigation measures followed by the fishers were documented from 100 locations of 8 maritime states*
- *Developed, standardized and dive-evaluated CIFT-MPEDA-TED with international standards for adoption in Indian waters*
- *Developed and popularised the fuel efficient CIFT-VSOB in different states of India to reduce diesel consumption, $CO_2$ emission and operational cost of trawling*
- *Designed a propulsion system with diesel engine and transmission gear through Z drive system*
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- *Traps with yellow funnel entrance had better catching efficiency compared to the green and black coloured funnels*
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- *Nano carbon dot-graphene composite was found to reduce biofouling of aquaculture cage nets*
- *Hydroxyapatite nano silver composite (HAP-Ag) was found to have excellent biocidal activity*
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- *A methodology was standardized for the quantification of abandoned FRP fishing boats and their debris in the marine environment*
- *Impact of chemical emissions from backyard burning of abandoned FRP boats was determined*
- *Design and technical details of fishing systems in Morbe and Barvi reservoir in Maharashtra and Chulliar and Malampuzha reservoirs in Kerala were documented*
- *Designed frame gillnets (polyamide monofilament) for reservoir fishing*

## CHIEF FINDINGS

## 1. Studies on resource and energy conservation in trawl systems

**Baseline survey on otter board details along Indian coast**

A baseline survey was conducted along the Saurashtra coast (Veraval, Mangrol, Porbandar and Okha) to collect the existing otter board designs used in trawl fishing in Gujarat. Similar surveys were carried out in Maharashtra, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Orissa and West Bengal. It was found that most of the trawlers used flat rectangular otter boards made of wooden planks. In Kerala and Karnataka, V-form steel otter boards were also used. Price of OBs ranged from Rs. 15,000 to 40,000 and life ranged from 2-3 years.

**Field trials of CIFT-MPEDA-TED onboard Matsyakumari II off-Kochi**

The trials of CIFT-MPEDA-TED were conducted onboard research vessel RV Matsyakumari II. TEDs were attached to 36 m and 45 m shrimp trawl net with square mesh codend having mesh size of 25 mm. Preliminary trials revealed that there was no catch loss while dragging the net. There was no increase in fuel consumption when the TED was attached to the trawl net.

**Dive evaluation of CIFT-MPEDA-TED**

A 15 m shrimp trawl was fabricated for dive evaluation of CIFT-MPEDA-TED from smaller vessels at Poovar, where the underwater visibility is better. Dive evaluation was conducted using FRP OBM boat. 25 m shrimp trawl was used for the study and commercial SCUBA divers were hired. Underwater camera footage shows excellent performance of CIFT-MPEDA-TED in flap sealing at 3 knots speed. Flap sealing ensures no catch loss in trawl nets fitted with TED and this footage together with the results of TED trials onboard CIFT research vessel MK-II will be able to convince the trawl operators for adoption of TED.

Dive evaluation of CIFT-MPEDA TED at Poovaar, Kerala

**Commercial Evaluation of CIFT-MPEDA-TED off Mandapam, Tamil Nadu from Commercial Vessel**

The onboard trials of CIFT-MPEDA-TED in commercial vessels were carried out in Mandapam, Tamil Nadu. The trials were conducted parallelly with two trawlers of same speed and hauling time, one with TED and the other without TED.

The total catch of 8 hauls with TED came upto 244.6 kg and without TED came upto 177 kg. The average catch with TED was 30.5 kg and without TED was 22.1 kg per haul and the average difference in catch was 8.4 kg in favour of TED per haul.

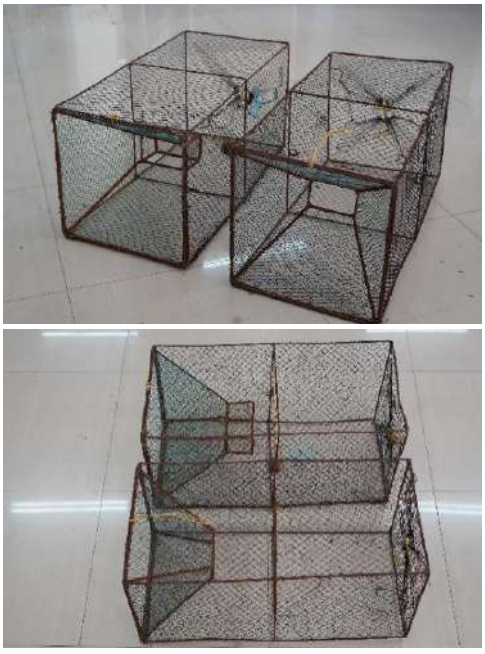
**Comparison of T0 and T90 codends**

Trials onboard MK-II revealed that the average CPUE in the T0 and T90 codends were 24.3 kg/h and 26.5 kg/h, respectively and the mean catches were not significantly different (Kruskal-Wallis rank sum test, Chi-squared=1.651, P=0.19). The major species caught in the T0 codend were *Uroteuthis (P) duvauceli* with a mean CPUE of 5.13 kg/h, followed by catch of sharks (4.16 kg/h) and *Fenneropenaeus indicus* (0.03 kg/h). In case of T90 codend, the three major species caught were silver biddies (9.79 kg/h), *Metapenaeus monoceros* and *Rastrelliger kanagurta* (1.77 kg/h).

## 2. Studies on fish behaviour as an input for developing responsible fishing systems

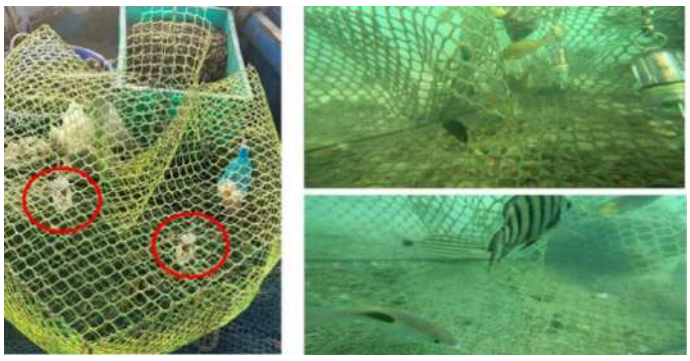
**Improvisation of traditional design of crab traps**

Study was carried out to investigate if a simple pot modification by extending the entrance of the traditional pots, can improve the catch efficiency of mud crab. The results indicated the catch efficiency for all sizes of mud crab is on average more than six times higher with the modified entrance pots compared to the traditional pots (622% (CI: 344–1867%)). However, significant quantities of juvenile crabs were caught in modified pots. Further, the bycatch ratio was significantly reduced for the modified trap, compared to the standard entrance pots in this fishery. These results showed that such pot modifications have potential to significantly improve the catches in mud crab pot fisheries without increasing capture of bycatch species.

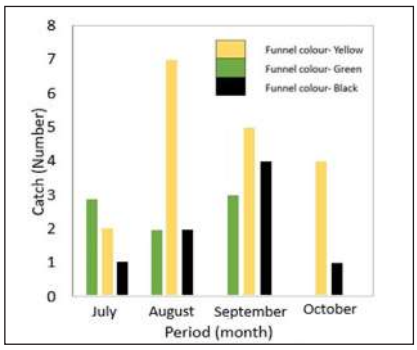


Improved crab traps

## 3. Designing responsible fishing systems: Integrating fish morphology and behavioral responses to fishing stimuli



Field experiments with artificial lights




Graph indicating the effect of trap funnel colour on catch retention

**In-situ studies and field investigations to enhance trap efficiency**

***Use of artificial lights to enhance efficiency of traps***

Field experiments were carried out to investigate the behaviour of reef fishes in response to artificial light (i.e., Light Emitting Diode (LED) lights). Results from the field experiments indicated that reef-associated fishes responded positively to artificial lights, with low-powered LED lights increasing the Catch Per Unit Effort (CPUE; the number of reef fishes) of the traps (i.e., 1.7 kg/trap and 2.7 kg/trap for control and trap with LED lights, respectively). Overall, the results of the present investigation demonstrate that artificial light can improve the catch rates of reef fish in traps.

Trap funnel entrance with different colours

***Studies on the effect of the colour of trap funnel on capture efficiency***

Studies on the effect of trap funnel color on catch retention were carried out. Thirty-nine observations were made during the reporting period. The experiment was carried out in a specially designed octagonal trap unit. Hatchery reared Anabas was used as the experimental fish and trash fish was used as bait. The bait was added simultaneously by four observers and the observations were recorded. The observations indicated that traps with yellow funnel entrance showed more catching efficiency compared to the green and black coloured funnels.

## 4. Investigation of environmental burdens associated with selected small-scale fishing systems, value-added fishery product/aquaculture system of India using LCA approach

As an input for LCA study, baseline survey was carried out for documenting small scale fishing gears operated in selected inland fishing centres around Vembanad lake. Valanthakkad and Cheppanam, two island fishing villages were selected for data collection for the small-scale gillnets and trammel nets. Nylon monofilament gillnets (mesh sizes 25-155 mm, dia 0.16-0.28 mm) were the major fishing gear and the target species were *Etroplus suratensis, Mugil cephalus, Tilapia icus, Fenneropenaeus indicus, Metapenaeus monoceros, M. dobsonii and Scylla serrata.* Catch varied from 0.5 - 4.0 kg/day/person. Trammel nets with inner and outer mesh size were 60 and 150 mm; mesh dia 0.16 and 0.39 mm). Apple shaped plastic floats (60x20 and 70x20 mm) and disc shaped small floats are commonly used in gillnets. Head

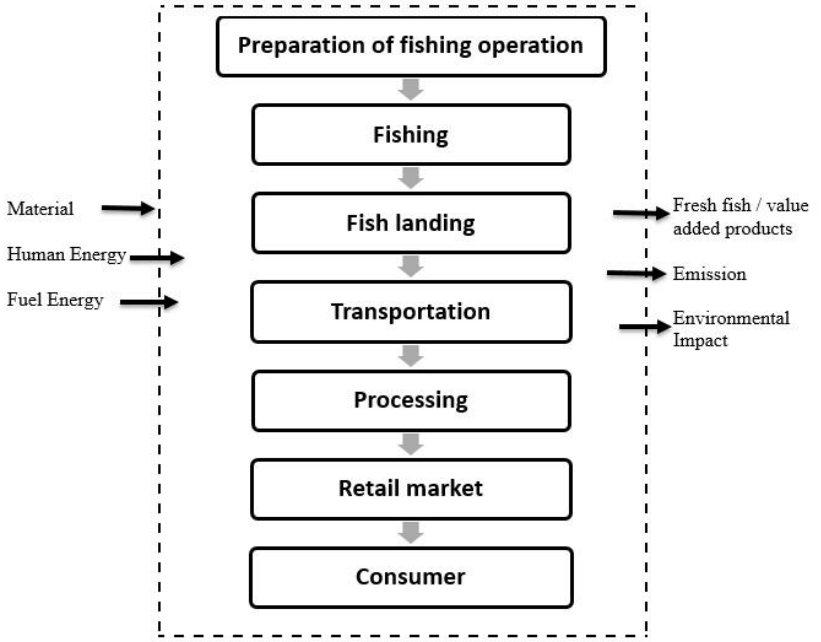
rope of polypropylene (2 mm dia) and foot rope made of aluminium electric wires, (7.2 mm) are used without lead sinkers. Mesh depth varied from 25-50 numbers. Gillnets are operated from wooden boats (5.5-6m $L_{OA}$) made of oil nut tree *(Punna)*.

**Assessment of Abandoned, lost, or discarded fishing gear and ghost fishing through retrieval studies**

Retrieval of ALDFG as evidence of ghost fishing was conducted through bottom trawl surveys at a depth range of 33-34 m onboard MATSYAKUMARI -II, Off Cochin. A total of 13.57 kg of lost gears/accessories were retrieved from the 1.050 sq km area. The recovered gears include gillnet panel (multi filament 6x3 ply, mesh size 110 mm, mesh depth 60 numbers, weight 1.46 kg), HDPE Shrimp Trawl (41 meter), Squid jig (length 15cm, and piece of jig line 110 cm), locally made lead jig with triple hook (15 cm), monofilament lines (main line dia: 0.84 mm and 0.89 mm; branch line dia: 0.64 mm, 0.69 mm). Other monofilament lines (0.7 mm dia), squid jig and apple shaped plastic float (85x110 mm) were also present. There was no record of fouler on retrieved nets. Mechanical strength properties of retrieved lines were also analysed and showed a 14% decline in breaking strength compared to unexposed lines of similar diameter.

**Inventory analysis of small-scale boat building materials from different boat building yards**

The estimated material and chemical compositions of 7 m boats constructed entirely of FRP or sheathed with three layers of glass mat are shown in Table based on information gathered from boat construction yards and data reported. FRP sheathed boats are light in weight than FRP boats, with low percentage of glass mat, resin and chalk powder but with significant contributions from wood, paints and copper nails.




Most common value chain in Indian local market for value added products

Inventory details for a 7m LoA fishing boat

| Item | Units | 7m LoA fishing boat | |
|---|---|---|---|
| | | FRP | Sheathed |
| Glass mat CSM | Kg | 22 | 9 |
| Glass mat WR | Kg | 15 | 7 |
| Epoxy Resin | Kg | 66 | 30 |
| Gel coat | Kg | 12 | 2 |
| Pigment | Kg | 1.2 | 0.5 |
| Accelerator | Litre | 2 | 0.8 |
| Catalyst | Litre | 0.2 | 0.08 |
| Acetone | Litre | 3 | 2 |
| Electricity | KWH | 2 | 1 |
| Fresh water | Litre | 50 | 50 |
| Chalk powder | Kg | 70 | 20 |
| Wax | Kg | 1 | 0 |
| Wood | Kg | 0 | 60 |
| Copper nail | Kg | 0 | 7 |
| Paint | Litre | 0 | 10 |

**Study on the value chain of value-added fishery product in the local market**

The value chain for the value-added fishery products was developed based on local market survey. The most common flow of value chain in the local market in Ernakulam is shown in figure. Process starts from preparation of fishing vessels for fishing operation, followed by fishing, landing, processing, retail marketing and finally reaches to consumers. The input data includes the human energy, fuel energy, and material supplies needed during one operation.

**Data collection on inventories of fishing vessel at Lakshadweep**

Details on fishing boats and gears of Androth, Bitra, Amini and Minicoy islands of Lakshadweep were collected. The fishing boats were

of five types based on their design namely, Maldivian pablo, open type pablo, gillnetter cum long liner, OBM boats and country boats. Maldivian type pablo boats are used predominantly in Minicoy Island (85%) whereas open type pablo boats are common in Androth, Amini and Bitra (43-67%).

IBM fishing vessels are mostly installed with an engine of high capacity ranging between 16 -205 hp. Gillnetter cum longliner vessels was installed of 16-55 hp engine with diesel tank capacity of nearly 180 l. The engine of open-type pablo vessels ranged from 16-105 hp engine with diesel tank capacity of around 400 l, the vessel operates between 7-15 h/day. Maldivian pablo vessels are operating maximum of 15 h/day and the engine ranged from 55-205 hp with diesel tank capacity of 800 l. The OBM fishing boats were mostly installed with the lower-capacity engines of between 6-9.9 hp.

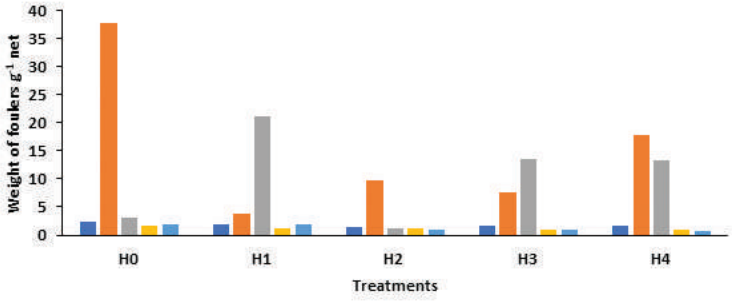
## 5. Development of nano sensors for precision aquaculture and technologies to protect fishing materials

**Biofouling resistance of polyaniline-(nano carbon dot-graphene hybrid) coated aquaculture cage nets**

Studies on the biofouling resistance of fish eye derived nano carbon dot-graphene (CD-graphene) hybrid composite treated aquaculture cage nets exhibited excellent biofouling resistance in 0.08% CD-graphene hybrid coated net. Samples exposed for 4 months exhibited less biofouling due to the summer showers which lowered the salinity and sloughed off the bivalve foulers. FTIR, TEM and XRD clearly established that the composite was strongly attached over the net.

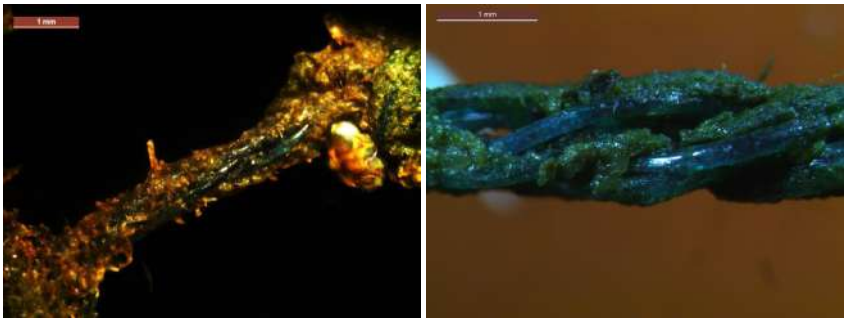
**Biofouling resistance of carbon dot -$TiO_2$ composite**

Nano carbon dot – Titanium oxide (CD-$TiO_2$) composite was synthesized by green microwave synthesis method and the composite was characterised using UV-visible spectroscopy, FTIR and ROS generation through dye degradation. Reactive oxygen species generation was confirmed through dye degradation studies. The composite of varied concentrations was coated over polyaniline surface modified aquaculture cage nets and exposed in the estuarine environment. four months exposure in the estuary exhibited excellent biofouling resistance.

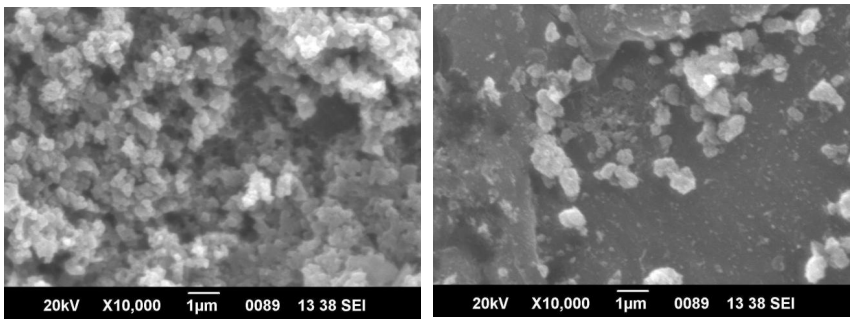



Biofouling accumulation in control and nano CD-graphene hybrid coated polyethylene aquaculture cagenet

*[H0- PE, H1 – PANI coated PE, H2- PANI + CD-Graphene hybrid (0.02%), H 3- PANI + CD-Graphene hybrid (0.04%), H4-PANI + CD-Graphene hy brid (0.08%)]*

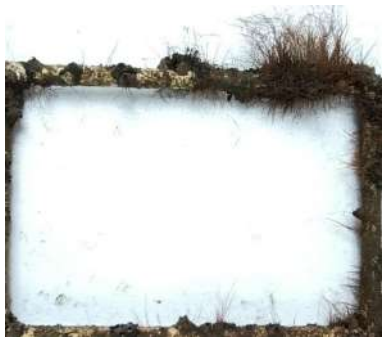


Biofouling accumulation in control and nano CD-graphene hybrid coated polyethylene aquaculture cagenet after 4 months exposure in the Cochin estuary




CD-$TiO_2$ treated net surface; PE-PANI treated and PE-PANI-CDTi$O_2$ treated net

Growth rate of *Mytella strigata*



Hydroids on PVC frame

Bivalves species involved in biofouling
*(Crassostrea, P.viridis, Mytella strigata, Modiolus striatulus)*

Foulers in exposed samples

**Synthesis of nano hydroxyapatite doped silver nano particle as a biocide**

Hydroxyapatite nano silver composite (HAP-Ag) was synthesised and studied its antimicrobial and antifungal properties. The HAP-Ag composite was incorporated in a weather guard paint formulation and tested its coating characteristics after coating over a mild steel plate. The paint formulation was characterized using FTIR, SEM etc. The introduction of HAP-Ag in the matrix decreased pH slightly, improved the viscosity and conductivity of the paint matrix and imparted good stability. The formulation exhibited antimicrobial activity and also linear polarization studies showed improved corrosion resistance. The study highlights the potential of this paint.

**Formulation of Nano-CCB for application to prevent biodeterioration of materials in marine environment**

Trials were conducted to integrate nano copper-chromium-boron to prepare more efficient, less polluting biocide instead of existing high concentration CCB formulation. The conventional CCB consists of components from 5-10% and the present study aimed to develop formulation using nano materials with very low concentrations. Trials were carried out using varied concentrations and ratios of the individual components and their dispersions in surfactants like SDS, Tween 20. Optimised SDS as surfactant and nano dispersion of nano CCB and the combination exhibited linearity in absorbance values with concentration of the nano materials.

**Changes in fouling and boring community from the Vembanad estuary**

Changes in fouling and boring community were continuously assessed from the Vembanad estuary since 2020. During the last year the most dominated species was *Mytella strigata.* The abundance and distribution of *M. strigata* was more in February and followed by May with density of 989/$m^2$ and 735/$m^2$ respectively. The diversity of bivalves was high during pre-monsoon with species such as *Modiolus Striatulus, M. strigata, Perna viridis, Crassostrea sp,* and *Martesia sp.* Average length of *P. viridis* was 30.02 mm with average width of 10.32 mm while the average length of spat of *M. strigata* was 20.99 mm with average height of 14.64 mm. Other fouling organisms like barnacles, isopods, hydroids, and sponges were found along with associated organisms like polychaetes, crab instars, shrimp larvae. The abundance of offspring's isopod (*sphaeroma* sp.) was highest during May. The radius of barnacles was 8.11 mm. The distribution, abundance and diversity of biofoulers were very low during monsoon (June-July).

**Diversity of fouling and boring organisms in Gujarat**

A study on marine fouling and boring organisms of the Gujarat coast was initiated during 2023. During the first month, barnacles and tube worms were the dominant foulers. The other fouling-associated organisms were *Neries* sp. and isopods.

# 6. Technological interventions for improvement of the fishing system in selected water bodies of India

### Documentation of fishing systems in selected reservoirs of India

Design and technical details of fishing systems in Morbe and Barvi reservoir in Maharashtra; Chulliar and Malampuzha reservoirs in Kerala were documented. In Morbe reservoir, Raigad the major gears used were gillnets and cast nets. Gillnets mainly targeted *Catla catla* (polyamide monofilament gillnet, diameter 0.20 - 0.23 mm, mesh size 45-50mm) weighing 1-1.5 kg. Floats used were made of thermocol) and cylindrical lead sinkers were used (20 g). In Barvi reservoir, Thane, gill nets, cast nets, and traps were the common fishing gears used. Gill nets were similar to those used in the Morbe reservoir, with the only difference being the material used for the sinker; instead of lead, burnt clay were used. Traps were constructed from old, discarded plastic jars or oil drums (10 l), with an inlet and escape window made of bamboo and baits used were either fish flesh or small fishes.

In Malampuzha reservoir, Palakkad, coracles (1.8 m dia, height 0.65 m) were used as craft and inflated tyre tubes were also used. Major fishing gear used were surface and bottom set gillnets. Surface set gillnets (Polyamide monofilament, diameter 0.16 - 0.23 mm) having mesh sizes of 130 - 250 mm were commonly used for capturing stocked fishes (Indian Major carps). Sinkers were small cylindrical shaped lead sinkers (2 g). Long lines were also used by few fishers for catching eels (Main line made of PP rope 1.5 - 2 mm dia, branch line PA mono 0. 32 mm dia). In Chulliar reservoir, Palakkad surface set gillnets were mainly used (Polyamide monofilament, diameter 0.16-0.23 mm) with mesh sizes varying from 75-250 mm.

### Design and development of framed gillnets for reservoir fishing

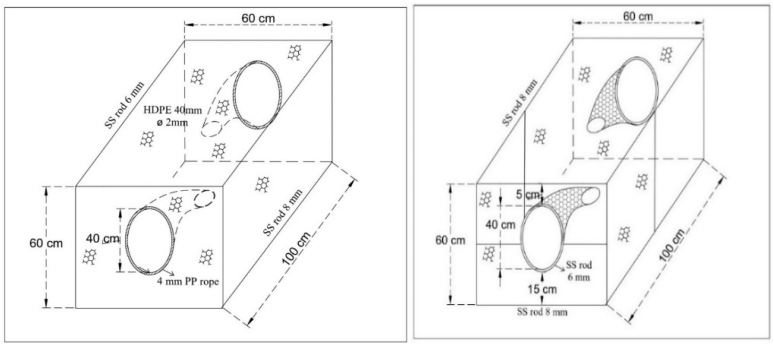
Designed the frame gillnets for reservoir fishing with main webbing made of PA monofilament of diameter 0.23 mm with mesh size of 150 mm and 50 mesh depth. Frame was made using PA multifilament twines (4x3 dimension) and area of each frame was 1 sqm. Head rope made from two layers of PA multifilament twines (8x3 dimension). Floats were disc shaped plastic floats (75x35 mm). Foot rope (2 mm) was made of PP rope and cylindrical lead sinker (10x 5 mm) were used. Horizontal and vertical hanging coefficient were 0.5. Frame gillnet was given to fishers at Malampuzha reservoir, Palakkad for field trials. Similar design of frame gillnet (mesh size 120 mm, diameter 0.20 mm, depth 20 meshes) was also been fabricated for field trails at Kolte Reservoir, Maharashtra.

### Assessment of the catch efficiency of trammel nets in comparison to commercial simple gillnets in selected reservoirs of South-West India

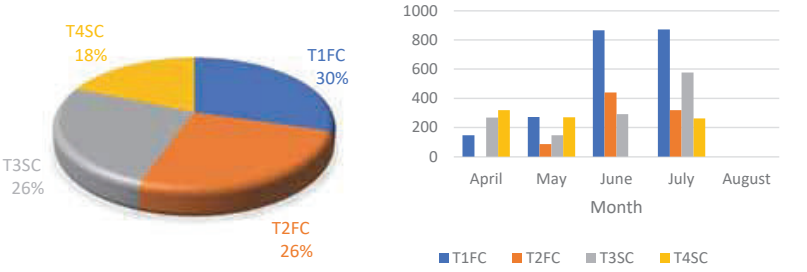
Field trails for assessment of catch efficiency of trammel nets (Inner layer: PA monofilament 0.16 mm dia, 50 mm mesh size and E1 = 0.4; Outer layer: PA multifilament 210x3x3, 250 mm mesh size, E1 = 0.70) in comparison to simple gillnets (PA monofilament 0.16 mm dia, 50 mm mesh size and E1 = 0.4) were carried out at Pothundi reservoir, Palakkad. Soaking time was 12h and the nets were set at a depth of 5-7 m. Foot rope (wire rope) used for trammel nets in previous trials in Mangalam were replaced with PP rope due to the entanglement and handling difficulty for fishers. Average catch in trammel net was 690g/day/net, mainly composed of commercially important species such as *Oreochromis mossambicus* and *Cirrhinus mrigala*. The average catch in simple gillnet was similar to that of trammel net (696g/day/net), but mainly composed of small indigenous fishes such as *Ambassis ambassis, Puntius filamentosus, P. chola, Glossogobius giuris, Mystus sp.* etc.

### Performance evaluation of CIFT collapsible fish traps

Performance evaluation of collapsible fish traps was carried over a four-month period from April to August 2023, in Mundempally fishing village (9°54'12.9''N latitude and 76°19'03.3''E longitude), situated on the shores of the Vembanad backwater in Kerala. Two fully collapsible traps (T1FC, T2FC and semi collapsible traps (T1SC and T2SC) made of stainless steel (SS) were used for the study, with the same overall dimensions. The traps were covered with 40 mm High Density Polyethylene (HDPE) mesh with 2 mm dia. FC trap was made up of two rectangular SS frames (1.0 m×0.60 m). The upper SS frame is of 6 mm and lower is 8 mm in dia. SC trap was made up of two rectangular stainless steel (SS) frame with a size of 1.0 m×0.60 m and two square frames of 0.60×0.60 m. Funnel mouth made of HDPE webbing are provided on both sides for the entry of fishes in both type of traps. The bait consisted of a combination including trash fish, as well as a mixture of refined wheat flour, regular wheat flour and turmeric. The baits were placed in HDPE webbing placed at the center of the trap hung from the top. Cotton twine was used for tying the frames and attachment of floats. The traps were deployed at a depth of 2m and were soaked for 24-48 hours.




Design of CIFT collapsible fish traps




Percentage contribution and month wise catch in different traps (fully collapsible traps T1FC & T2FC; semi collapsible traps T3SC & T4SC)

### Catch rate and composition in fish traps

Maximum catch rates (30% & 26%) were recorded in the fully collapsible traps (T1FC & T2FC), where as in semicollapsible trap (T3SC) catch rate was 26%. The lowest catch rates were recorded in second semicollapsible trap T4SC (18%). In fully collapsible fish trap, *Lutjanus* spp. was the highest percentage of catch (34%) followed by *Etroplus suratensis* (20%), *Scatophagus argus* (13%), *Arius arius* (13%), *Daysciaena albida* (13%), *Scylla serrata* (7%). In semi collapsible fish trap, *E. suratensis* was the species with highest percentage of catch (34%), followed by *Colletteichthys dussummieri* (17%) and *Scylla serrata* (17%).

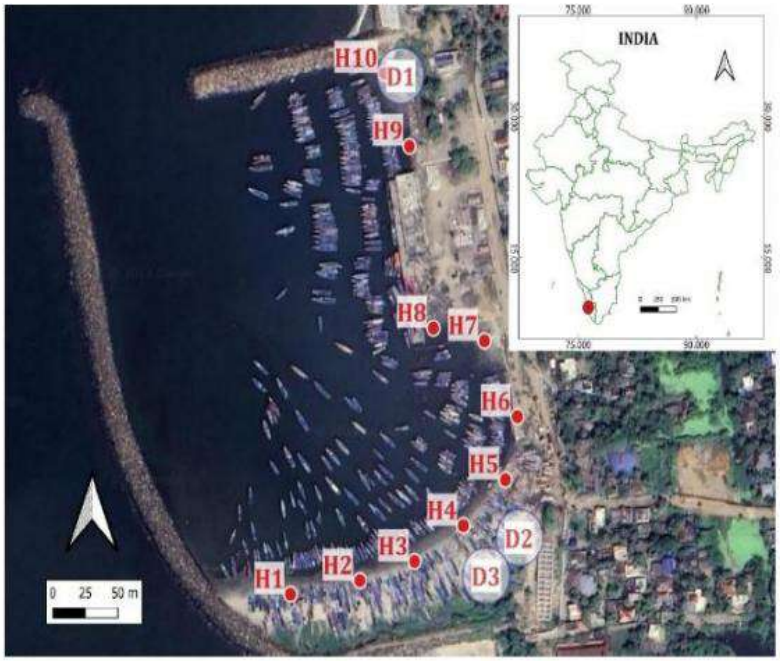
## 7. Fishing material debris assessment and studies on its degradation and aquatic faunal intakes

### Fishing debris assessment

Survey was initiated in 27 landing centers of 9 maritime districts of Kerala to understand the extend and scale of disposal of fishing debris. Abandoned FRP Fishing boats were mostly from the motorized sector with length below 14 m. The expected life span of these boats is upto ten years but may be significantly shortened by bad weather and rough seas. With no formal disposal process, end-of-life boats are commonly abandoned along the beaches.

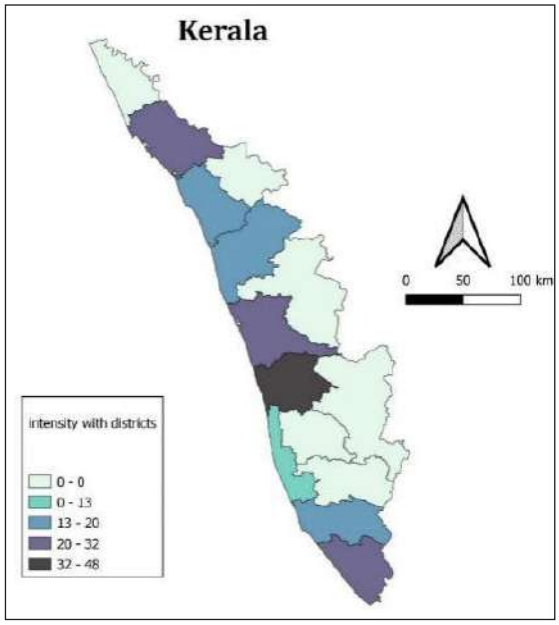
### Standardisation of methodology for the quantification of abandoned FRP fishing boats

To quantify fishing boat abandonment, discarded or end-of-life boats (often inverted, free of any accessories and with visible damage) were visually counted, landside and




Representation of High Water Lane (HWL) and disposal sites in a selected landing centre


Standardisation of a methodology for the classification of FRP debris



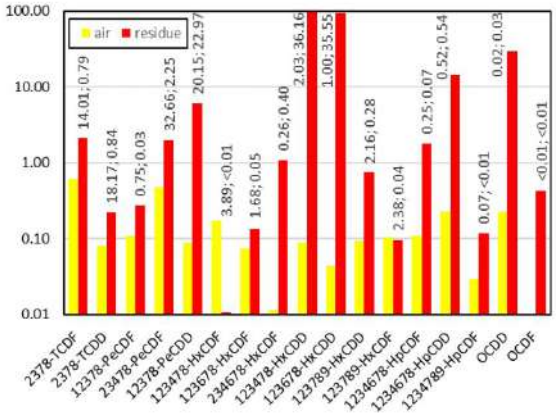

Intensity mapping of abandoned FRP fishing boats from the selected landing sites of Kerala

Different types of plastics in the marine environment

waterside, along a transect of the high-water line of the entire landing centre and within the disposal sites. Plastic visible at the surface was manually collected from each quadrat and classified as FRP (relatively brittle and flat fragments, often painted on one side and with visible fibres and remains of a wooden substrate on the other side), fishing waste (including polyurethane foam used as an insulating material, fishing nets, floats, sinkers, ropes and lines) and other plastics (e.g., bottles and bottle tops, food packaging, shoes, toys, bags covers and other fragments).

A total of 479 abandonded boats were observed with an intensity of 23/km of the selected 18 beach landing centers of Kerala. All the abandoned boats were FRP sheathed boats and types of abandonment or disposals observed include abandoned in the beach or disposal site, burnt in the coastal environment, sunken in the soil or landfilled. Vaddy beach landing centre of Kollam exhibited the most alarming plastic litter intensity at 971 $gm^{-2}$ along its high-water line. Following closely was Needakara, with an intensity of 885 $gm^{-2}$. Mararikulam, Alleppey stands out as the least polluted in the studied locations (102 $gm^{-2}$). Along the HWL, 43% of the marine litter originated from fishing gear and accessories, such as monofilament gillnets, ropes, twines, and floats. The subsequent 19% consists of Fibre Reinforced Plastic (FRP) debris derived from mega-sized (>100 cm) to macro-sized (>2.5 cm) fragments, often originating from abandoned boats. The remaining 38% of marine litter is attributed to plastic, encompassing both floating and sinking varieties. Along the disposal sites, Andhakaranazhi exhibited the highest intensity at 3134 $gm^{-2}$, followed by Vizhinjam with a total plastics intensity of 2587 $gm^{-2}$ in the disposal sites. Mararikulam beach landing centre represents the least polluted disposal site, registering a density of 844 $gm^{-2}$. The overall litter composition at these disposal sites reveals a significant presence of FRP debris, constituting 45% of the total litter. Fishing debris contributed 37%, while other plastics made up 17%.

Burnt FRP boats in marine environment




Concentrations of polychlorinated dibenzodioxins and dibenzofurans

**Study on impact of chemical emissions arising from backyard burning of abandoned FRP boats**

During the survey it was observed that fishers were adopting backyard burning of the abandoned FRP boats to save space for fishing activities, as there is no other guidelines or options of disposal. Backyard burning of FRP boats lead to the emission of toxic pollutants to the environment. To understand the impact, a simulated combustion study using material collected from abandoned fishing boats was conducted in an open burning test facility.

**Simulated combustion study of FRP debris**

Broken boat parts from a number of FRP-sheathed vessels were collected and mixed and a representative subsample for analysis followed by US EPA method 23 (US EPA, 1991). In controlled combustion experiment, simulating open burning, revealed that 63% of original boat mass is emitted to the atmosphere, with the remainder forming a burnt residue. Concentrations of polychlorinated dibenzodioxins and dibenzofurans emitted and remaining were found to be 2.6 ng Nm- 3 and 249.6 μg kg-1, respectively, with respective calculated toxicity equivalence (TEQ) levels of 437.6 pg TEQ Nm-3 and 26.6 μg TEQ kg-1. These figures are equivalent to the total emission from FRP boat burning of about 17000 μg TEQ t-1.

# Fish Processing Division

## Institute Projects

1. *Valorisation of marine and agro waste for development of green packaging materials*
2. *SMART PACK: Development and characterization of smart packaging films for enhancing quality and shelf life of fishery products*
3. *Development and validation of biomedical and cosmetic products from secondary fishery raw materials*
4. *Development of Efficient Statistical and Reliability Tools for Fish Products*
5. *Technological interventions in value addition and advanced processing techniques for fish and shell fish*
6. *Development of Food and Industrial products from secondary raw materials of aquatic origin*
7. *Process development and scaling up of production of different molecular weight chitosan with different degree of de-acetylation and evaluation of their applications*
8. *Development of Soft Computing Systems in Fisheries Technology for Technology Dissemination and Policy Formulation.*

### *Most Significant Achievements*

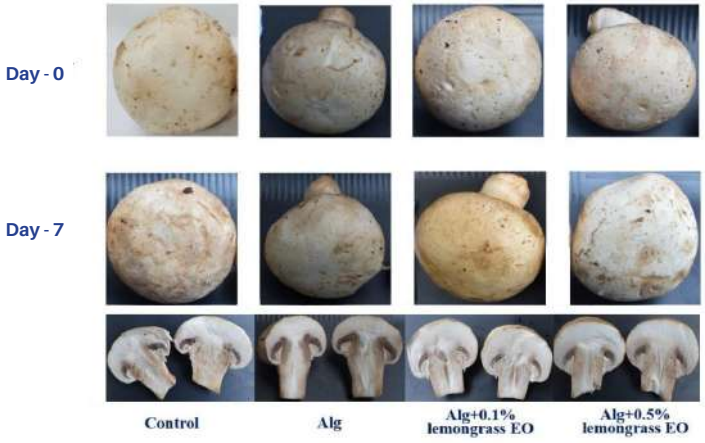
- Edible coating and films were found suitable for enhancing the storage stability of dried fish and button mushrooms
- Antioxidant drink from Spirulina hydrolysate and fish scale collagen peptide was developed
- Feed enriched with antioxidant using shrimp shell protein was developed
- Incorporation of extracts from squid skin and melanin free ink enhanced functionality of biobased film
- Synthesis of gold nanoparticles and its characterization using chitosan as capping agent was done
- Developed D-optimal blocked second order response surface regression model under equi-correlated error structure
- Vegetable tanning process for production of fish skin leather was standardised
- Seaweed and millet incorporated value added products were developed
- Soup cubes enriched with fish collagen peptide was developed
- White bread fortified with calcium by incorporating cuttlebone powder was developed
- Web based Technology Information System (TIS) to support entrepreneurs and stakeholders was developed
- Developed a prototype for waterless transportation of aquatic species
- Optimized process conditions for Kottayam style 'shrimp roast' in ready to eat form in retortable pouches
- Shelf life of Ready to Eat Goan style Chicken Xacauti was found to be more than 9 months
- Designed and fabricated freshness indicator holder for ice box using 3D printing and filed for IP protection

## CHIEF FINDINGS

## 1. Valorisation of marine and agro waste for development of green packaging materials

**Alginate coating incorporated with the lemongrass EO**

The effect of alginate with lemongrass essential oil coating on the quality of button mushroom during chilled storage was investigated. Quality parameters such as dehydration, hardness, total phenolic content, antioxidant capacity, colour etc. were analysed during the study period. Application of an alginate coating incorporated with the lemongrass EO improved the quality of mushroom by increasing the retention of color, texture, total phenolic content and antioxidant activity compared to those of control.




The effect of alginate with lemongrass essential oil coating on the quality of button mushroom during chilled storage

**Development of Chitosan-Alginate films incorporated with eucalyptus essential oil**

Chitosan-Alginate films incorporated with eucalyptus essential oil for potential wound healing applications was developed. Chitosan-alginate films incorporated with eucalyptus essential oil were prepared layer by layer method. The antimicrobial properties of films were carried out and based on the result, the best combinations were selected to study the wound healing properties in albino rats.

**Development of liquid smoke incorporated chitosan film**

Liquid smoke incorporated chitosan film was developed for food packaging applications and the characterization of films for various properties was done. Chitosan films were incorporated with 0, 1.0, 3.0 and 5.0% (v/v) liquid smoke of Coconut, Jackfruit and mango. Highest tensile strength was observed for 1.0% coconut smoke incorporated film while oxygen transmission rate and water vapour transmission rate were highest for 5.0% jack fruit smoke incorporated film and 1.0% coconut smoke incorporated films, respectively.

**Edible food coating with active ingredients for dried fish**

An edible food coating with active ingredients for enhancing shelf life of dried fish was developed using bee wax and sodium alginate. Three treatments as T1 (Beeswax and sodium alginate (1.5%) coating, T2 (Beeswax) and T3 (control without coating) were formulated for dipping. Tween 80 and glycerol were added accordingly for solubilization and plasticizing effect.

**Development of paper based functional food wraps coated with chitosan**

The effect of coating unbleached cellulose food wrap (CP) with chitosan of low, medium and high molecular weight (0.5 and 1.0%) on the physical and structural properties were evaluated. The mechanical properties showed a decrease in the tensile strength and an increase in the percentage elongation values upon coating with chitosan. Cobb's 1 minute value also increased in chitosan coated samples. The chitosan coatings made the paper more hydrophilic. Bursting strength values of paper increased upon chitosan coating.

## 2. SMART PACK: Development and characterization of smart packaging films for enhancing quality and shelf life of fishery products

**Evaluation of chemical combinations for $O_2$ scavenging ability**

Three chemical combinations were evaluated for $O_2$ scavenging ability and its kinetics in comparison to control air pack, in the presence of fish, Indian oil sardine. Lower ratio of combination of iron powder and citric acid was effective in absorbing oxygen from pack compared to higher ratio.

**Synthesis of gold nanoparticles and its characterization**

Synthesis of gold nanoparticles and its characterization using chitosan as capping agent was done using microwave heating. High molecular weight chitosan (1% w/v) was solubilized under thermal treatment for one hour and gold nanoparticles synthesized using precursor auric chloride. Microwave assisted gold nanoparticle synthesis resulted in reduction of more than 50% of heating time.

**Antimicrobial and physico-chemical properties of film as influenced by chitosan**

Influence of intrinsic properties of chitosan and its concentration on the antimicrobial and physico-chemical properties of film were undertaken. Film prepared with high MW chitosan resulted in better antimicrobial properties.

**Development of functional bio-based film**

Squid skin extract and melanin free ink were characterized for the development of functional biobased film. combination of Gelatin and chitosan resulted in improved physical properties for the biobased film.

## 3. Development and validation of biomedical and cosmetic products from secondary fishery raw materials

### Formulation of antioxidant drink

Spirulina hydrolysate (SPH) was produced through enzyme hydrolysis and subsequent spray drying. This was then combined with collagen peptide (CP) to formulate an antioxidant drink. Comprehensive analyses covered physical, functional, mineral profile, amino acid composition, and antioxidant attributes of the mix. Amino acid analysis revealed the presence of essential and non-essential amino acids and superior antioxidant activity compared to collagen peptide. Sensory analysis, incorporating a selected blend of SPH and CP mix indicated acceptance.

*Spirulina platensis*

*Spirulina hydrolysate*

Collagen peptide soup cubes

### Cookies from dried microalgae

Cookies were prepared with the addition of dried microalgae, *Nannochloropsis occulata*. Phenolic content of cookies increased with the addition of microalgae. Metal chelating power, DPPH scavenging activity and singlet oxygen scavenging activity also increased with increase in concentration of microalgae.

### Development of collagen peptide soup cubes

Collagen peptide soup cubes were developed and their antioxidant analysis was conducted at various concentrations. DPPH values showed a dose-dependent trend. An online market survey assessed the potential introduction of fortified soup powder in the domestic market. The survey gathered details on customer preferences, with approximately 27% expressing a regular preference for fortified soup. Taste was identified as the primary influencing factor for purchasing decisions, followed by nutritional value, convenience, price, and brand.

## 4. Development of Efficient Statistical and Reliability Tools for Fish Products

### Development of statistical model for value added fish products

Developed D-optimal blocked second order response surface regression model under equi-correlated error structure when the error terms of a process optimization for the development of value-added fish-based products is correlated.

- D-optimality condition also derived for second order response surface regression model under equi-correlated error structure with block effect
- A D-optimum orthogonally blocked second order response surface design under equi-correlated error structure is obtained by maximizing $D= \det (X_1' V^{-1}) X_1 - X_1' V^{-1}B(B' V^{-1}B)^{-1} B' V^{-1}X_1)$, where
- **X** is design matrix, **B** is the block diagonal matrix of the form $B=diag\ (1_{k1}, 1_{k2}..., 1_{kb}\ )$, where $K_1$ is the size of the $l^{th}$ block and **V** represents equi-correlated error structure.
- The rotatability conditions under equi-correlated error structure was derived and validated.

# 5. Technological interventions in value addition and advanced processing techniques for fish and shell fish

**Effect of novel active batter coating incorporated with banana pseudo-stem flour in combination with ultrasound pre-treatment on the quality and oil uptake of deep-fried fish finger**

An active batter coating formulation was prepared by incorporating banana pseudo-stem flour for studying its effect on the quality and oil-uptake of ultrasound pre-treated fish finger during deep frying. Banana pseudo-stem flour (BF) was prepared by drying and grinding the banana (*Musa acuminata*) pseudo-stem. Fish finger from Pangasius (*Pangasianodon hypophthalmus*) coated with 20% BF batter had the highest score for overall acceptability in sensory evaluation. There was 10% decrease in the fat content of fish fingers with ultrasound pre-treatment and coated with 20% BF incorporated batter.

Fish fingers coated different levels (0%, 2.5%, 5%, 10%, 20%, 40%) of BF incorporated batter

**Development of a plant protein based extruded snack**

Extruded snacks were developed by incorporating sprouted proteins and plant-based proteins by incorporating the same at 10, 30, 50 and 70% levels. Four other batches were prepared by incorporating 90% rice flour with 10% banana powder banana grit, and banana gram and ashwagandha. The expansion ratio was greater for samples incorporated with 10% incorporation of plant proteins whereas for those with 70%, it was less. The water absorption ratio ranged from 613- 517 g $H_2O$ whereas the fat absorption ratio ranged from 194 to 132 g oil.

Extruded noodles incorporated with Tilapia mince

**Development of tilapia noodles**

Noodles were developed in the single screw extruder by incorporating Tilapia mince at various levels (5%, 10%, 20%, 30%, and 50%). Of the different Tilapia fish concentrations

Extruded snack products incorporated with plant proteins

Tofu without fish & with added fish

Liquid smoke flavoured fish wafer preparation


Blood clam irradiated at 5kGy dose

used, 20% and 30% fish incorporated noodle samples showed better quality and were more suitable for consumption as a new product.

**Effect of marination on drying characteristics of anchovy**

The drying of fresh anchovies was carried out in the forced convection hot air-assisted pilot-scale infrared dryer. Two treatments such as raw and marinated anchovies were prepared for drying. Marination was done 30 min prior to drying. The drying operations were carried out at the infrared intensity of 3000 W/m$^2$ and 60℃ hot air inlet temperature. The percentage shrinkage was found to be 31.79 and 29.82 for raw and marinated anchovies respectively.

**Effect of blanching on drying characteristics of squid**

The drying of squid rings was carried out in the forced convection hot air-assisted pilot-scale infrared dryer. Blanching as a pre-treatment was given to squid rings before drying using steam blancher at 100℃ for 5 min. The moisture content reduced from 84.92% to 13.61% in 3 h for blanched squid rings, whereas un-blanched squid rings took 3 h 30 min to reach the final moisture content of 12.91% in infrared dryer. The percentage shrinkage was found to be 48.44 and 50.11 for blanched and un-blanched squid rings, respectively.

**Development of fish tofu**

Protein cubes (fish tofu) was made utilizing the fish mince as animal protein and soy milk as plant protein source. The product had a white colour with good texture and sensory qualities. It contained 16-20% protein with an average calorie value of 157-170 Kcal/g.

**Development of liquid smoke flavoured fish wafer**

Liquid smoke (LS) flavoured fish wafers were prepared using Tilapia fish meat. Colour analysis showed 4 % LS added wafer had better brightness value.

**Development of ready to eat muffins incorporated with squid ink**

The squid ink collected from *Uroteuthis edulis* was freeze dried. Ready to eat chocolate muffins were fortified with freeze dried squid ink powder at 0%, 0.25%, 0.5%, 0.75% and 1% (w/w) and was subjected to analysis of quality characteristics. The sensory evaluation concluded that the muffins fortified with 0.75% squid ink powder has the highest overall acceptability.

**Standardization of the formulation of dry shrimp roast and dry shrimp roast powder**

To enhance the utilization, market value and demand of dried shrimp, different ready-to-eat value added products were prepared. The formulation of dry shrimp roast and dry shrimp roast powder was standardized. The nutritional facts of the developed products (100 g) were determined. Both the products were stable for three months at room temperature storage.

**Refrigerated storage study of irradiated blood clam**

Irradiation of steamed blood clam was carried out at Bhabha Atomic Research Centre (BARC). The meat was removed from the shell and divided into four lots for subjecting it into different dose of irradiation, viz. control, 1 kGy, 2 kGy and 5 kGy. Shelf life obtained for control, 1 kGy, 2 kGy and 5 kGy samples were 13, 18, 24 and 30 days, respectively.

Little millet cookies incorporated with 1% fish oil

Fish roe flakes


Fish and Shrimp Spread

White bread fortified with calcium by using cuttlebone powder

**Development of little millet based functional gluten free biscuits/ cookies incorporated with omega-3 rich fish oil**

Little millet based functional gluten free (GF) cookies incorporated with omega-3 rich fish oil (1-5%) were developed. Cookies incorporated with 1% fish oil (FO) were sensorily more acceptable.

**Development of seaweed enriched chocolate**

Red seaweed powder prepared from *Gracilaria edulis* and *Kappaphycus alvarezii* were added, separately, to dark chocolate at different concentration of 1%, 2.5%, 5%, 7.5% (w/w) and kept at 2-4˚C. Sensory evaluation revealed that chocolate with seaweed up to 7.5% were sensorily acceptable. Also, organoleptic acceptance was significantly ($p<0.05$) higher for chocolate enriched with *K. alvarezii* as compared to chocolate enriched with *G. edulis*.

**Development of fish roe flakes**

A process was standardized to prepare spiced fish roe flakes. Fish roe from Rohu fish was removed from egg sac and washed two times in 3% brine containing 1% sodium bicarbonate (1:1 ratio). Washing helped to reduce the fatty odour in the developed product. Spices including turmeric, pepper and chilly powder were added to the washed roe. The dried roe had 48% protein and 6% fat content. Sensory analysis indicated a crunchy texture and was accepted by the panellists.

**Standardization of protocols for fish spread from Tilapia and shrimp spread from *Litopenaeus vannamei***

Standardization of protocol for fish spread from Tilapia and shrimp spread from *L. vannamei* were carried out. A level of 30% fish was found optimum for incorporation in fish spread and 20% shrimp in shrimp spread along with other major ingredients viz., veg. mayonnaise and boiled egg.

**Development of shredded fish or fish floss products**

Fish floss was prepared from hot-smoked Ariid cat fish (*Plicofollis dussumieri*) and Trigger fish (*Canthidermis maculata*). Sensory analysis revealed that smoked flavour and sensory characteristics for fish floss produced from Ariid cat fish was better compared to floss product from Trigger fish, but the texture was inferior to that of Trigger fish floss.

**Process optimization of blanching conditions of shrimp for drying using response surface methodology**

The shrimps were subjected to steam blanching with different salt concentration (0.5%, 1% & 1.5%) for different time duration (1 min, 2 min, and 3 min) before drying. Response surface methodology and Face-Centered Central Composite Design (FCCCD) were used to study the combined effect of salt concentration (0.5-1.5%) and blanching time (1-3 min) on colour, texture, salt content, rehydration ratio, shrinkage and drying rate of shrimp (*Metapenaeus dobsoni*). The optimum blanching and drying conditions that yielded products with high preference and consumer-acceptability were: blanching time of 2 min with salt concentration of 0.5%.

**Development of white bread fortified with calcium by using cuttlebone powder**

White bread was developed incorporating different concentration of cuttlebone powder (0%, 1%, 1.5%,

Male and Female crab, *Podophthalmus vigil*

2%, 3.5% and 5%). Based on the sensory evaluation and analysis of other quality parameters, bread with 2% cuttlebone powder was selected. The highest baking loss was noted for bread with 1.5% CBP and the lowest for bread with 3.5% CBP. Bread incorporated with 2% cuttlebone powder was found to have 2069 ppm calcium.

**Nutritional composition and chilled storage trial of unconventional crab species (Male and female), *Podophthalmus vigil***

Male crabs exhibited higher moisture content compared to female crabs, while female crabs displayed high protein (17.2%) and lipid (1.2%) levels in contrast to male crabs (15.9% protein and 0.8% lipid). The shelf life of the crab species was estimated to be 12 days based on sensory scores and TVB-N values. The mesophilic and psychrotrophic bacterial counts were higher in male crab.

**Effect of different microwave power on the drying kinetics and physicochemical quality of brown shrimp (*Metapenaeus dobsonii*)**

The effect of microwave power 600W (105 & 100 min), 800W (95 & 90 min), and 1000W (80 & 65 min) and temperature (60 & 70˚C) on the drying kinetics and quality of microwave dried shrimp were investigated. Between 70 and 60˚C, a drying time reduction of 18.75, 5.26 and 4.76% was observed for shrimps processed at 1000, 800 and 600W, respectively indicating higher process time reduction for higher microwave power.

**Development of protein enriched extruded snack incorporated with dual millet mix flour and fish mince**

Protein-enriched extruded snacks using a composite blend of tilapia mince, millet mix flour, and rice flour through the use of a twin-screw extruder was developed. Among the various blends studied, the most acceptable in terms of sensory and other quality parameters were the extruded snacks with 25% rice flour and 75% millet mix flour, as well as those with 20% rice flour, 75% millet mix flour, and 5% fish mince.

## 6. Development of Food and Industrial products from secondary raw materials of aquatic origin

**Development of vegetable tanning process for production of fish skin leather**

Freshly cleaned tilapia (*Oreochromis niloticus*) and pangasius (*Pangasianodon hypophthalmus)* skin were treated with sodium sulphide followed by calcium hydroxide. Further it was treated with ammonium chloride followed by lemon leaf powder paste. After washing with potable water it was subjected to color treatment using food color and dried. Proximate composition was analyzed at every stage of treatment. Results indicated that at the end of treatment, there was a decrease in protein (7.3%-9.97%),

Tilapia skin leather

Pangasius skin leather

*P. vannamei* shrimp shell

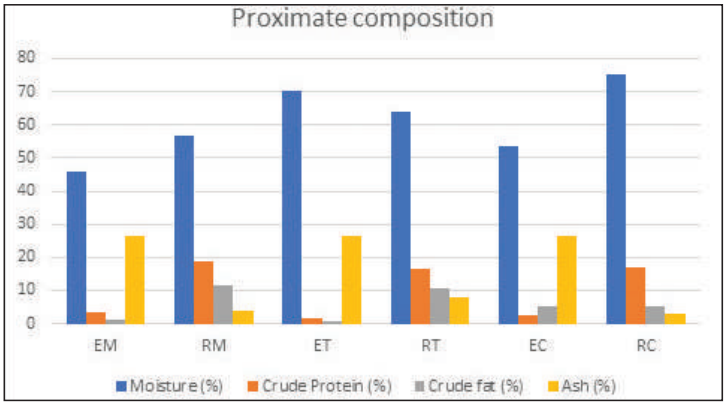
Protein extract from *P. vannamei* head waste

Shrimp protein incorporated fish feed

fat (3.68%-4.79%), and ash (0.94%-1.35%) contents. There was a significant difference in compositional profile between both tilapia and pangasius skin during treatment. Texture analysis was carried out for prepared fish skin leather. Results indicated that fish skin leather from pangasius skin had improved tensile and tear strength.

**Prawn shell-derived protein for the development of feed enriched with antioxidant properties**

Shrimp protein was extracted from *P. vannamei* head waste by a mechanical process. Then it was used as base material and rice bran was added at a ratio of 1.4:1 for the development of fish feed ingredients. The proximate composition revealed that it had a protein content of 17.1% and 16.17% ash content.




Proximate composition of fishes and its exudates; EM: Exudate of Mackerel; RM: Raw Mackerel; ET: Exudate of Threadfin bream; RT: Raw Threadfin bream; EC: Exudate of Croaker; RC: Raw Croaker

**Development of food and industrial products from secondary raw materials of aquatic origin**

Characterized the exudates collected from salting process of three different fish species to explore the potential ways for its utilization. The layer salting was done by following the standard protocol developed by ICAR-CIFT, Kochi. The proximate compositions of raw fishes (Mackerel, Threadfin bream and Croaker) and its exudate were compared. The mineral composition of the exudates detected higher content of Ca, K, Mg, Na and P in the samples which was also compared with the raw samples and the salt used for salting process.

## 7. Process development and scaling up of production of different molecular weight chitosan with different degree of deacetylation and evaluation of their applications

**Effect of deacetylation cycles on the properties of chitosan**

The multiple cycle of deacetylation increased the DDA and decreased the viscosity of chitosan from *Parapenaeus stylifera*. From second cycle onwards the DDA can be increased using lesser concentration of alkali than used in first cycle. From third cycle onwards, duration of deacetylation, concentration of alkali has no significant effect on DDA and but the viscosity decreased from second cycle to third cycle of deacetylation. However, at higher concentration a marginal increase in DDA was observed, but not significant.

**Wound healing chitosan cream**

Wound healing cream prepared using medium MW chitosan was found to be more stable at 20±5°C and 4±1°C and exhibited higher antibacterial activity compared to low and high MW chitosan.

Deacetylation of chitin to chitosan

# 8. Development of Soft Computing Systems in Fisheries Technology for Technology Dissemination and Policy Formulation.

**Development of Web based Technology Information System (TIS) to support entrepreneurs and stakeholders**

A web based Technology Information System (TIS) has been designed and developed to support the stakeholders for entrepreneurship development programmes.

This system provides information on various technologies developed by the institute in fisheries harvest and post-harvest sector, the mode of know-how transfer and what institute offers to the entrepreneurs to hand hold their entrepreneurship programme.

The TIS was designed in HTML (Hypertext Markup Language) and CSS (Cascading Style Sheet) using Bootstrap framework and written in PHP (Hypertext Preprocessor) scripting language. The computer codes for hyperlinking the home page and inner pages have been also developed and validated the hyperlinks.

The home page contains general information about the TIS. The technologies were identified and listed out as harvest, post-harvest and engineering with a hyperlink.

The TIS provides a general information about each technology, key features of the technology, what mode of technology transfer, what ICAR-CIFT offers and contact details.

**Development of Modified Demerit Score Based Shrimp Quality Index (SQI) to Assess the Freshness of Shrimp using Internet Assisted Web Application**

Designed and developed web-based Shrimp Quality Index (SQI) system to assess the quality or grade of freshness of shrimp.

SQI can be accessed on any online platform, aiding the consumers in an efficient assessment and acceptability of fresh shrimp, on-site.

The quality assessment system is based on the physical evaluation of the general characteristics of fresh shrimp such as shell appearance, shell meat adherence, meat appearance, meat texture, meat color and odour.

Then, based on the user input, the system calculates the quality index score of the shrimp in the range 0 to 1 by using the calculate function defined in JavaScript.

The design and development of the application were achieved using HyperText Markup Language (HTML), Cascading Style Sheet (CSS) and Bootstrap framework.

Being a web-based platform, SQI is accessible from any hand-held device including mobiles or tablets thus extending the advantage of being applicable for day to day consumer applications.


# Quality Assurance and Management Division

## Institute Projects

1. *Development of rapid testing platforms for quality assessment of seafood*
2. *Valorization of seaweed resources for functional food, nutraceutical, biomedical, and bioremediation applications*
3. *Ensuring safety of fish and fishery products: Framework for validating regulatory specifications*

### *Most Significant Method for Achievements*

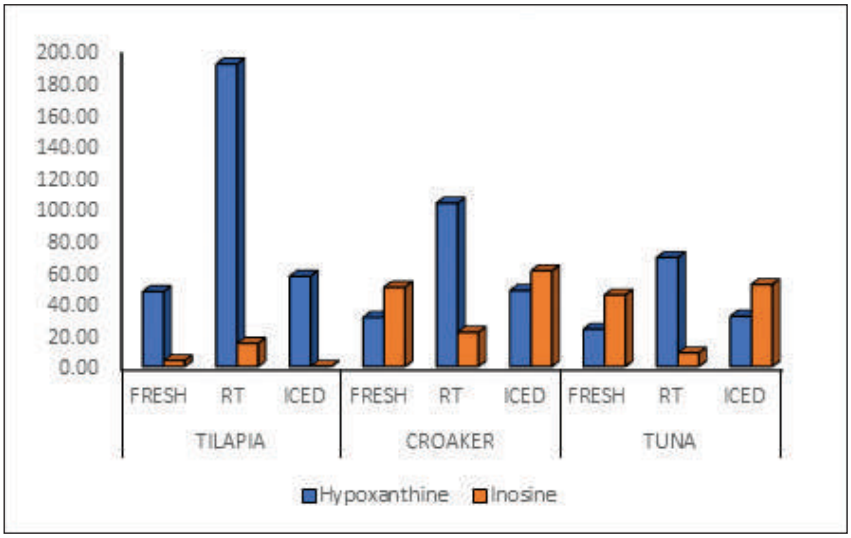
- Rapid testing of hypoxanthine content in fish was developed
- A colorimetric assay for rapid identification of spoilage bacteria in fish was developed
- Mass spectral database of metabolite was created for commercially important seaweeds
- Multi-residue detection method for 38 antibiotics in sediment samples using Liquid chromatography QTRAP mass spectrometry were optimized
- UPLC method was developed and validated for simultaneous determination of butylated hydroxyanisole (BHA) and butylated hydroxytoluene (BHT)
- Using tandem mass spectrometry and liquid chromatography, the Clotrimazole residue in fish was validated
- A rapid analytical method was developed based on REIMS High resolution mass spectrometer, and chemometrics modelling for real time species and geographical origin authentication of commercially important shrimp species

## CHIEF FINDINGS

## 1. Development of rapid testing platforms for quality assessment of seafood

**Hypoxanthine content in marketed fishes under temperature abused and iced storage conditions**

A study was carried out to evaluate the formation of nucleotide degradation products and changes of spoilage in marketed fishes under temperature abused and iced storage condition. The changes in nucleotide degradation products of six species Viz.; *Sardinella longiceps* (Indian oil sardine), *Nemipterus japonicus* (pink perch), *Rastrelliger kanagurta* (Indian Mackerel), *Oreochromis niloticus* (Tilapia) *Johnius elongatus* (Spindle croaker), *Auxis rochei* (Tuna) were investigated.




Changes in hypoxanthine and inosine content in fishes during different conditions of storage

**Rapid testing of hypoxanthine content in fish**

Rapid testing of hypoxanthine content in fish was optimized and is under validation. The method is for selective detection of hypoxanthine based on enzymatic assay. The method can identify spoiled fish from fresh fish.

**Colorimetric Assay for rapid identification of spoilage bacteria**

A colorimetric assay for rapid identification of spoilage bacteria in fish was developed and the specificity of the assay against different spoilage bacterial cultures were evaluated. The assay develops prominent yellow colour in the presence of spoilage bacteria (*Shewenella* spp.)

**Colorimetric testing for added phosphate content in shrimp**

Colorimetric testing platform for added phosphate content in shrimp is under optimization. A instrumental method was optimized for the determination of added phosphate (orthophosphate, pyrophosphate and polyphosphate) using Ion chromatography.

**Antibacterial activity of carbon dots prepared from fish eye**

Carbon dot prepared from sardine eye (*Sardinella longiceps*) was evaluated for antibacterial activity and efficacy against faecal indicator and hygiene indicator organisms.

## 2. Valorization of seaweed resources for functional food, nutraceutical, biomedical, and bioremediation applications

**Development of fermented nutraceutical drink**

A fermented nutraceutical drink using *Padina tetrastromatica* and tea was developed. The seaweed fermented drink contained significantly higher count for LAB and yeast when compared to fermented drink prepared using tea alone. The fermentation process significantly reduced the heavy metal content in the seaweed.

**Microencapsulation of PUFA rich chia seed oil**

Polysaccharide extracted from green seaweed *Ulva lactuca* was used as a wall material along with whey protein isolate for microencapsulation of PUFA rich chia seed oil. Following optimized process parameters 30% loading of the chia seed oil in the encapsulate was achieved.

**Evaluation of different techniques for drying seaweed**

Different drying techniques were evaluated for drying of seaweed. When compared to electrical drying, solar drier, or shade drying, Infrared drying was found to be a novel and rapid process, conserving the phytochemical content.

## 3. Ensuring safety of fish and fishery products: Framework for validating Regulatory specifications

***Compliance to Food Safety and Standard Regulations for RTE fish products***

Fish pickle samples (n=14) under RTE fish products from different locations in India were found within the compliance for permitted class II preservatives like benzoate and *E. coli* count, *Staphylococcus aureus,* and *Salmonella*.

**Compliance to Food Safety and Standard Regulations for unregulated fish products**

Unregulated fish products (20 nos.) were found to be free from *Salmonella* and *V. cholerae* but the Aerobic plate count exceeded log CFU/g in 10% of samples analysed.

**Quantification of micro and Mesoplastic litter in fishery products**

Microplastic contamination in commercial frozen shrimp samples were 6-12 microplastic particles/ PUD shrimp, while the PD shrimp carried less than 1 item/individual.

**Compliance to Food Safety and Standard Regulations for Fermented fish products**

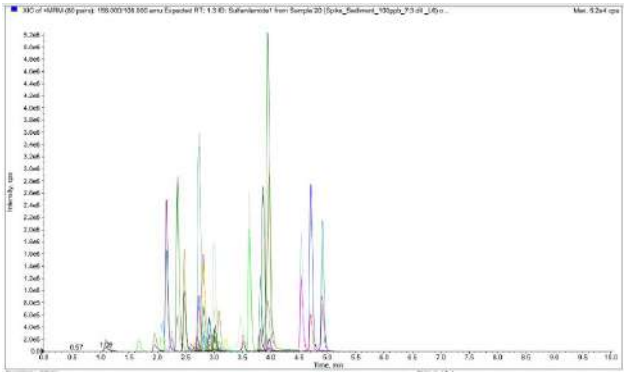
Puthi shidal samples (n=25) were tested for presence of histamine and total histamine forming bacterial count and all samples were found to comply with regulatory requirements.

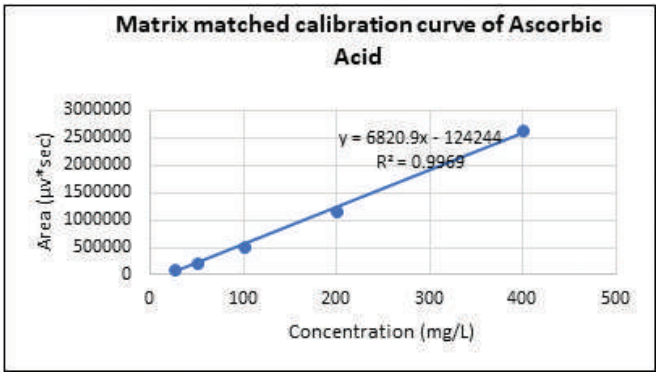
**Quality and safety of dried fish/ shrimp prepared in solar dryers**

Biochemical quality and microbial safety of dried fish/shrimp prepared by ICAR-CIFT incubates was evaluated. A set of 10 samples of dried shrimp and fish dried in solar dryers by ICAR-CIFT were free from *E. coli, Salmonella, and S. aureus*

**Method developments for determination of antibiotics in sediments**

Multi-residue detection method for antibiotics (38) in sediment samples using Liquid chromatography QTRAP mass spectrometry were optimized.






Extracted ion chromatogram (XIC) of multi- residue analysis of spiked antibiotics at 100 µg/kg concentration from sediment samples

**Method development for Additives and contaminates**

An UPLC method was developed for determination of ascorbic acid in fish and fish products with BEH RP18 column.

An UPLC method with photo diode array detection was optimized and validated for the simultaneous determination of butylated hydroxyanisole (BHA) and butylated hydroxytoluene (BHT) synthetic antioxidants in fish and fishery products.

Determination of allergens in raw and cooked samples of *Mytella strigata* and *Crassostrea madrasensis* were carried out.

Out of 09 *Vibrio cholerae* isolates tested, four isolates were resistant to Ceftazidime, 3 isolates were resistant to Trimethoprim, 01 isolate was resistant to Erythromycin.

*Staphylococcus watneri* and *S. lentus* were isolated from marinated and from sardine samples respectively.

Coagulase test for *S. aureus* was optimised with reduced use of rabbit plasma and indicator.

## 4. Enhancing Utilization of rest raw materials of aquatic origin for feed, Agricultural and Industrial product development

**Pilot scale production and on farm trial experiments**

Pilot scale production of foliar spray from prawn shell waste was carried out for the field level studies. The product is under field testing in 17 KVKs of NEH region for various regional crops.

Field level testing of foliar spray was conducted in tomato *(Solanum lycopersicum L.)* to test the effect on growth and yield of tomato. The highest fruit yield per plant (3.40 kg) was obtained for the treatment with 15 ml/litre whereas control plant yield was 1.43 kg only.

Pilot scale production of foliar spray

# Microbiology, Fermentation and Biotechnology Division

## Institute Projects

1. *Biotechnological approaches for utilization of aquatic microbial resources and their products*
2. *Virulence and antibiotic resistance profiling of seafood-borne pathogens and development of control measures*
3. *Production of poly unsaturated fatty acids (PUFAs) from heterotrophic eukaryotes: A biotechnological approach*

### *Most Significant Achievements*

- Co-resistance to Cetylpyridinium chloride was found in more than 85% of ESBL-producing *E. coli* strains from seafood
- The prevalence of *V. vulnificus* in aquaculture ponds of Thrissur and Alappuzha districts of Kerala was 11% while it was 3 % in the retail fish markets of Ernakulam regions
- *tdh* positive potentially pathogenic *V. parahaemolyticus* strains were isolated from two retail seafood samples
- The SXT integrase gene of conjugative transposable element was detected in five *Vibrio* sp.
- The *Aurantiochytrium* sp. M54 exhibited the presence of omega-3 and omega-6 polyunsaturated fatty acids and produced biomass of 8.3g/l of dry cell weight
- A modified process for host range analysis of multiple host's enriched MRSA-lysate spots was developed
- The enriched phage lysates were able to lyse 90% of the MRSA hosts and 71% of the MSSA hosts tested
- A faster method was developed for downstream isolation and characterization of broad host range bacteriophages
- Standardized protocol for obtaining defined plaques from pinhead sized plaque for MRSA and MSSA phages

## CHIEF FINDINGS

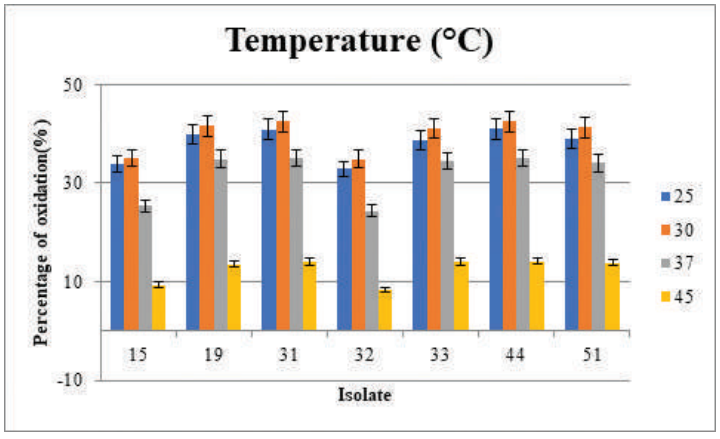
## 1. Biotechnological approaches for utilization of aquatic microbial resources and their products

**Bioconversion of shrimp shell waste for extracting chitin employing *Bacillus licheniformis* and *Lactobacillus fermentum***

Successive co-fermentation of shrimp shell with *B. licheniformis* followed by *L. fermentum* gave deproteinization (DP) and demineralization (DM) of 90 and 87.47% respectively whereas by simultaneous fermentation it was 87.2 and 81.2% respectively. The FTIR spectra of chitin exhibited similar structural characteristics as commercial chitin. The culture supernatant after fermentation exhibited high DPPH free radical activity and protease activity. The study concluded that successive co-fermentation was better than simultaneous fermentation for extraction of chitin.

**Characterisation of endolysisn gene from phages**

Amplified endolysins genes from φEC24 and φEC21 of 1.7 kb and 450 bp respectively. Endolysin gene amplification and sequencing revealed that endolysin belonged to N-acetyl muramidase based endolysin.



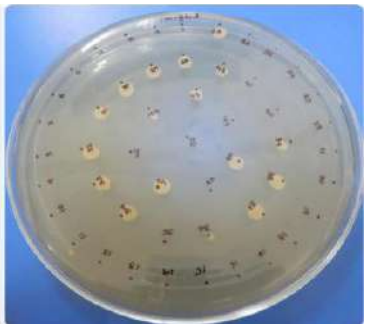

Sulphide oxidation by heterotrophic bacteria

**Heterotrophic sulphur oxidation bacteria**

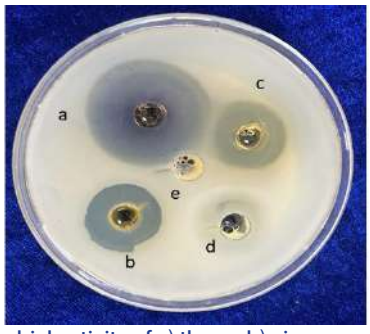
Heterotrophic sulphur oxidation bacteria were isolated from aquaculture sediments and three bacterial strains that showed more than 42% oxidation were identified as *Enterobacter kobei* and can convert sulphide over a temperature range of 25°C-45°C, salinities from 10–20 ppt (Optimum 20 ppt).

**Probiotic effect of Bacillus spp. from aquaculture environment with antagonistic activity against major shrimp pathogens of shrimp**

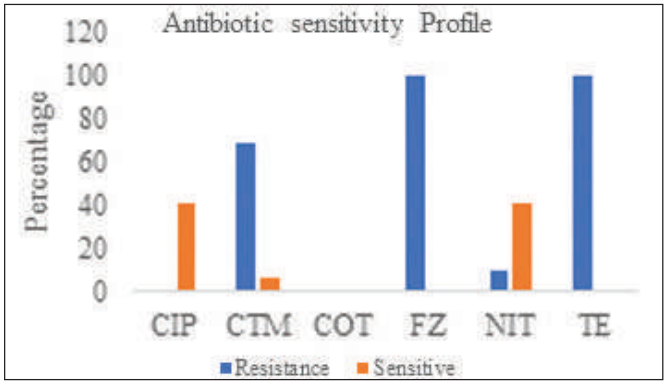
Bacillus strains isolated from aquaculture farms were screened for antagonistic activity against



*tet*$^{HR}$ isolates exhibiting resistance at 128 µg/mL of tetracycline hydrochloride




Antimicrobial activity of a) thyme b) cinnamon c) clove d) apple cider vinegar e) Sterile water against tet$^{HR}$ isolates.




Antibiotic resistance profile of *tet*$^{HR}$ isolates against four antibiotics (CIP: Ciprofloxacin; CTM: Cefotaxime; COT: Co-trimoxazole; NIT: Nitrofurantoin; TE: Tetracycline

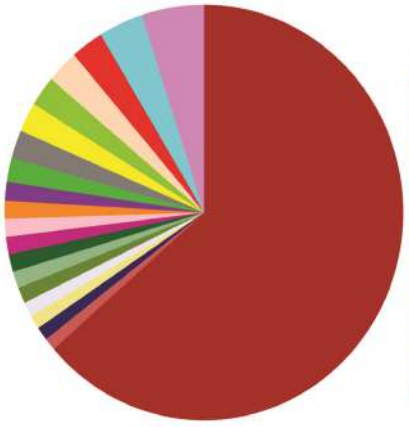
five aquaculture pathogenic Vibrio; *Vibrio parahaemolyticus, V. harveyi, V. alginolyticus, V. vulnificus* and *V. cholerae*. Five strains that showed activity against all five tested *Vibrio* spp. were identified as *B. velezensis, B. subtilis, B. amyloliquefaciens* and *B. tequilensis*. The strains could grow at a temperature range of 25°C-45°C, wide range of salinities from 0-40 ppt (Optimum 20 ppt) and pH from 5 to 10. These bacterial isolates can be candidate probiotic for prevention of Vibrio infection in shrimp aquaculture.

**Tetracycline resistance potential in heterotrophic bacteria isolated from *Penaeus vannamei* culture ponds**

A total of 277 tet$^{R}$ bacterial isolates recovered from sludge pits, sediments and water were examined for maximum tetracycline resistance potential (MRP). Twenty nine isolates (10.1%) showed resistance to tetracycline at 128 µg/mL were considered as (*tet*$^{HR}$). Among the 29 tet$^{HR}$ isolateS, 28 were identified as *Vibrio* sp., and one isolate was identified as *Photobacterium* sp. The cross resistance study of the isolates showed resistance to Furazolidone (100% resistance) followed by Cefotaxime (69% resistance) and there was no resistance against Co-trimoxazole and ciprofloxacin. Among the *tet* genes identified in 29 (*tet*$^{HR}$) isolates, the predominant gene found was *tet*A. Thyme oil showed maximum antimicrobial activity to the *tet*$^{HR}$ *isolates with* a maximum zone of inhibition (upto 35 mm±2 mm) followed by cinnamon (upto 30 mm±2 mm) and clove (upto 28 mm±2 mm).

**Diversity and composition of microbiota in sludge pit of shrimp culture ponds**

DNA isolated from sludge pits was subjected to Illumina Hiseq 2500



| Legends | Taxonomy | Abundance |
|---|---|---|
| | d__Bacteria;p__Bacteroidota;c__Bacteroidia;o__Chitinophagales;f__Saprospiraceae;g__uncultured | 5.08% |
| | d__Bacteria;p__Proteobacteria;c__Alphaproteobacteria;o__Rhodobacterales;f__Rhodobacteraceae;__ | 3.59% |
| | d__Bacteria;p__Proteobacteria;c__Gammaproteobacteria;__;__;__ | 2.63% |
| | d__Bacteria;p__Actinobacteriota;c__Acidimicrobiia;o__Microtrichales;f__Ilumatobacteraceae;g__Ilumatobacter | 2.61% |
| | d__Archaea;p__Nanoarchaeota;c__Nanoarchaeia;o__Woesearchaeales;f__Woesearchaeales;g__Woesearchaeales | 2.35% |
| | d__Bacteria;p__Chloroflexi;c__Anaerolineae;o__Anaerolineales;f__Anaerolineaceae;g__uncultured | 2.3% |
| | d__Bacteria;p__Chloroflexi;c__Anaerolineae;o__Caldilineales;f__Caldilineaceae;g__uncultured | 2.25% |
| | d__Bacteria;p__Proteobacteria;c__Gammaproteobacteria;o__Cellvibrionales;f__Halieaceae;__ | 1.83% |
| | d__Bacteria;p__Desulfobacterota;c__Desulfobulbia;o__Desulfobulbales;f__Desulfocapsaceae;__ | 1.45% |
| | d__Bacteria;p__Dependentiae;c__Babeliae;o__Babeliales;f__Babeliales;g__Babeliales | 1.4% |
| | d__Bacteria;p__Proteobacteria;c__Gammaproteobacteria;o__Chromatiales;f__Chromatiaceae;g__Candidatus_Thiobios | 1.39% |
| | d__Bacteria;p__Bacteroidota;c__Bacteroidia;o__Flavobacteriales;f__Flavobacteriaceae;__ | 1.38% |
| | d__Bacteria;p__Planctomycetota;c__Planctomycetes;o__Pirellulales;f__Pirellulaceae;g__Blastopirellula | 1.35% |
| | d__Bacteria;p__Proteobacteria;c__Gammaproteobacteria;o__Gammaproteobacteria_Incertae_Sedis;f__Unknown_Family;g__uncultured | 1.3% |
| | d__Bacteria;p__Proteobacteria;c__Gammaproteobacteria;o__Vibrionales;f__Vibrionaceae;g__Vibrio | 1.25% |
| | d__Bacteria;p__Bacteroidota;c__Bacteroidia;o__Chitinophagales;f__Saprospiraceae;__ | 1.13% |
| | d__Bacteria;p__Planctomycetota;c__Planctomycetes;o__Pirellulales;f__Pirellulaceae;g__uncultured | 1.09% |
| | d__Bacteria;p__Desulfobacterota;c__Desulfobulbia;o__Desulfobulbales;f__Desulfocapsaceae;g__uncultured | 1.06% |
| | d__Bacteria;p__Verrucomicrobiota;c__Verrucomicrobiae;o__Opitutales;f__Puniceicoccaceae;g__Verruc-01 | 0.96% |
| | Others | 63.59% |

Abundance of bacterial genus in the sludge pit

ABST of *V. parahaemolyticus* strains isolated from seafood samples procured from online markets

sequencing followed by quality control checking, trimming, filtering of the sequences yielded 2,28,450 reads from sediment samples. The total reads were attributed to 44 phyla, 112 classes, 238 orders, 346 families, 501 genera and 745 species. Overall, the most abundant taxonomy identified in the sample at different taxanomy level include *Proteobacteria* (23.7%), *Bacteroidia* (15.89%), *Chitinophagales* (6.97%), *Saprospiraceae* (6.63%), uncultured genus and species (4-5%).

**Microbiological quality of seafood sold in online markets**

Twenty one *V. parahaemolyticus* strains isolated from seafood from online markets were tested for antibiotic sensitivity against 12 antibiotics and the MAR index ranged from 0.25-0.41. Eight isolates (38%) demonstrated strong biofilm activity whereas remaining (62%) were weak biofilm producers. All the isolates were positive for DNase, Lipase and amylase activity.

**Characterization of spoilage specific flora**

Antimicrobial resistance in the SSO's isolates of Indian Mackerel revealed that *Aeromonas* sp. and *Shewanella* sp. demonstrated substantial resistance to imipenem; additionally, colistin resistance in *Shewanella* sp., ciprofloxacin resistance in *Pseudomonas* sp. were observed. The growth analysis of the SSO's revealed that the temperature preference for growth of SSOs was 25°C, followed by 15°C, 5°C and the least preferred temperature was 35°C. Thirteen phages spots were isolated for *Shewanella* sp. Host range analysis of 13 spots of lytic phages against 13 *Shewanella* sp., was able to control 30 host of *Shewanella* sp., out of 36 tested.

**Microbial composting of household waste with fishery waste**

A microbial consortium comprising four bacterial species; *Bacillus amyloliquefaciens*, *Bacillus subtilis* subsp. *Subtilis*, *Bacillus velezensis*, *Bacillus subtilis* were found suitable for degrading household vegetable waste including fish waste. The bacterial consortium inoculated at $10^8$ CFU of each bacteria per kilogram of crushed waste yielded compost in 25 days in comparison to the commercial waste composters which requires 35-45 days.

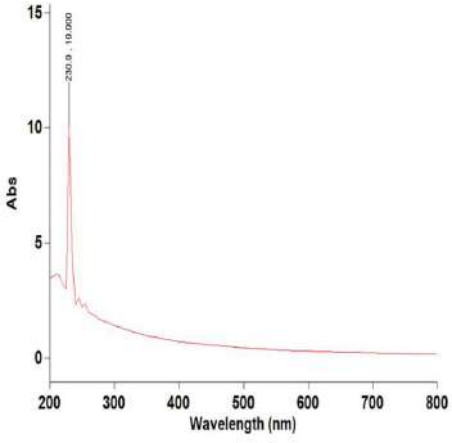
## 2. Virulence and antibiotic resistance profiling of seafood borne pathogens and development of control measures

**Preparation and characterization of Magnesium Oxide Nanoparticles**

Optimization of magnesium nanoparticles (MgO-NPs) was carried out using the Sol-Gel method, with varying molar concentrations of $MgSO_4$ and NaOH. The nano-size was initially confirmed through the blue shift observed using the UV-visible spectrophotometer.

**Haemolytic activity of *V. parahaemolyticus* of seafood origin**

A total of 142 strains of *V. parahaemolyticus* from seafood were screened for hemolysin production. During the screening process, it was found that 20 isolates could produce hemolysin on sheep blood agar. Also two isolates were found positive for *tdh* gene.




Absorption maxima for the MgO-NPs

**Biofilm formation capability of *V. parahaemolyticus***

The biofilm formation capability of *V. parahaemolyticus* was assessed using the crystal violet method in a 96 well plate. It was observed that the strains of *V. parahaemolyticus* from seafood samples exhibited varying levels of biofilm production, with 13.04%, 41.30%, and 45.65% strains

Beta-hemolysis of *V. parahaemolyticus* strains on sheep blood agar

representing high, medium, and low biofilm producers, respectively

**Antimicrobial resistance and virulence profiling of *Salmonella* from seafood of Mumbai region**

An analysis was conducted on 23 *Salmonella* strains obtained from 55 fresh seafood samples to determine their resistance to 17 different antibiotics. The results revealed a significant level of resistance to azithromycin, with 78% (n=18) of the strains being resistant. Gentamicin exhibited resistance to 69% (n=16) of strains, followed by ampicillin at 61% (n=14), and ciprofloxacin at 48% (n=11). Only a small percentage of the strains, 17% (n=4) and 13% (n=3), showed resistance to co-trimoxazole and chloramphenicol respectively.

**Occurrence of *Vibrio vulnificus* in aquaculture ponds and retail fish market:**

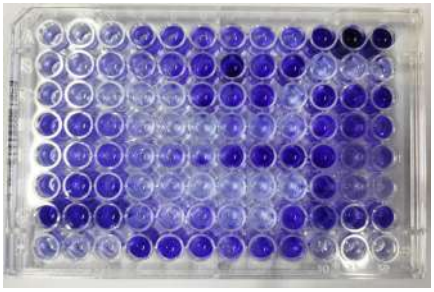
*Vibrio vulnificus* was detected in the aquaculture ponds of Thrissur and Alappuzha district of Kerala. It was observed that *V. vulnificus* was present in five pond samples, including fish, water, and mud. The prevalence in the aquaculture environment was 11%. Similarly, a total of 102 seafood samples from the retail fish market of Ernakulam had a prevalence rate of 2.9%.

**Occurrence of *V. cholerae in* retail fish market of Ernakulam region**

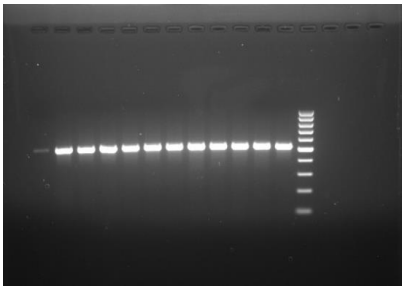
The occurrence of *V. cholerae* in various seafoods was evaluated from 85 fresh seafood samples, including 71 from retail and landing centers, and 14 others. It was observed that 5 of these samples tested positive for *V. cholerae.*

**Occurrence of *Cronobacter sakazakii* in the seafood retail market of Navi Mumbai**

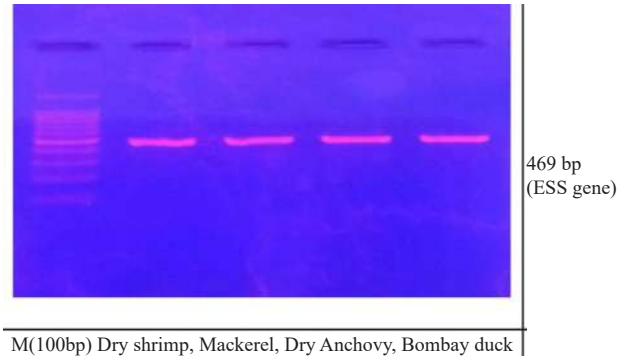
Totally 25 seafood samples were collected from the retail fish market of Navi Mumbai and screened for the presence of *Cronobacter sakazakii* as per the standard isolation protocol and found that three out of twenty-five samples were positive.



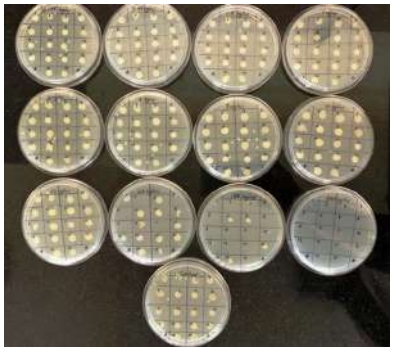
V. parahaemolyticus biofilm stained with 0.1% crystal violet



Amplification of 527bp of hemolysin gene of *V. vulnificus*




PCR for detection of *Cronobacter sakazakii*



Determination of MIC for Benzalkonium chloride

**ESBL-*E. coli* with co-resistance to biocides**

Fifty ESBL-producing *E. coli* strains isolated from the seafood samples were evaluated for their resistance to biocides and found that a higher level (>85.0%) of resistance to Cetylpyridinium chloride followed by Hexa-decyl trimethyl ammonium bromide (44.0%), Cetrimide (44.0%) and Benzalkonium chloride (25.0%) with the minimum inhibitory concentration (MIC) of 256 µg/ml. The present findings revealed that the ESBL-producing *E. coli* strains from the market samples showed co-resistance to biocides.

**Level of Biofilm production *by Klebsiella pneumoniae* of seafood origin from Visakhapatnam region (Andhra Pradesh)**

A total of 12 *K. pneumonia* strains isolated from the seafood samples of Visakhapatnam region were checked for biofilm production ability. Among the 12 isolates, 11 were strong biofilm producers, and 1 was a weak biofilm producer.

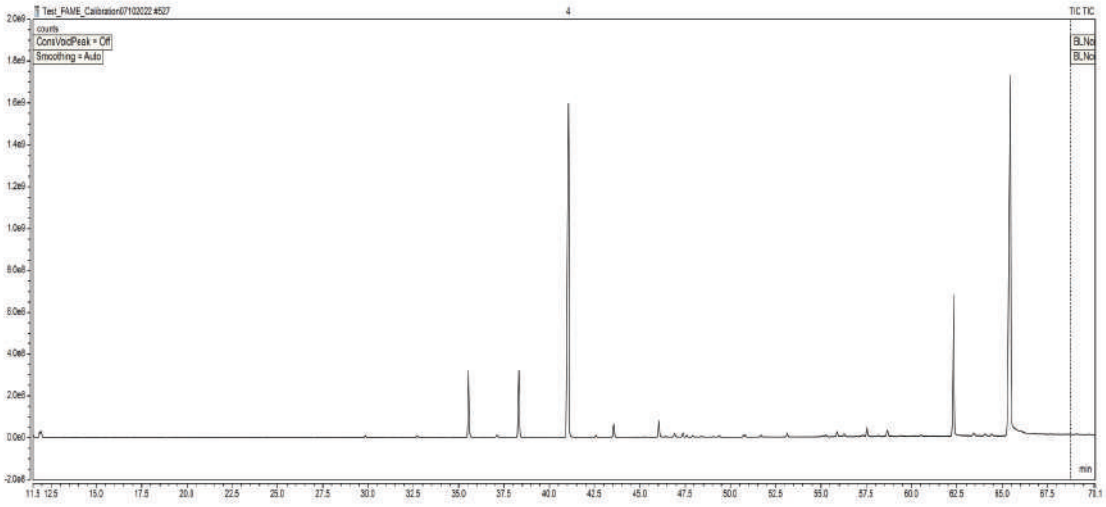
# 3. Production of poly unsaturated fatty acids (PUFAs) from heterotrophic eukaryotes: A biotechnological approach

**Isolation and screening of PUFA produ cing Thraustochytrids**

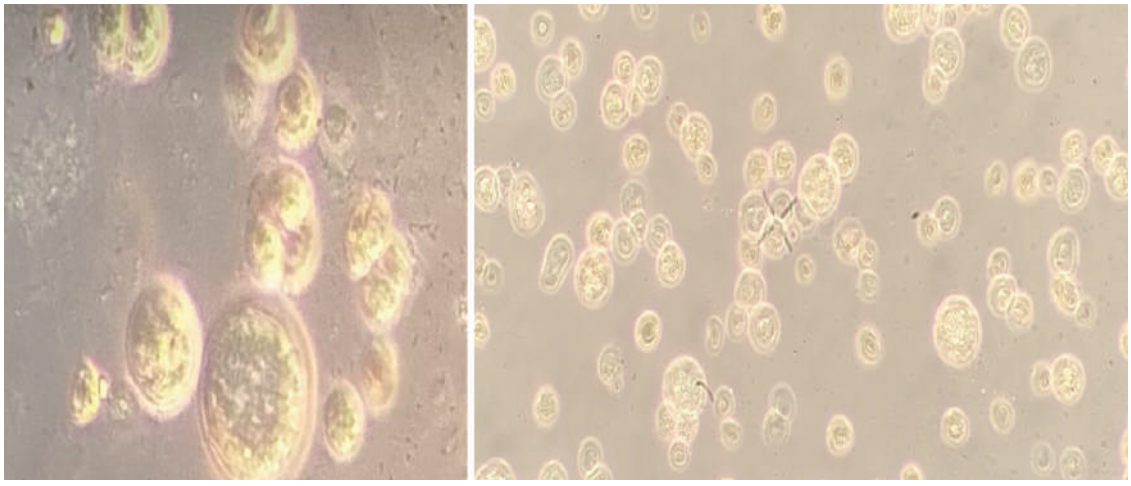
A total of 154 isolates presumptive PUFA producing Thraustochytrids were isolated from seawater water samples, fallen mangrove leaves, and sediments from the Cochin region. A total of 30 morphologically and culturally distant strains were selected for further study. All the isolates were lipase and protease positive, and 11 were amylase positive. The isolates were amplified using 18srRNA for molecular identification. The biomass production of ten isolates were in the range of 1.93-8.3 g/l, with the highest found in isolate M54.

**Fatty acid profiling of isolates**

The fatty acid profile of the isolates were determined, and it was found that both saturated fatty acids and unsaturated fatty acids were present in these isolates. Among the saturated fatty acids, palmitic acid was the highest. Other fatty acids, such as C17:1 (hexadecanoic acid), C17:0 (margaric acid), and C18:1 (oleic acid), were also present. Unsaturated fatty acids such as alpha-linolenic acid (C18:3, n-3), arachidonic acid (C20:4, n-6), eicosapentaenoic acid (C20:5, n-3), and docosahexaenoic acid (C22:6, n-3) were detected in the isolate M54.




Detection of DHA in Thraustochytrid using GC-MS



Morphology of thraustochytrid showing single cells and cluster of cells under 40× magnification in the light microscope

# Biochemistry and Nutrition Division

## Institute Projects

1. *A Green Technology approach on isolation, purification and product development from marine biomolecules*
2. *Establishing nutritional and bio-functional potential of selected fishery products through in vitro/in vivo digestibility studies*
3. *Development of a marine biorefinery based on tuna processing waste – A greener approach*
4. *Evaluation of anti- nutritional factors (ANFs) /secondary metabolites in fish feed and feed ingredients*

### *Most Significant Achievements*

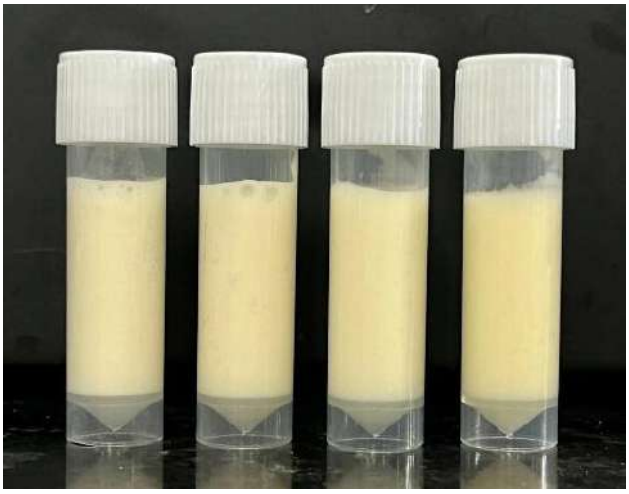
- Protocol for the synthesis of CH-GPH nanoparticle complexes was standardized
- A method for the preparation of Chitosan-Gelatin-Lignin hydrogel was developed
- Synthesis of rhamnolipid nanoparticles grafted chitosan and alginate was developed
- Bio-polymer coated nanoliposome with bioactive peptides was prepared
- Pickering emulsions was prepared using chitosan-gelatin protein hydrolysate (CHI-GPH) nanocomplexes and fish oil
- A methodology for development of polymerized whey protein as a delivery system for lipophilic compounds was designed
- A methodology for development of self assembled chitosan as a pickering emulsion stabilizer was designed
- Developed curcumin-based supplement was found to improve the growth performance of *Macrobrachium rosenbergii*
- A technology was developed for fabrication of sodium alginate beads loaded with squalene as a nutraceutical agent
- Fatty acid profiling of different tuna processing fractions was carried out
- Supercritical fluid-based extraction protocol was developed for recovering omega-3 PUFA from canned tuna skin fractions
- Studies on fish purchase and consumption behaviour in Meghalaya (Ri-Bhoi and West Garo Hills) were carried out
- Nutritional and fatty acid profiling of selected brown seaweeds from Mandapam coast were determined
- Supercritical fluid extraction protocol for obtaining phlorotannin from brown seaweed was developed
- Developed an enzyme assisted extraction method for obtaining bioactives from brown seaweed
- Developed a pressurized extraction method for obtaining bioactives from brown seaweed

## CHIEF FINDINGS

## 1. A green technology approach on isolation, purification and product development from marine biomolecules

**Protocol for the synthesis of CH-GPH nanoparticle complexes**

Protocol for the synthesis of Chitosan Gelatin Protein Hydrolysate (CH-GPH) complexes was standardized and applied to stabilize Pickering emulsions for potential functional food formulations. Pickering emulsions were prepared using fish oil and compared with standard commercial vegetable oil. Our study suggests that the potential of biopolymer-peptide-based nanocomplexes as core wall materials for developing Pickering emulsions and their efficiency in delivering bioactive peptides



Pickering emulsions stabilized by CH-GPH nanocomplexes

**Preparation of Chitosan-Gelatin-Lignin Hydrogels**

A method for the preparation of Chitosan-Gelatin-Lignin Hydrogels was developed for tissue engineering and regenerative medicinal applications. The hydrogel possessed biocompatible, antioxidant capacity, and wound environmental management ability enhanced by the addition of lignin.

**Synthesis of rhamnolipid nano-particles grafted chitosan and alginate**

Rhamnolipid nanoparticles grafted chitosan and alginate was synthesised and its physico-chemical, rheological and biocompatibility properties were characterized. *In vitro* stability studies revealed that the addition of rhamnolipid nanoparticles (RHLP-NPs) to biopolymers reduced the aggregation and facilitated the production of uniform particles, thereby improving the stability of the synthesized nanoparticles. Biopolymer-reinforced rhamnolipid biosurfactant nanoparticles have good potential for use in food processing and pharmaceutical, biomedical and tissue engineering applications.

**Development of Pickering emulsions**

Pickering emulsions using chitosan-gelatin protein hydrolysate (CHI-GPH) nanocomplexes and fish oil was prepared. An *in vitro* gastrointestinal (GI) model consisting of mouth, gastric and intestinal phases was used to characterize the bioaccessibility of the Pickering emulsions. Oral dietary administration of Pickering emulsion enhanced the functional ability, as revealed by lipid profile and liver and renal function test analysis. The fatty acid profile of the intestines showed high concentrations of DHA and EPA fatty acids.

Lignin based Hydrogels

Bio-polymer coated nanoliposome with bioactive peptides

**Preparation of Bio-polymer coated nanoliposome**

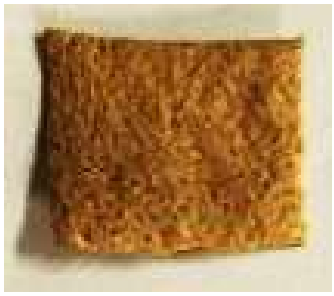
A methodology was designed for developing polymerized whey protein (WP) as a delivery system for marine lipids by taking temperature and time as the independent variables. An increase in temperature was found to have a significant effect on the particle size of polymerized protein with particle size increased from 291.77 to 766.20nm by heating in the range of 70 to 90°C. Further, irrespective of the nature of treatments all thermally treated WP samples were found to be polydisperse in nature as shown by poly dispersity index (PDI).

**Pickering emulsions with hydrophobically modified chitosan**

Developed pickering emulsions with hydrophobically modified chitosan made from low and medium molecular weight. Self-assembled chitosan fabricated from medium molecular weight chitosan has exhibited better stability attributes than the low molecular weight-based ones. The study further demonstrated that by employing an additional ultrasonication step in the pickering emulsion process, stability parameters can also be improved.

**Effect of curcumin-based supplement on growth and disease resistance in *Macrobrachium rosenbergii***

Influence of curcumin-based supplement on growth and disease resistance in *M. rosenbergii* was studied. Animals fed with curcumin-based supplement at 150 PPM in the diet showed higher growth rate compared to the control and other treatment groups. Specific growth rate also followed the similar trend with weight gain percentage and the highest SGR has been recorded in the T2 fed with 150 PPM curcumin-based supplement in diet. Though FCR and PER, did not show significant ($P<0.05$) difference between the control and treatment group, a noticeable trend was recorded. Better FCR and PER were recorded in the T2 group fed with 150 PPM curcumin. Survival rate of *M.rosenbergii* did not show significant ($P<0.05$) difference between the control and treatment group (Fig 5). Lowest survival rate was recorded in the control (animals fed without curcumin-based supplement) and T4 (fed with 100 PPM curcumin) has recorded higher survival rate. Mortality during the experiment was



Chitosan-Alginate-Lignin Hydrogel

Chitosan-Gelatin Hydrogel

mainly linked to cannibalism which was due to moulting.

**Methodologies Developed**

- Analytical method developed – Fatty acid profile of fish oil by GC-MS/MS
- Optimized enzyme assisted and supercritical fluid extraction protocols for potential bioactive compounds from brown seaweeds
- Methodology developed for preparation of nanoliposomes coated with biopolymer
- Methodology developed for preparation of chlorhexidine grafted nano chitosan films for wound healing applications
- Methodology designed for developing polymerized whey protein as delivery system for marine lipids
- Developed a method to synthesise stable pickering emulsions from self-assembled chitosan
- Influence of curcumin based supplement on growth and disease resistance in *Macrobrachium rosenbergii* was established

**Products developed**

- Lignin based hydrogel
- Bio-polymer coated nanoliposome with bioactive peptides
- Pickering emulsions using chitosan - gelatin protein hydrolysate (CHI-GPH) nanocomplexes and fish oil
- Nano encapsulated phloro-glucinol
- Chlorhexidine grafted nano chitosan films
- Rhamnolipid nanoparticles grafted chitosan and alginate

## 2. Establishing nutritional and bio-functional potential of selected fishery products through in vitro/in vivo digestibility studies

***In vivo* studies on wound healing properties of chitooligosaccharide-based cream**

Developed chitooligosaccharide-based cream and studied the wound-healing properties of cream in an *in vivo* model. The study revealed that chitooligosaccharide was effective for preparing cream with higher antimicrobial properties for animal application. The cream had the stability of 3 months at room temperature.

***In vivo* digestibility study of dried anchovy fish powder**

Animal study was conducted for the in-vivo digestibility study of dried anchovy fish powder. The study found that the fish powder-fed male wistar rats had a specific growth rate of 1.39% compared to 1.25% of the normal basel-fed male wistar rats. The dried anchovy fish powder increased weight (36.18%) of male Wistar rats after 28 days of study.

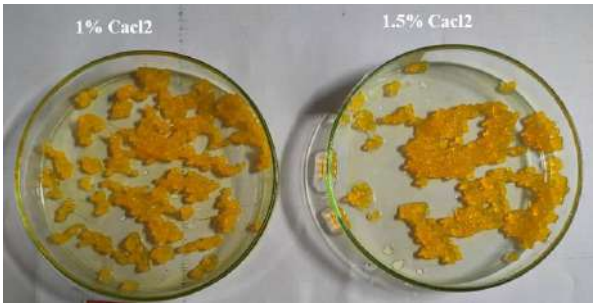
***In vitro* bio accessibility of chitosan protein hydrolysate nanoparticle**

Chitosan-gelatin protein hydrolysates (CH-GPH) nanoparticles were synthesized and applied to stabilize pickering emulsions for potential functional food formulations. At different pH, the particle size of CH-GPH nanoparticle suspensions was found to have smaller particle size at lower pH (3 – 5) compared to that of higher pH (9 – 11).


Chitooligosaccharide based cream

**Chitosan beads loaded with curcumin as an aquafeed additive**

To retain the bioavailability of curcumin, a bead-based delivery system was developed. For this, chitosan of different molecular weight was chosen. Ionic gelation technique was followed for formulation of chitosan beads loaded with chitosan. The developed method resulted in stable chitosan beads with sustained release of curcumin.




Curcumin loaded beads

**Sodium alginate beads loaded with squalene as a nutraceutical agent**

A methodology was devised for loading squalene into the sodium alginate beads. The sustained release of squalene was analysed in different simulated fluids.The beads fabricated were shown to facilitate the slow release of squalene.

Squalene loaded beads

## 3. Development of a marine biorefinery based on tuna processing waste – A greener approach

**Nutrient profiling of tuna processing waste**

Detailed nutrient profiling of tuna processing waste obtained from two major processing lines: canning and masmin production was analysed and established. The fatty acid profiling indicated that canned bones were superior in terms of the omega-3 PUFA content.

**Recovery of bioactive lipids from canned skin**

The effect of co-solvent flow rate on recovering bioactive lipids from canned skin were investigated. It was observed that yield of oil increased from 10.89 to 19.42 % by increasing the flow rate from 0 to 2 g/min. However, by further increasing the flow rate to 3 g/min, the yield has significantly reduced to 15.53% suggesting 2 g/min as the ideal flow rate. Fatty acid acid profiling also revealed that a higher flow rate of co-solvent was not favouring the extraction of DHA and EPA. A lower flow rate of co-solvent was found effective in terms of the yield and fatty acid content, especially PUFA.

**Effect of drying techniques on the yield and fatty acid content of oil recovered using supercritical fluid extraction technique**

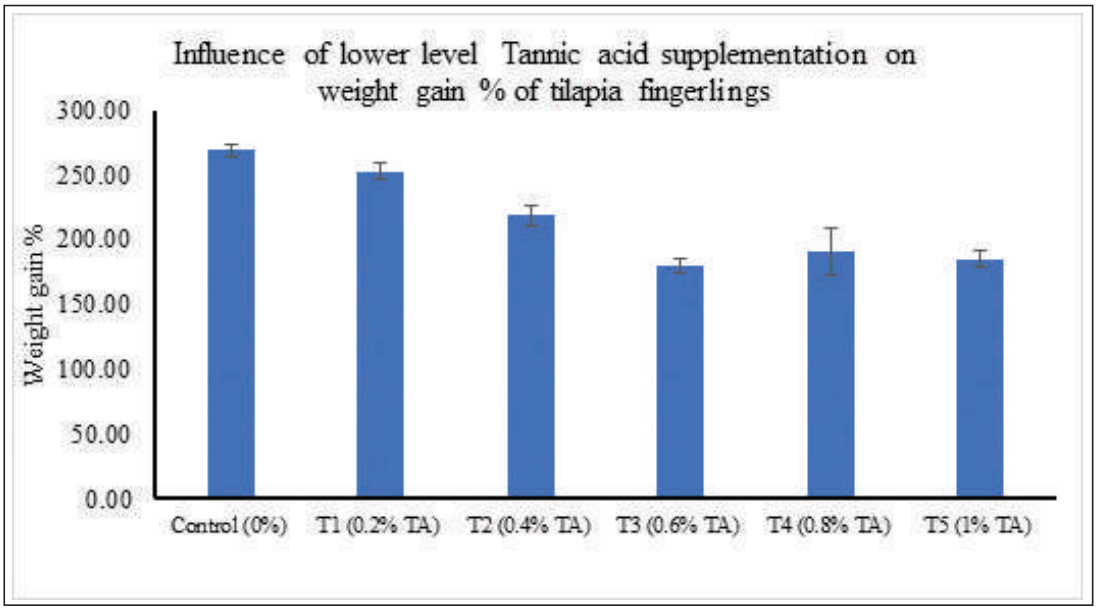
The effect of different drying techniques, oven and infra-red drying on the yield and fatty acid content of oil recovered using supercritical fluid extraction technique was investigated. The yield of oil was found to be 14.73 and 11.03% for oven dried and infra-red dried tuna skin samples. Further, the fatty acid profiling suggested that among the PUFA fractions, Docosahexaenoic acid (DHA) was the most dominant followed by eicosapentenoic acid (EPA). The findings of the study suggested that oven drying can be resorted an economical pre-treatment for drying of samples for the purpose of supercritical fluid extraction technique.

Tuna bone oil

**Protein based delivery system as carrier for omega-3 PUFA**

A protein based delivery system developed as carrier system for the omega-3 PUFA from tuna bone and skin oil. Analysis of emulsions showed that it had a particle size of 212 nm, zeta potential was -18.8 mV with a PDI value of 0.89.

## 4. Evaluation of anti- nutritional factors (ANFs) /secondary metabolites in fish feed and feed ingredients




**Determination of tolerable limit of anti-nutritional factor (tannic acid) in the diet**

A study was executed to identity the tolerable limit of anti-nutritional factor (tannic acid) in the diet. With this background, influence of lower level of dietary tannic acid (0%, 0.2%, 0.40%, 0.6%, 0.8% and 1.0%) on growth performance in *Oreochromis niloticus* fingerlings was carried for period of 90 days. Control group of fishes fed without tannic acid in diet have recorded better growth performance. Whereas, dietary supplementation of tannic acid at lower level (above 0.4%) in the diet has showed negative impact on growth performance. Tilapia fingerlings fed with tannic acid up to 0.4% showed growth performance at par with control group fed without tannic acid. Fishes fed with the diet containing more than 0.4% tannic acid in the diet revealed reduced growth performance. FCR showed significant difference between the control and treatment group, better FCR was noticed in fishes fed without tannic acid in the diet and also in the treatment group fed with tannic acid at low level upto 0.4%. Similar to our earlier studies, animals fed with tannic acid were found to excrete higher quantity of fecal matter compared to the control group. It was concluded that presence of tannic acid levels in the diet upto 0.4% will not negatively impact growth performance of tilapia fingerlings.

# Engineering Section

## Institute Projects

1. *Engineering interventions in the post-harvest sector*
2. *Carbon nanodots and nanocomposite PCM based energy efficient solar dryer*

### *Most Significant Achievements*

- Prepared design for improved solar refrigerated kiosk for fish vending
- Developed and evaluated performance of a prototype of multi-purpose solar thermal conversion system with a gasifier heat backup for shrimp drying
- Developed a portable device for non-destructive evaluation of fish quality and freshness
- Established ammonia/carbon dioxide (natural refrigerant) cascade refrigeration in seafood processing at at a seafood processing establishment in Kochi.
- Performance and techno-economic analysis of solar tunnel dryer was carried out using shrimp and clam
- Performance evaluation of pilot scale IR dryer was carried out
- Drying and quality characteristics of clam and sole fish in various CIFT dryers were evaluated

## CHIEF FINDINGS

## 1. Engineering interventions in the post-harvest sector

**Design of fish smoking kiln**

Fish smoking kiln was designed to hold 20 kg of fish. The kiln included a furnace to supply hot smoke, a filter mechanism to remove undesirable smoke particles/hydrocarbons and a provision for cross-flow of smoke and air. A provision is also made for intermittent smoking and drying to obtain the optimum quality product at the desirable moisture levels. The equipment is provided with electrical heating coils to maintain the desired internal chamber temperature. Manual turning of fish and shifting of trays are avoided in this design.

**Improved design of solar-powered fish feed dispenser**

A solar-powered automatic fish feed dispenser was developed using a single-board microcontroller which dispenses a predetermined amount of feed at set time intervals. The unit consists of a solar PV panel, charge controller, ATmega 328P microcontroller, feed hopper, feed dispensing rotating plate, DC motor, battery, keypad, real-time clock module, LCD, high-density polyethylene (HDPE) aqua float and a propeller. In this unit, there is an electronic system built on the framework of Internet of Things (IoT) with a Radiofrequency (RF) module for wireless data transmission. In this improved design, a propeller is fixed instead of the paddle wheels for the movement of the feed dispenser. A transmitter node allows the user to send control signals to the receiver node which facilitates the movement of the propeller and thereby the feeder system can be driven in the water.

Solar-powered automatic fish feed dispenser

**Clam drying in CIFT dryers**

The drying characteristics of clam in various CIFT dryers (solar electrical dryer (SED), solar tunnel dryer (STD), solar LPG hybrid dryer (S-LPG), electrical dryer (ED) and hot air assisted infrared dryer (IR)) and open sun drying (OSD) were analysed. The result revealed that the clam dried in an IR dryer had significantly lesser drying time (2.5 h), and higher drying efficiency (44%) with reduced energy consumption.

**Performance evaluation of pilot scale infrared dryer using raw and marinated anchovies**

Drying of raw and marinated anchovies were carried out in the

Clam (a) fresh (b) dried in pilot-scale hot air-assisted IR dryer (c) Rehydrated

Schematic representation of proposed solar-powered fish vending kiosk

forced convection hot air-assisted pilot-scale infrared dryer. Marination of anchovies was carried out using salt, lemon juice and spice powders at least 30 min before drying. The dryer was operated at an infrared intensity of 1500 W/m$^2$ and hot air inlet temperature of 50℃ and 60℃. The moisture content of the raw anchovies was reduced from 74.41 (% w.b) to 24.51% and 24.28 (% w.b) in 3 h in the infrared dryer at 50℃ and 60℃, respectively. In the case of marinated anchovies, the moisture content reduced to 23.68 (% w.b) and 23.02 (% w.b) in 3 h in the infrared dryer at 50℃ and 60℃, respectively. Specific energy consumption was found to be less for marinated anchovies. Better rehydration ratio and less shrinkage were reported for raw anchovies after drying.

(a) Open sun drying (b) Solar-LPG hybrid dryer (c) Batch type IR dryer
Different drying techniques employed for sole fish drying

(a) Fresh (b) Dried
Sole fish before and after drying in batch-type IR dryer

**Performance evaluation of modified solar-powered refrigerated fish vending kiosk and design of improved model**

The existing model of the fish vending kiosk was retrofitted combining both conduction and convection cooling techniques to provide a sustainable and environment-friendly solution for delivering high-quality fish to end users. It has been observed that the average temperature of the fish reached 4.3°C from 7.8°C within 25 min after loading. Throughout the test, the cooling chamber's bottom surface temperature was observed within the range of 2 to 6°C and the temperature of the chilled air inside the chamber was observed within the range of 4 to -1°C. The average temperature of the fish was brought down to 2.9°C within 1.5 h of loading while the supply air temperature was at 0°C.

The modified version of solar-powered refrigerated mobile fish vending kiosks has a few limitations such as the longer time for attainment of desired chamber temperature, loss of heat from the closing door/lid, no hybrid charging provision, etc. Hence, an improved model was designed to meet the requirements of the display of 30 kg fish under chilled conditions. In this improved model, an airtight lid was provided, the total weight of the unit was reduced with lightweight materials, and an inverter was included for hybrid charging options. The high-capacity compressor will be used for quick cooling with an appropriately sized solar PV panel, battery, and charge controller.

**Comparison of different drying methods for sole fish**

The effect of drying techniques such as a batch-type infrared dryer, a solar-LPG hybrid dryer, and open sun drying methods on the drying characteristics and quality attributes of sole fish was analysed.

The sole fish sample had an initial moisture content of 75.32 (% w.b) which was reduced to 16.77 (% w.b) in open sun drying, 14.82 (%w.b) in Solar-LPG dryer, and 12.78 (% w.b)

in batch type infrared dryer. The sample dried in batch type infrared dryer dried within 8 h whereas solar-LPG dryer took 11 h and open sun drying required 19 h. IR drying took significantly less time to reach the required moisture content. Moreover, IR drying recorded improved drying rates and resulted in lesser shrinkage and a higher rehydration ratio.

**Techno-economic analysis and performance evaluation of solar tunnel dryer using shrimp and clam**

The performance of a walk-in-type semi-cylindrical solar tunnel dryer using shrimp (*Metapenaeus dobsoni*) and clam (*Villorita cyprinoides*) was evaluated by assessing drying characteristics, modelling drying behaviour, assessing quality aspects of the dried product and carrying out techno-economic analysis. The average ambient air temperature, relative humidity and solar radiation during the experiments ranged between 31.05°C and 41.84 °C, 25.49% and 60.99 %, and 325 $Wm^2$ and 644.11 $W/m^2$, respectively. The moisture content decreased significantly from the initial value of 79.70% (w.b.) to 11.74% (w.b.) for shrimp and 76.80% (w.b.) to 12.45% (w.b.) for clam in 9 h of drying. Average drying rates for clams and shrimps were found to be 0.81 g/h and 0.77 g/h, respectively. The drying efficiency of shrimps varied from 3.33% to 11.39% with an average efficiency of 7.38%, and the drying efficiency of clams ranged from 2.05% to 26.19% with an average efficiency of 7.74%. Mathematical modelling of the drying process indicated that the Two-term exponential model and Henderson and Pabis model could accurately predict the drying behaviour of shrimp and clam, respectively. From economic analysis, the payback period of the solar tunnel dryer was estimated to be about 2.94 and 2.73 years for the drying of shrimp and clam samples. The rehydration ratio of shrimp and clam dried in the solar tunnel dryer was found to be 2.36 and 1.94, respectively. A shrinkage ratio of 17.78% and 21.00% was observed in shrimp and clam samples, respectively.

## 2. Carbon nanodots and nanocomposite PCM based energy efficient solar dryer

**Design of solar dryer with double pass flat plate air collector coated with carbon nanodots**

Solar dryer (5 kg) was designed and fabricated for drying of fish. Drying experiments were conducted at 0.021 kg/s air flow and the maximum drying chamber temperature of 53.4°C was observed. The temperature of 50-55°C is suitable for drying of fish and fishery products.

Solar dryer with double pass flat plate air collector coated with carbon nanodots

# Extension, Information and Statistics Division

## *Institute Projects*

1. Modelling economic risks in fisheries and assessing existing mitigation strategies
2. A study on the entrepreneurship ecosystem in fisheries and the cybernetics of Women Initiated Enterprises in Fisheries (WIEF) in selected coastal states of India
3. A study of digital fish marketing ecosystem in India
4. Assessment of post-harvest losses in the fish value chain
5. Impact assessment of ICAR-CIFT Technologies
6. An assessment of extension system in marine fisheries sector of kerala

### *Most Significant Achievements*

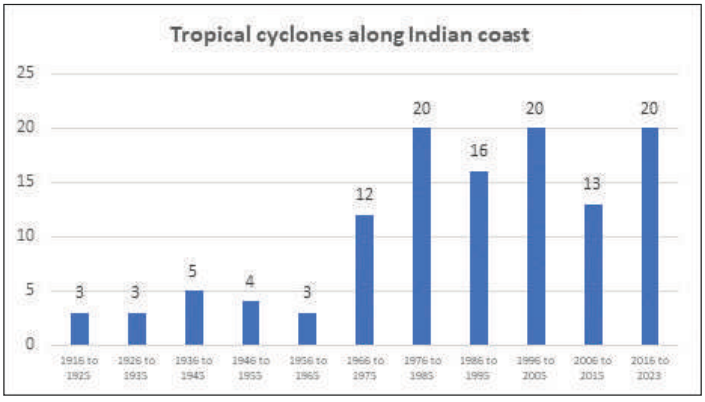
- Strategic landscape of online fish vending and a conceptual model of drivers and barriers to online fish purchase was also created
- A comprehensive dashboard for the monitoring and impact assessment of successful technologies at ICAR-CIFT was developed using identified key indicators
- Informal Fish Loss Assessment Method was used to assess post-harvest losses in marine fisheries
- For modelling economic risks, data indicates that fishermen engaged in single-day fishing are more prone to economic risks as weather warnings for storms and cyclones restrict fishing operations for a minimum of 4 days during each occurrence

## CHIEF FINDINGS

## 1. Modelling economic risks in fisheries and assessing existing mitigation strategies

**Analysis of extreme events and loss of fishing days**

During the period 1916 to 2023, it was observed that a total of 119 tropical cyclone and 36 storms have occurred along the coastal districts which led to heavy winds, rainfall, and flooding and subsequently warnings were issued by IMD to fishermen not to venture for fishing. East coast was more prone to cyclone occurrences compared to the West, with Andhra Pradesh recording 44 cyclones during the 100+ year period. For assessing economic losses from fisheries, sampling plan was devised.




Secondary data on the income of a sample of 250 fishermen engaged in motorised sector from 2017 to 2023 was collected from Kozhikode. ARIMA model was fitted to the time-series data on the income of fishermen operating *thanguvallom.* AR(1,1,0) model was best fit with AIC=2370.99, and Box Ljung test indicated significance at 1% level. Similarly, the timeseries analysis of data on income of fishers engaged in small fishing vessels revealed that AR(1,1,0) model was best fit with AIC 3083.43 and significance of Box test at $p<0.01$.

## 2. A study on the entrepreneurship ecosystem in fisheries and the cybernetics of Women Initiated Enterprises in Fisheries (WIEF) in selected coastal states of India

**Entrepreneurial Ecosystem (EE) For Promoting Women Entrepreneurship**

The Principal components of en trepreneurial ecosystem (EE) for promoting women entrepreneurship in India including Finance and Policy were documented in Kerala, Andhra Pradesh, Maharashtra and Orissa and a very encouraging environment with respect to these components. The Supports system and Markets are also promising, but number of those with entrepreneurial intention and budding entrepreneurs among coastal women were very poor.

Perceived support of entrepreneurial ecosystem among women with entrepreneurial intention was studied through case study mode in Mumbai and Veraval, while in Kerala process study mode was adopted and found that the information was miserably poor and thus the access. It was also observed that majority of women did not possess vital entrepreneurial attributes like passion, vision, resilience, and flexibility at personal level indicating dominance of necessity entrepreneurs rather than real entrepreneurs.

Action regulation factors at personal, interpersonal, and social level in women led fishery enterprises were studied through action research by starting two women led enterprises at Udayamperoor and Vaikkom. Between women-initiated enterprises in coastal belts and other units, evident differences were observed with respect to Objective, Growth, Leadership traits, Team traits, Management Strategy, Idea and Market share.

It was reported that though the family take a supportive role for women to initiate enterprises, later they turn criticising and unsupportive, owing to the "inconveniences" created by absence of women at home. But the lack of profitability and tangible growth in women-initiated enterprises was the factual reason recorded from family response.

A major conclusion from the study was that the entrepreneurial cybernetics is weak and need to be revitalised through refining 'information literacy' and 'access to information' among potential women entrepreneurs.

## 3. A study of digital fish marketing ecosystem in India

**Unique selling points and grey areas of major digital fish vending firms**

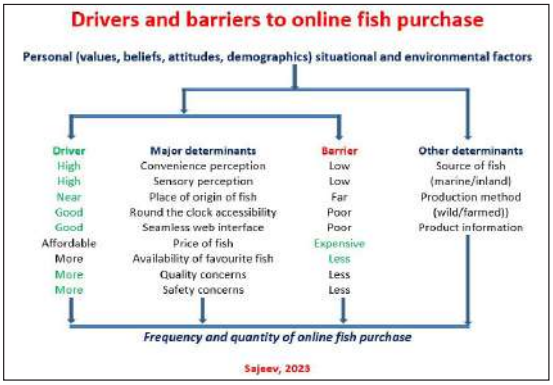
'Number of products available' and 'variety of fish on sale' were the most important factors found to attract or deter consumers to and from a particular digital fish vending portal thereby acting as their USP as well as grey area. 'Payment options provided' and 'marketing channels used' were the next level of USP as well as grey area for the digital firms studied. Based on the findings strategic landscape of online fish vending was created.

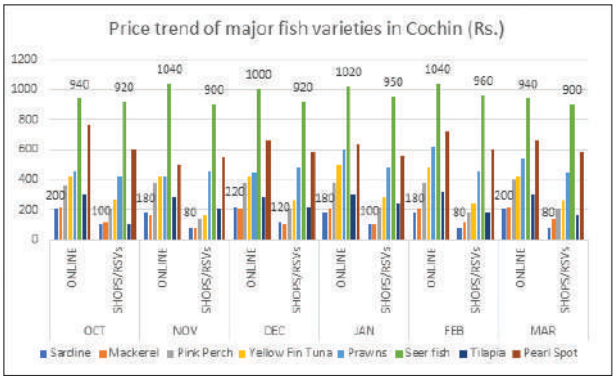
Conceptual model of drivers and barriers to online fish purchase was also created based on the findings. Convenience perception, sensory perception, place of origin of fish, round the clock accessibility, seamless web interface, price of fish, availability of favourite fish, quality and safety concerns were the major determinants of online fish purchase acting as both drivers and barriers as per situation.

Source of fish (marine/inland), production method (wild/farmed) and product information were the other determinants of online fish purchase.

Price trend study revealed that price of fish on digital portals were almost double in Cochin compared to local shops/traditional markets while in Vizag; the portals were found charging more than double the price of fish in local shops. The digital firms


Strategic landscape of online fish vending




Price and availability trends of major fish species in online portals compared to traditional markets

in Mumbai were found to charge a premium of 50 to 80 % more than local shops depending on the fish variety.

Trend in seasonal availability of fish on digital vending firms in relation to the local shops/roadside vendors were studied in Cochin, Mumbai and Visakhapatnam. Availability of fish varieties was always more than double for digital firms compared to local shops in all the states studied.

**Issues in retail online fish marketing and coping strategies adopted**

The major issues in online fish business were documented as supply chain disruptions, restrictions on fish trade in markets, restrictions on fishing trips due to recurrent weather warnings, seasonal fishing bans, competition from other online vendors, government regulations, maintenance issues in online portals, payment gateway issues, poor knowledge of online marketing, advertisement issues customer preference for in-shop/market purchases.

The coping strategies adopted by major digital fish vending firms were found to be procurement from small boats during seasonal fishing ban periods, price adjustments, provision of better variety to consumers, better delivery systems, better online backend support and increased advertisement channels.

## 4. Assessment of post-harvest losses in the fish value chain

**Assessment of post-harvest losses of fish using qualitative methods**

The post-harvest losses of fish assessment using qualitative methods was carried out in three stages viz., harbour, wholesale market and retail market covering three states viz., Kerala, Tamil Nadu and Andhra Pradesh. The qualitative method follows the Informal Fish Loss Assessment Method (IFLAM). The Key Informants Interview (KII) was attempted to assess the types, causes, intensity, seasonality and species differentials in losses. Fishers, boat owners, commission agents, fisheries officials, fish workers, sellers at wholesale and retail markets were the key informants. Eleven of the 25 key informants expressed that the large proportion of small-sized fishes were the major cause of post-harvest loss in fish in Kerala, while in Tamil Nadu and Andhra Pradesh among the key respondents, eight of 20 and eight of 18 responded that improper handling was the major cause for the post-harvest losses. It was also found that lack of transportation was not attributed to post-harvest loss. More than 50% key informants responded that the post-harvest loss in fish is high during June to November and it was less during December to May. Most of the key informants mentioned that the loss is comparatively high in the species viz., sardine, ribbon fish, anchovies and squid.

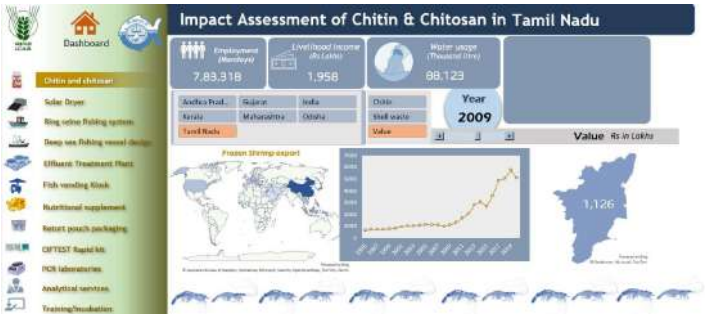
The perception survey to explore the knowledge of key informants on post-harvest loss in fish was also been carried out using Likert's scale.

Post-harvest loss at the harbour level

Key informants interview in Tamil Nadu and Kerala

## 5. Impact assessment of ICAR CIFT technologies

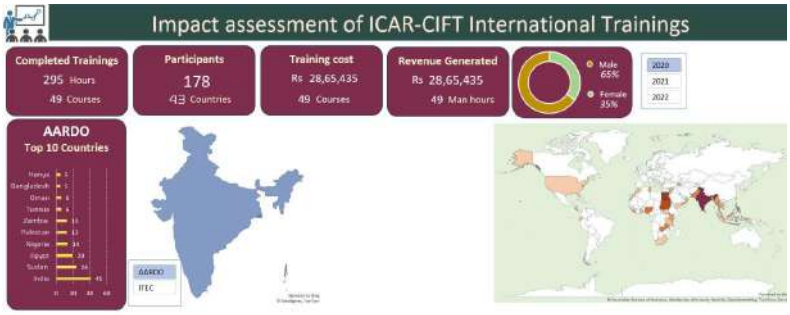

Dashboard of national level training programme




Sample of technology assessment page of the dashboard

**Dashboard Development for ICAR CIFT Technologies**

A comprehensive dashboard for the monitoring and impact assessment of successful technologies at ICAR-CIFT using key indicators is being developed. Various aspects related to technology adoption, economic impact, environmental sustainability, and overall effectiveness were covered, providing a holistic view for the development of a comprehensive dashboard.




Dashboard of national level training programme

**Training Impact Assessment**

Database about the participants who attended the training programs conducted under flagship initiatives such as the Scheduled Caste Special Component Plan (SCSP), Tribal Sub-Plan (TSP), and international training programs like the Indian Technical and Economic Cooperation (ITEC) was created.

## 6. An Assessment of Extension System in Marine Fisheries Sector of Kerala

**Extension System in Marine Fisheries Sector of Kerala**

Extension System in Marine Fisheries Sector of Kerala is highly pluralistic in nature with the presence of agencies in public, private, and civil society segments which are undertaking number of activities including provision of technological inputs and livelihood assistance. Presence of multiple agencies add to the strength of fishery extension system in Kerala. The challenge lies in coordinating every actor in the system and convergence of efforts of various agencies for enhanced effectiveness of the system

Regarding information need and access to information, more than half of the respondent fishermen have accorded high importance to information related to weather, potential fishing zone, fuel efficiency, maintenance of craft, credit, subsidy, and government policies. But proportion of respondents having high level of access to required information was found to be very less, except in the case of weather and potential fishing zones.Thematic analysis of data collected revealed the major themes like extension inadequacy, need for complimentary inputs and incentives, need for innovation system perspective and an enabling environment.

Assessment of perceived role performance of fisheries extension personnel pointed out that performance was high with respect to traditional roles like awareness generation, implementation of schemes, conducting training and demonstration programmes etc. perceived performance of other roles like promotion of ICTs, feedback and demanding policy, market linkage activities, group based extension etc are yet to be improved.

Areas of capacity development of fisheries extension personnel identified include Information updating, leveraging policies and programmes, networking and collaboration, feedback for policy intervention, mobilization of collectives and regulatory aspects, planning and monitoring, participatory approaches and use of ICTs.

# Visakhapatnam Research Centre of ICAR-CIFT

## Institute Projects

1. Augmenting value and safety of wild and farmed fish of the East Coast through technological approaches
2. Interventions for ensuring diversity and quality of products from aquatic resources of East Coast through innovative technologies
3. Development of Smart Trawls Systems for the North East maritime states of India

## Most Significant Achievements

- Determined the tetracycline resistance of heterotrophic bacteria recovered from finfish aquaculture system
- UV light treatment for dried fish significantly controlled the bacterial and mould growth and chemical spoilage during storage
- Developed fish sauce from Mahi mahi fish fillet frame waste
- Developed millet-based batter formulation for coated fish product
- Survey on existing trawl systems of Andhra Pradesh and Odisha states and the challenges in trawl fishing was conducted
- *E. coli,* coagulase negative Staphylococci (CoNS) and *Vibrio* spp. isolated from *Penaeus vannamei* shrimp and from pond water showed similar pattern of antimicrobial resistance

## CHIEF FINDINGS

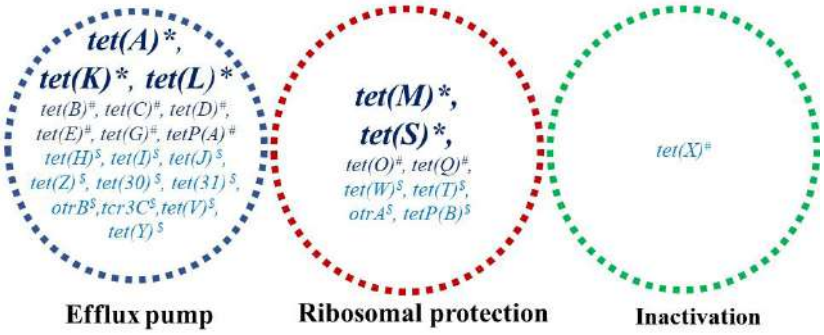
# 1. Augmenting value and safety of wild and farmed fish of East Coast through technological approaches

### Effect of post-blanch peeling on the storage quality of dried shrimp

Storage study of peeled and dried shrimp (peeling before blanching in different concentrations of brine-5 and 10% salt in 1% citric acid solution and peeling after blanching in different concentrations of brine) was carried out. The redness value (a*) of the control sample was lower than the treated sample and its rate of reduction during storage was higher with control sample. Moisture content of the sample was in the range of 17-20%, which was increased by 1-4% during the storage period of 105 days. Microbial and chemical spoilage parameters of all samples were within the acceptable limit at the end of storage. Water activity, TVB-N and total plate count of the control sample (peeled shrimp blanched in boiling water) was the highest at the end of 105 days. There were no significant variations between the biochemical and microbial quality parameters of pre-blanch peeled and post-blanch peeled shrimp., however, the color, appearance and rehydration properties of post-blanch peeled shrimp was better than pre-blanch peeled shrimp.

### Tetracycline resistance potential of heterotrophic bacteria recovered from finfish aquaculture system

A total of 261 tetracycline resistant bacteria ($tet^R$) were recovered from twenty-four finfish ponds of Andhra Pradesh. High tetracycline resistant bacteria ($tet^{HR}$) (n=30) that were resistant to tetracycline concentrations ranging between 128 $\mu gmL^{-1}$ and 1024 $\mu gmL^{-1}$ were




*tet genes detected in this study.
# tet genes previously reported but not detected in this study
$ tet genes previously reported but not tested in this study

predominantly *Lactococcus garvieae* followed by *Enterobacter spp., Lactococcus lactis, Enterobacter hormaechei, Staphylococcus arlettae, Streptococcus lutetiensis, Staphylococcus spp., Brevundimonas faecalis, Exiguobacterium profundum, Lysinibacillus spp., Stutzerimonas stutzeri, Enterobacter cloacae* and *Lactococcus taiwanensis*. *Tet(A)* (67%) was the predominant resistance gene in $tet^R$ followed by *tet(L), tet(S), tet(K) and tet(M)* The $tet^R$ bacteria showed higher cross-resistance to furazolidone (100%) followed by co-trimoxazole (47.5%) and enrofloxacin (11%). This study underlines the constructive interventions to be implemented for the control of tetracycline resistant bacteria in fish ponds.

### Incidence, biofilm forming ability of *Staphylococcus aureus* from farmed *Penaeus vannamei* shrimp and their response to plant essential oils

Out of 52 samples (n=26 from retail markets of Visakhapatnam; n=26 from culture ponds) tested, 5.76% of the samples harbored CoPS and 94.2% samples contained CoNS. In total, 11.5% of the test isolates (n=52) were confirmed as *Staphylococcus aureus*. The study found that 16/26 (61.53%) of farm isolates and 23/26 (88.46%) of retail markets showed biofilm formation capability. Among the essential oils tested, thyme oil showed superior activity against the CoPS and CoNS recovered in this study. The presence of CoPS & CoNS in shrimps of farmed and retail markets indicates high risk to shrimp handlers and consumers.

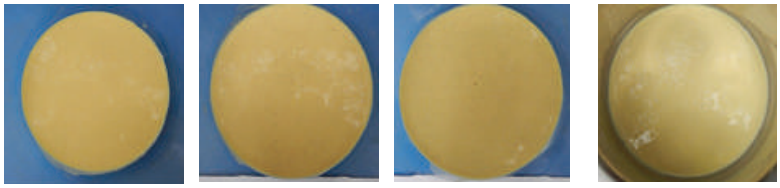
### Reduction in *E. coli* counts in shrimp exposed to bacteriophage cocktail

The ability of bacteriophage cocktail to reduce the *E. coli* counts was assessed by dipping the spiked shrimp in 3 levels of coliphage cocktail solutions viz., MOI-10, MOI-100 and MOI-1000. The *E. coli* counts of spiked-shrimp decreased by 83%, 91% and 94% after 10 min exposure to bacteriophage cocktail at MOI-10, MOI-100 and MOI-1000, respectively.

## 2. Interventions for ensuring diversity and quality of products from aquatic resources of East Coast through innovative technologies

**Millet based batter formulation for coated seafood products**

A study was conducted to evaluate the performance of millet flour for replacing all-purpose flour in conventional batter. Pearl millet flour, little millet flour and Jowar millet flour were chosen for the study. Batter was prepared following the standard recipe of CIFT by replacing the quantity of maida with 20%, 30% and 50% millet flour. Fish nuggets from Nile tilapia was prepared and battered and breaded using the modified batter. The coating characteristics of the modified batter and proximate composition of the products were compared with that of conventional batter. The coating pick up of the product with little millet and jowar millet incorporated batter was comparable to that of conventional batter (43.9%), where as that of pearl millet was lesser than control (38-42%). Cooking yield of millet incorporated battered product was higher (27-34%) than that of conventionally battered product (25%). Replacement of maida with millet flour significantly increased the protein content of the final product (battered, breaded and fried product). However, incorporation of millet flour especially, pearl millet followed by jowar millet increased the fat content after frying.



Little millet batter | Jowar millet batter | Pearl millet batter | Convention batter

Nuggets coated with millet batter

UV-C light treatment for dried fishes

***Effect of UV-C radiation on the microbial and biochemical qualities of dried fish***

Sciaenid fish in butterfly style was salt dried to a moisture content of approximately 30%. The dried fish were exposed to UV-C light (254 nm) in a laminar flow chamber for 20 min (T1) and 30 min (T2), respectively. There was a significant effect of UV-C treatment on the biochemical and microbial spoilage indices of the dried fish during storage. TVB-N increased from 19.32 to 39.02 mg% in control sample, but in T1 and T2, the TVB-N content increased to 28-29 mg% after 5 months storage. Similarly sharp increase in TMA-N was observed in control sample compared to UV treated samples (9.66 to 29.2 mg%). On the other hand, TBARS content was slightly higher in T1 (0.882 mg MDA/Kg) and T2 (0.893 mg MDA/Kg) compared to control (0.782 mg MDA/Kg). The TPC values were lower in T2 (19,000 cfu/g) compared to T1 (80,000 cfu/g) and control fish (1,80,000 cfu/g) after 5 months. The total yeast mould count after 5 months of storage was 1,56,000 cfu/g in control fish, 2300 cfu/g in T1 fish but only 100 cfu/g in T2 fish samples The microbial analysis indicated that exposure to 30 minutes of UV-C light (T2) has resulted in an initial reduction in total plate count (TPC) and Yeast and Mold counts. Overall,

the results indicated that exposing dried fish to ultraviolet radiation for a minimum period of 30 minutes is useful in reducing the bacterial and fungal loads and spoilage.

***Shelf life assessment of phosphate treated and non-treated frozen stored P. vannamei shrimp***

A study was initiated in collaboration with a leading seafood processing plant in Visakhapatnam to assess the shelf life of frozen stored *P.vannamei* shrimp. For the study, PD tail on vannamei shrimp (31-40 count) was selected, with and without phosphate treatment. The samples were frozen by IOF freezer in the processing plant and stored in the cold store (-18$^0$C). The treated and non-treated frozen shrimps was analysed at 2 months interval. After 4 months frozen storage, significant variations were observed in physicochemical parameters of the treated and non-treated samples. Phosphate treated shrimp had higher moisture content (83%) than the non-treated shrimp (80.5%). Water holding capacity of treated samples was markedly higher than non-treated samples where as a reverse trend was observed for drip loss and cooking loss. Lightness value ($L*$) of raw and cooked treated shrimps was higher than that of control shrimps, but the control shrimp after cooking had significantly higher redness value ($a*$) than the phosphate treated shrimps.

***Effect of temperature on the osmo-dehydration of Tilapia fillets***

Tilapia fillets were osmo-dehydrated in 40% glycerol containing 10% salt for 3 h at different temperatures (4°C, room temperature, 40°C and 50°C). Moisture content was reduced from initial 81% to 71.48, 66.66, 63.75 and 61.48% in the fishes osmodehydrated at 4°C, room temperature, 40°C and 50°C, respectively. The water activity was reduced to 0.912 at 40°C, but the fillets treated at 40°C was more sensory acceptable than those treated at 50°C.

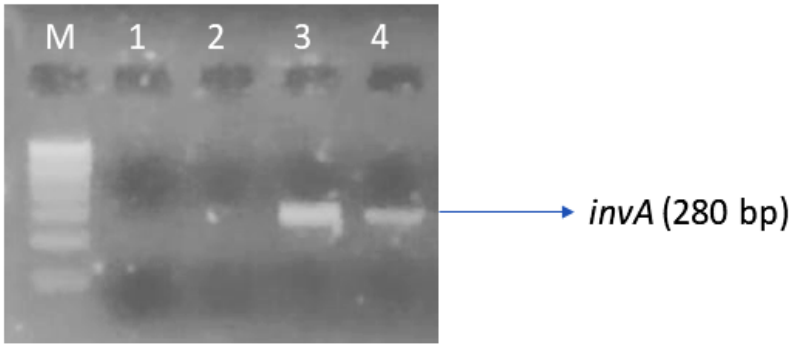
***Production of fish sauce from Mahi mahi fillet frame waste***

A process was developed to prepare fish sauce from the fillet frame waste of mahi mahi fish. Chemical properties such total nitrogen, formaldehyde nitrogen, ammonia nitrogen, amino nitrogen, NaCl content etc. and physical properties (colour, nonenzymatic browning and acceptability testing) of fish sauce from Mahi mahi frame were analysed. The total nitrogen content of sample increased with increasing fermentation time (9.25 mgN/100 ml during 1$^{st}$ week to 19.35 mgN/100 ml during 5$^{th}$ week. Non enzymatic browning of fish sauce was highest at fermentation day 35, suggesting that brown pigment formed during the extended fermentation period.

Fish sauce from Mahi fillet frame waste

**Incidence of *Salmonella spp.* in retail fish markets**

A study was undertaken to isolate and characterize *Salmonella* spp., from fish and shellfish samples collected from retail markets of Andhra Pradesh. The isolation of *Salmonella* spp., from fish and shellfish was initially standardized following USFDA-BAM. A total of 12 fish samples and 18 shrimps collected from Visakhapatnam was investigated for *Salmonella* spp. PCR amplification of *invA* gene revealed that two out of 30 samples were positive for *Salmonella* spp.




PCR amplification of *invA* (280 bp) for confirmation of *Salmonella spp.*
(Lane M:100 bp; Lane 1-negative control, Lane 2,3,4- test isolates

## 3. Development of Smart trawl systems for the North East maritime states of India

**Designing of six seam shrimp trawls**

New shrimp trawls, ranging from 20 m to 28 m, were designed based on a survey of prevailing gear in Andhra Pradesh. The 27.4 m two-panel six-seam shrimp trawl featured webbing made of 0.85 mm twisted polyethylene twine with a 60 mm mesh size. The 20 m four-seam shrimp trawl, used in mini and large trawlers, had a net crafted with 1.5 mm polyethylene twine and 80 meshes in each upper and lower wing panel. Additionally, a 28 m semi-pelagic trawl was designed for 15.5 m wooden trawlers on the North East coast, along with finalized designs for 28 m and 30 m four-seam resource-specific anchovy and fish trawls. These new trawls aim to meet the demands of different fishing scenarios, including targeting anchovies with their specific gear requirements.

**Survey of existing trawl systems in Andhra Pradesh and Odisha**

A field survey was carried out in different districts in Andhra Pradesh and Odisha to assess the specifications of trawlers, trawls, accessories, and the challenges encountered by fishermen during trawling. The Visakhapatnam survey revealed trawl boats with OAL ranging from 10 to 16 meters, equipped with engines from 98 to 280 Hp. For an 11 m OAL boat with a 102 Hp engine, the average trip duration was 8 days, with 5-6 operations/day, consuming 1400-1600 liters of diesel. Kakinada's survey revealed trawl boats with an OAL of 10-16 m and engines ranging from 98-280 Hp. Otter boards, mostly rectangle, weigh 70-115 Kg, with a unique 130 Kg V-slotted steel otter board. Trips last for 8 days, with 4-5 daily operations using 3000-3500 liters of diesel. Trawl boats in Nizampatnam had an overall length (OAL) ranging from 10 to 17 meters, powered by engines with 104 to 280 Hp. Steel V-form slotted otter boards, weighing 100-150 kgs, are commonly used. For 10-meter OAL boats with 104 Hp engines, the average trip duration was 7 days, involving 5-6 operations per day and consuming 1400-1600 liters of diesel. Challenges in trawl fishing in Andhra Pradesh include net entanglement, reduced durability, trash fish catch, otter board damage, winch movement challenges, marine fouling, communication issues, net tearing, grading difficulties, knot tightening, foot rope damage, and float wrinkling. In Odisha, the trawl fishing operations faced challenges such as net cutting, brittleness, waste catch, increased fuel consumption, GPS location issues, communication difficulties during storms, net recovery problems, extended grading time leading to fish spoilage, low durability of nets and otter boards, extended operation times, reduced catch, and chain breakage.

# Veraval Research Centre of ICAR-CIFT

## *Institute Project*

Harvest and post-harvest interventions in marine resources available along Saurashtra coast1.

## *Most Significant Achievements*

- Hazard identification and health risk in terms of heavy metals were evaluated in elasmobranch including shark and guitar fish landed at Saurashtra coast
- Standardized method for value addition of low value Ariid cat fish *(Plicofollis dussumieri)* of Saurashtra coast
- Optimized the method for extraction of β-chitin from squid pen for the utilization of squid waste generated along Saurashtra coast

## CHIEF FINDINGS

# 1. Harvest and post-harvest interventions in marine resources available along Saurashtra coast

**Development of cold smoked and smoke-dried products from fishes of Gujarat**

Conducted thermal validation studies for hot-smoked Ariid catfish which was further chilled stored under vacuum packaging. Thermal validation studies for hot-smoked and chilled Ariid catfish (with precooking followed by smoking) reached cumulative F-value of 1 with reference temperatures (at 63 °C and 72°C) considering 6 log reduction of *L. monocytogenes*.

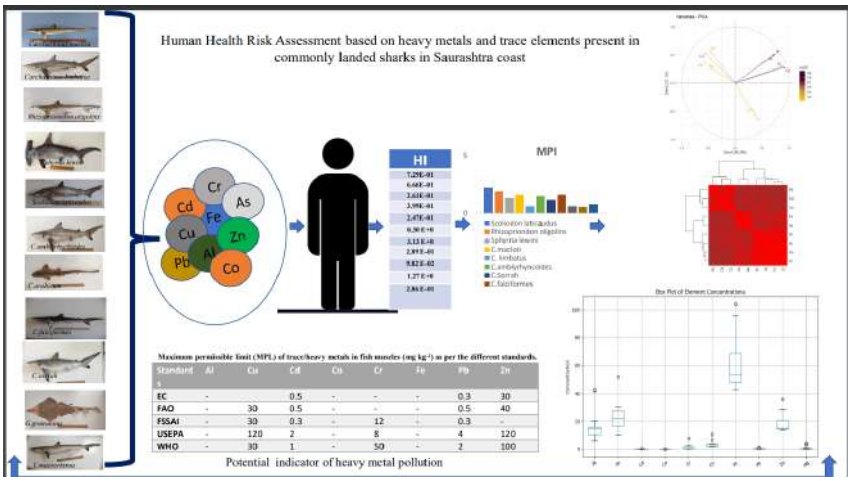
Analysis of the shelf-life of hot-smoked Ariid catfish in chilled condition under vacuum packaging was done. Changes in the quality of hot-smoked Ariid catfish were determined just after smoking and during chilled storage in vacuum packaging. During analysis it was found that hot smoked catfish samples were unfit for human consumption by 28$^{th}$ day according to microbiological and sensory analysis. There was no significant difference in shelf life between samples processed at 63 °C and 72°C.

**Drying and lamination of Bombay duck**

Extended need based technical support for drying and lamination of Bombay duck to the fisher firm of Jafrabad, Gujarat (M/S Jafrabad, Gujarat).

**Utilization of industrial generated squid pen waste**

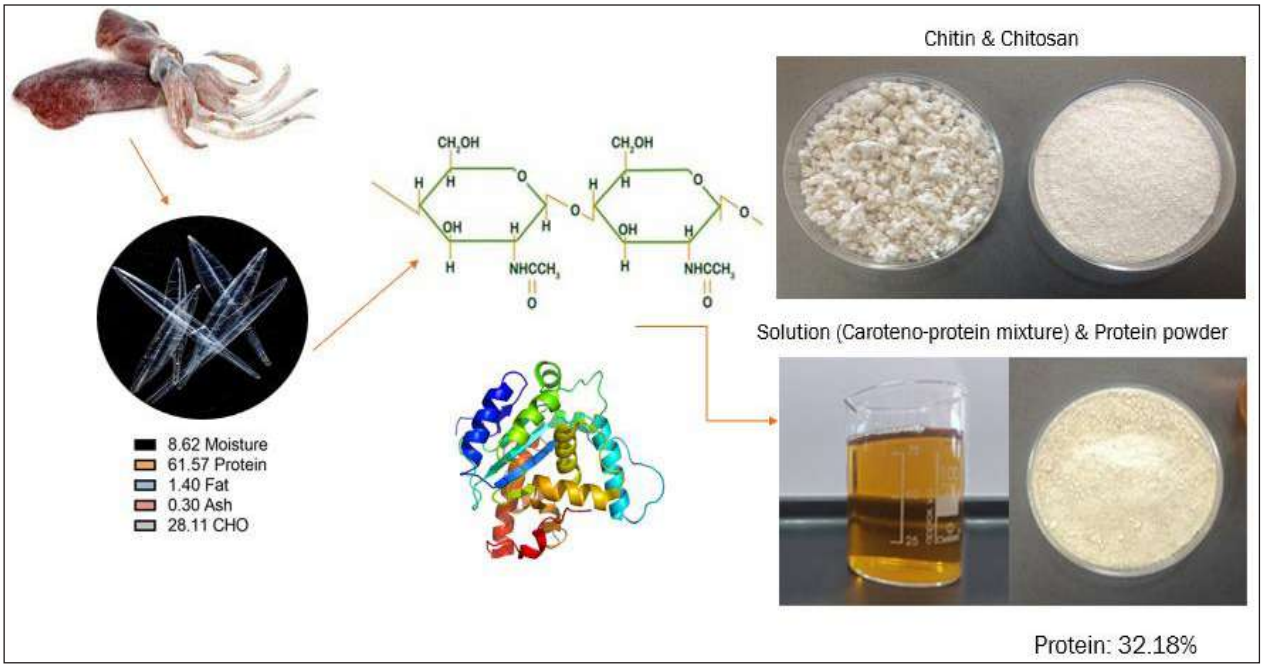
Squid pen was utilized for the extraction of chitin-chitosan and the residual water after chitin extraction was used for the extraction of protein. β-chitin extraction was tried out with different extraction methods like hot and cold at different time and temperature combinations. The modified cold extraction protocol was found to be better when compared to hot extraction. An average yield of 32-34% in chitin extraction and




Fish mineralogy for heavy metals and trace element

Pretreated catfish before smoke drying

Smoke dried catfish




Extraction of Chitin and chitosan from squid pen & recovery of the caroteno protein after extraction

25-28% chitosan extraction was observed. A maximum 90-92% degree of deacetylation (DDA) was observed in cold extracted chitin samples. XRD analysis exhibit three diffraction peaks at 8.5, 19.9 and 26.4 showed the crystalline nature of the polymer. FTIR results showed similar peaks in squid pen chitosan with different functional groups of organic as in normal chitosan.

Millet fish based muffins and cookies

**Formulation and preparation of millet-fish based cookies**

Conventionally used flours were replaced with Jowar and little millet powders, thereby can achieve an average reduction of 50% of gluten content in biscuits. Products observed to have good sensory acceptance and shelf life.

**Occurrence and characterization of Shiga toxin-producing *Escherichia coli* from seafood from Veraval, Gujarat**

Around 170 isolates of Shiga Toxin-Producing *E. coli* were isolated from 60 seafood samples. All the isolates were tested for the Shiga toxin-producing genes i.e stx1 & amp; stx2 Out of 170 isolates, 25 were positive for the stx1 gene and 29 samples were positive for the stx2 gene. Five percent of the isolates were positive for *eae*A & *hly*A. Serological test has shown the incidence of *E. coli* O157:H7 strain which is a major foodborne pathogen causing severe disease in humans worldwide.

**Survey on different fishing practices along the South Gujarat coast**

Data was collected from artisanal hook and line fishing from Veraval harbour by small boat (12m $L_{OA}$; 8-9 Hp engine) and measured the length-weight of fish caught. *Lethrinus* spp. formed the major catch followed by grouper and catfish etc.

Data on oceanic squid catch in deep-sea gillnets were also collected from the fishing vessels operated from Veraval harbour and it was found that the oceanic squid *Sthenoteuthis oualaniensis* were caught on the gillnets when they pray on tuna caught in the gillnets.

Catch data of squids using lights has been collected from Jaleshwar, Gujarat. It was found that the LED bulb has been replaced by metal halide lamb for more efficiency in terms of catch and fuel saving.

Catch data from artisanal gillnets operated off-Veraval coast was collected from the Jaleshwar landing centre. It was noted that unusual heavy landing of Indian mackerel *Rastrelliger kanagurta* along the Saurashtra coast. They used 55-60 mm monofilament gillnet to catch the mackerel shoal; the average catch per boat was 700-1000 kg/day.

Deep sea gillnet catch analysis

Survey on existing trap fishing along the South Gujarat coast

# Mumbai Research Centre of ICAR-CIFT

## *Institute Project*

Assessment of fish harvest and post-harvest technological aspects and mitigation measures for problems with special reference to Maharashtra

### *Most Significant Achievements*

- Blood clam exudate (CBE) powder was developed
- Recipe for Ready to Cook (RTC) Blood clam cutlet was standardized

## CHIEF FINDINGS

# 1. Assessment of fish harvest and post-harvest technological aspects and mitigation measures for problems with special reference to Maharashtra

**Development of Blood Clam Exudate (CBE) powder: a supplement for addressing Undernutrition and Micronutrient Malnutrition/Hidden Hunger**

Blood clam (*Anadorra granosa*) exudate, a red color liquid, collected during shucking of the clams was freeze-dried to obtain a powder rich in protein and minerals. The nutritional profile of the CBE powder showed percentage protein, fat, ash and moisture content of 72.2, 2.43, 18.42 and 7.1% respectively.

CBE powder was found to be rich in trace elements like iron, zinc, selenium etc and hence can find use as a supplement for addressing micronutrient malnutrition or hidden hunger.

Heavy metal content was assayed by ICP-OES as part of risk assessment of the product. Hg was not detected in any of the samples, while As, Cd, Cr, Pb were found to be present within legally permissible limits as prescribed by FSSAI, USFDA and EU.

Locally available clam species _Anadara granosa (Blood clam, 'Khube')

Fresh clams meat

Clam blood for CBE powder development

Clam Blood Exudate Powder

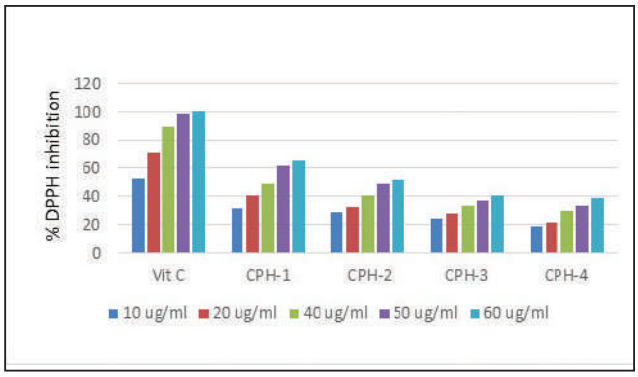
**Feeding trials of the CBE powder in animal experiments**

3 groups of rats – control, test-1 and test 2; control group rats were fed with normal laboratory rat diet whereas group 2 & 3 rats were supplemented with CBE powder- 42.8 µg/rat/day and 85.6 µg/rat/day respectively. There was uniform weight gain as recorded every week in all groups of rats indicating that the CBE powder did not have any adverse effect on the growth of rats. Organ weight (liver, heart and kidney) did not vary significantly between the control and the test groups

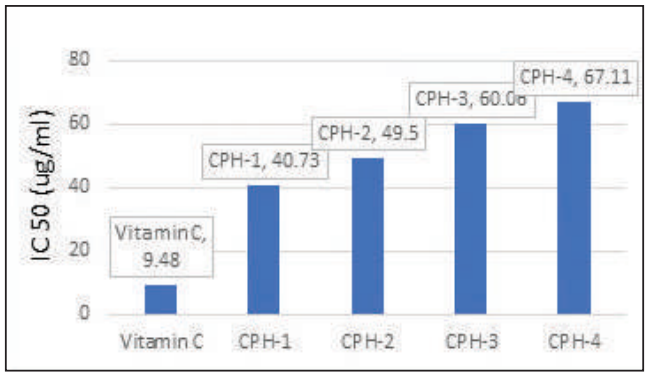
**Enzymatic hydrolysis of blood clam meat**

Blood clam meat hydrolysate was developed by digestion with Protease from *Aspergillus oryzae*. Steamed clam meat was defatted and dried to obtain clam protein powder and was used for hydrolysis at pH optimum of 7.5 at 37°C for 60 min. Yield of hydrolysate obtained was 8.2%. The hydrolysate was fractionated using ultra filtration discs MW cut off 10 KDa, 3 KDa and 1 KDa. Antioxidant activity in all fractions was determined by DPPH free radical scavenging assay.

The fraction which was less than 1 KDa had the lowest IC50 which indicates that CPH-1 had the most effective antioxidant capacity among all 4 fractions.



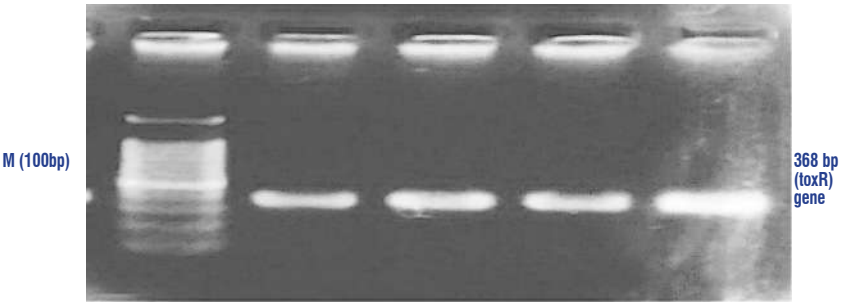

DPPH free radical scavengingactivitity of different clam protein hydrolysate fractions Vs Vitamin C




DPPH free radical scavenging Assay

**Isolation and characterization of foodborne pathogens from seafood and aquatic environments of Maharashtra**

Antibiogram profiling of 43 strains of *E.coli* isolated from fresh seafood of Mumbai region was conducted by disc diffusion assay on Mueller Hinten agar (BD and Difco, USA) against 17 antibiotics and in this study, high level of antibiotic resistance was exhibited by the *E. coli* isolates against Ampicillin (88.3%, n=38), Azithromycin (74.4%, n=32), Gentamycin (62.7%, n=27), Co-trimoxazole (60.4%, n=26), Chloramphenicol (53.5%, n=23), Tetracycline (41.8%, n=18), Nitrofurantoin (37.2%, n=16), Ciprofloxacin (32.6%, n=14), Cefpodoxime (30.23 %, n=13), Aztreonam (25.6%, n=11). Out of 23 gentamicin resistant isolates of *E. coli* 65.21% (n=15) exhibited resistance up to 256 µg/ml; while 4.3% (n=1) and 8.6% (n=2) exhibited MIC value of 32 µg/ml and 16 µg/ml respectively.



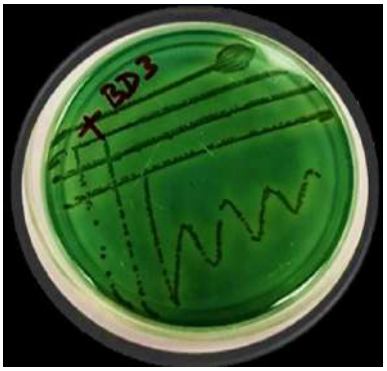

Molecular detection of *V. parahaemolyticus*

**Microbiological quality assessment of fish and fisheries products purchased online from Maharashtra**

Total of 20 samples of fish and fisheries products purchased through online app from Maharashtra were analysed for microbial quality TPC/gm range was $1.84x10^5$-$2.24x10^6$, *Vibrio cholerae* was present in three samples and *V. parahaemolyticus* in nine samples.

**Utilization of the blood clam shell**

The calcined blood clam shell was subjected to ICP and heavy metal analysis. The mineral analysis showned higher concentration of Ca (2603 ppm), K (4704 ppm), P (8926 ppm), Mg (2164 ppm), Fe (1858 ppm) and lesser concentration of heavy metals [Cd (4.657 ppm), Pb (0.3698 ppm), Hg -0.08227 ppm), As (1.918 ppm), Cr (3.389 ppm)] analysis.




Green colony of *V.Parahaemolyticus* on TCBS agar plate

Blood clam shells before treatment

Calcined blood clam shells

**Standardization of recipe for Ready to Cook (RTC) blood clam cutlet**

Live blood clam procured was steamed to collect the clam meat. Clam cutlet recipe was standardized by incorporating steam cooked clam along with other ingredients such as potato, onion, green chilly, ginger, garlic etc. Clam meat along with other ingredients was mixed to make the base of the culet which was then battered and breaded. The breaded product was fried to get the final product.

Ready to cook Blood clam cutlet

**Documentation of fishing techniques and associated challenges in fishing sector of selected sites of Maharashtra**

The study in Maharashtra, encompassing eight strategic locations including key sites like Sasson Dock and Versova in Mumbai, was conducted with a rigorous scientific approach. Methodologically, it entailed biweekly surveys to systematically document diverse fishing practices, gear types, and operational parameters. The findings revealed a heterogeneous array of fishing methods, ranging from traditional gill nets to modern purse seines and trawls. A significant observation was the transition towards sustainable materials like fiber-reinforced polymer in smaller vessels, underscoring an evolving environmental consciousness in the sector.

The study also critically identified key challenges such as rising fuel costs and the inefficiency in catch rates, high bycatch rates in dolnets and low catch efficiency in gill nets pointing to an urgent need for innovation and technological advancement in fishing practices. The regional variability, from urbanized ports to tribal-dominated reservoirs, highlighted the complex and adaptive nature of fishing practices in Maharashtra.

**Experimental trials of four different designs of modified dolnets (bag nets)**

To reduce the bycatch percentage and reduce the mortality rate in unintentional catch fishes. Square mesh and double cod end structure of dolnets were designed, fabricated and experimental trials were conducted at Karanja Creek in Raigad district of Maharashtra. The result showed a positive sign in the reduction of mortality of unintentionally.

Experimental trials of modified dolnets operation at Karanja Creek

Purse seine net mending operation at Alibag, Raigad District, Maharashtra

# Externally Funded Research Projects

## *International Projects*

1. FOOD, GENDER, ENTERPRISE: LEVERAGING INTERDISCIPLINARY FOR SUSTAINABLE SMALL-SCALE FISHERIES
2. FUTURE REFRIGERATION INDIA: INDEE+
3. ESTABLISHING VALUE CHAIN FOR FISH: TOWARDS NUTRITIONAL SECURITY FOR RURAL POPULATION
4. TRANSFORMING AGRI-FOOD SYSTEMS IN SOUTH ASIA (TAFSSA)

## National Projects

5. ZONAL TECHNOLOGY MANAGEMENT CENTRE (ZTM-NAIF)
6. AGRIBUSINESS INCUBATION (ABI-NAIF)
7. ALL INDIA NETWORK PROJECT ON FISH HEALTH
8. NETWORK PROGRAMME ON ASSESSMENT OF ANTIMICROBIAL RESISTANCE (AMR) IN MICROORGANISMS ASSOCIATED WITH FISHERIES AND AQUACULTURE IN INDIA
9. PRODUCTION SYSTEMS, AGRIBUSINESS AND INSTITUTIONS", COMPONENT- 1 "IMPACT OF AGRICULTURAL TECHNOLOGY- FISHERY TECHNOLOGY
10. A DETAILED FOODOMICS STUDY FOR FOOD AUTHENTICATION AND EXPLORATION OF NUTRACEUTICAL POTENTIAL
11. GREEN, CLEAN AND AFFORDABLE ENERGY FOR FISHERMEN COMMUNITY: DEVELOPMENT OF A MULTIPURPOSE SOLAR THERMAL CONVERSION SYSTEM WITH GASIFIER/BIOMASS HEATER BACKUP
12. DEVELOPMENT OF A FOLDABLE SMART LIVE FISH TRANSPORTATION SYSTEM FOR DISTANT TRADE OF TABLE FISH
13. DEVELOPMENT OF MILLET-BASED NOVEL READY-TO-EAT (RTE) SMART FUNCTIONAL FOODS FORTIFIED WITH FISH PROTEIN AND LIPID FOR ENTREPRENEURSHIP DEVELOPMENT IN THE STATE OF KERALA
14. DEVELOPING A BIOREFINERY WORKFLOW FOR HIGH VALUE NUTRACEUTICALS FROM SEAWEED BY GREEN CHEMISTRY APPROACH
15. FSSAI-NATIONAL REFERENCE LABORATORY
16. NETSCOFAN
17. NATIONAL SURVEILLANCE PROGRAMME FOR AQUATIC ANIMAL DISEASES – PHASE II
18. DEVELOPMENT & POPULARIZATION OF FUEL-EFFICIENT LONG-LASTING OTTER BOARDS FOR GREENING THE TRAWL FISHING SECTOR IN INDIA
19. PILOT SCALE IMPLEMENTATION SMART PACKAGING TECHNOLOGY FISH FRESHNESS INDICATOR AT FIELD LEVEL TO ENHANCE DOMESTIC FISH CONSUMPTION
20. THE PILOT-SCALE DEMONSTRATION OF SEAWEED BASED FEED PRODUCTION FOR FISH AND SHRIMP
21. MARINE MAMMAL STOCK ASSESSMENT IN INDIA
22. FINE TUNING OF CIFT-TED FOR ADOPTION IN THE TRAWL FISHERIES FOR CERTIFICATION OF MARINE SHRIMP HARVESTED FROM INDIA
23. DEPLOYMENT AND MAINTENANCE OF WAVE RIDER BUOY OFF VERAVAL AND DEVELOPMENT OF JELLYFISH AND SARDINE ADVISORIES
24. MATRIX SPECIFIC PHAGE FORMULATIONS FOR THE BIO-CONTROL OF ENTEROTOXIGENIC METHICILLIN SENSITIVE AND RESISTANT *STAPHYLOCOCCUS AUREUS* OF SAFETY CONCERN
25. DEVELOPMENT OF PORTABLE FISH FRESHNESS ASSESSMENT SENSOR
26. MARINE FISHERY IN KERALA: A STUDY ON EVOLUTION OF POLICY, COST AND EARNINGS OF FISHING UNITS AND INCOME OF FISHER HOUSEHOLDS
27. REPLACEMENT OF KEROSENE OBM WITH EXPERIMENTAL INBOARD/OUTBOARD DIESEL PROPULSION IN SMALL-SCALE FISHING BOATS OF KERALA

## 1. Food, gender, enterprise: Leveraging interdisciplinary for sustainable small-scale fisheries

*Principal Investigator:* **Dr.Nikita Gopal**

*Funding Agency:* **Royal Academy of Engineering, UK**

**Total Budget: ₹ 25.97 lakhs**

The project adopted innovative approach of combing social science and engineering methodologies to encapsulate the global challenges of biodiversity loss, declining catches, extreme climate events and effects of COVID -19 in small scale fisheries of Kerala, India. Under this project historical fish stock data was analyzed in relation to climate conditions and other environmental indicators. Trend analysis of socio-economic and cultural changes in small- scale fishing over time in Kerala, was performed at *Chellanam*, fishing village of Kerala through detailed interviews and workshops with fishing community members.

The challenges in fishing were high fuel price, damages to fishing nets by dolphins, jelly fish and puffer fish, marne litter monopoly of middlemen and fluctuations in fish prices.

Challenges faced in fish drying by women were poor access to finance to start the business, drudgery, sun burns due to prolonged exposure during open sum drying, product quality issues, limited access to fishing harbour, seasonal changes affecting production and poor waste management.

There has been a gradual decline of women labour in the sector. The educational and economic progress of the fishing community, changes in the perspective of social status, lack of interest, lower wages, drudgery, lack of financial assistance and inadequate technical assistance are the major reasons for decline in women in the sector.

Sensor chamber and the probes used

Foldable fish drying rack -participatory technology development

**Technological interventions**

To understand the water quality characteristics and sea surface conditions, a multipurpose data recorder was developed and was installed onboard the ICAR-CIFT research vessel R.V. Matsyakumari-II. Using GSM-GPRS-based wireless data telemetry, the gadget records data from numerous sensors, saves it on a micro-SD card, and transfers it to a central server. Water temperature, turbidity, dissolved oxygen, and GPS coordinates are monitored by sensors with the use of probes that are embedded into the sensors. A foldable SS fish rack was also designed and developed which was need based and took into consideration the limitations of space and addressed durability challenges.

## 2. Future refrigeration India: INDEE+

*Principal Investigator:* **Dr.George Ninan**

*Funding Agency:* **Norwegian University of Science and Technology (NTNU)**

***Total Budget:* ₹ 80.46 lakhs**

- Successfully commissioned a high-efficiency cooling system utilizing environmentally friendly natural refrigerants $NH_3/CO_2$ (ammonia/carbon dioxide) cascade system at NAS Fisheries Pvt. Ltd, Kochi, Kerala India which started operations on 9th Dec 2023 with great success on freezing shrimps and cuttlefish delivering cooling at -40°C in an IQF system manufactured and supplied by CF-TECH.
- Investing in advanced $CO_2$ refrigeration technology which will pave the way for the Indian food processing industry to adopt solutions with higher cooling capacity, efficiency in operations and achieving Carbon Neutrality.

## 3. Establishing value chain for fish: Towards nutritional security for rural population

*Principal Investigator:* ***Dr. Suseela Mathew***

*Funding Agency:* **WorldFish, Malaysia**

***Total Budget:* ₹ 125.54 lakhs**

- The project's outcomes position fish-based nutritional supplements as dependable and high-quality sources of essential nutrients, meeting stringent regulatory standards and surpassing consumer expectations.
- The unwavering commitment to quality control, adherence to Good Manufacturing Practices, and the integration of cutting-edge scientific advancements underscore the resilience of the results and the profound potential impact of these supplements on public health and overall well-being.
- The human intervention studies conducted in tribal districts of Wayanad by providing dried fish powder to children at 15 g on daily basis for a period of two months gave positive results with respect to health and nutrition. These supplements on public health and overall well-being. Role of entrepreneurship in development and distribution of products highlights the public-private partnership for the success of effective reach of the products in distant tribal areas.


Foldable fish drying rack -participatory technology development

**Products crafted during the initial trial phase, utilizing dried anchovy powder**

- In Wayanad, Kerala the yearly per capita fish intake was recorded at 12.36 kilograms, suggesting a moderate incorporation of fish in the local diet. On the other hand, Malappuram, Kerala exhibits a significantly higher consumption rate of 31.2 kilograms, indicating a strong preference for fish as a staple in the District's culinary habits. Chamarajanagar, Karnataka closely follows with a per capita consumption of 24.2 kilograms, highlighting the robust inclusion of fish in the region's culinary traditions. Dakshina Kannada, Karnataka with a consumption rate of 17.28 kilograms, reflects a moderate yet noteworthy reliance on fish. Cuttack and Khordha, Odisha with consumption rates of 22.56 and 20.28 kilograms respectively, demonstrated a substantial inclination towards fish in the diets of these districts. Ri Bhoi, Meghalaya displayed a comparatively lower consumption rate of 8.4 kilograms, signifying a lesser dependence on fish in the local cuisine. Finally, West Garo Hills, Meghalaya reports a per capita fish consumption of 12 kilograms, aligning with Wayanad in its moderate reliance on fish.

## 4. Transforming Agri-food Systems in South Asia (TAFSSA)

*Principal Investigator:* **Dr. A. Suresh**

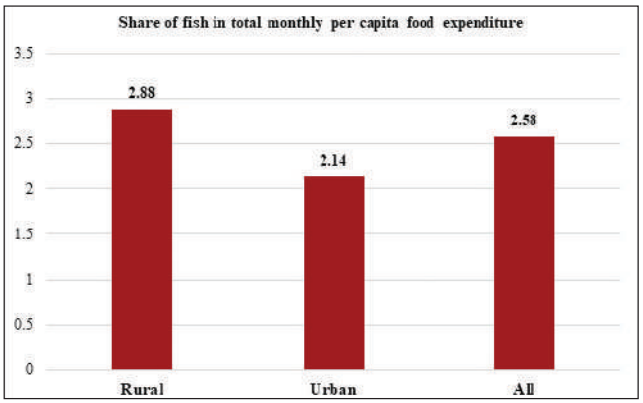
*Funding Agency:* **International Rice Research Institute, Philippines**

***Total Budget: ₹ 10.00 lakhs***

**Fish Consumption Behaviour of Indian Households: Trends and Socio-economic Correlates**

Data from the most recent available data from the 68th round of the consumer expenditure survey (2011-12) was used for this study.

The average monthly per-capita consumption expenditure (MPCE) of fish contributes 2.58 per cent of total food consumption at the national level. There is a positive relationship between income and fish consumption, as indicated by the increasing trend in the quantity and value of fish consumed across higher decile classes of income. The empirical model (logit) reveals a positive relationship between household fish consumption and the age of the head of the household, income level, and the size of the household. The findings imply that household fish consumption decisions significantly correlate with social and economic backgrounds and geographical locations




Source: NSSO, Government of India

# National Projects

## 5. Zonal Technology Management Centre (ZTM-NAIF)

*Principal Investigator:* **Dr. C. O. Mohan**

*Funding Agency:* ICAR

***Total Budget: ₹ 21.3 lakhs***

Details given in page: 147

## 6. Agribusiness Incubation (ABI-NAIF)

*Principal Investigator:* **Dr. C. O. Mohan**

*Funding Agency:* ICAR

***Total Budget: ₹ 35.6 lakhs***

Details given in page: 147

## 7. All India Network Project on Fish Health

*Principal Investigator:* **Dr. Ranjit Kumar Nadella**

*Funding Agency:* **ICAR**

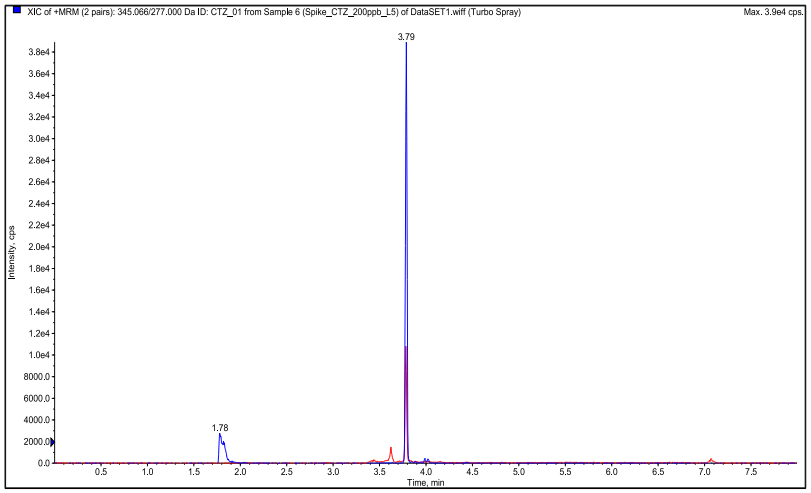
***Total Budget: ₹ 25.00 lakhs***

**Validation of Clotrimazole residue in fish using AB Sciex 4000 QTRAP LC-MS/M**

Clotrimazole is a medication belonging to the imidazole group that is used to treat and manage fungal infections. QuEChERS and QTRAP liquid chromatography tandem mass spectrometry (LC/MS/MS) were used to create the residue analysis of Clotrimazole in fish matrix. EU 2021/808 requirements were followed in the optimization and validation of the developed extraction process. Equipped with linear calibration curves of correlation coefficients r≥ 0.99, the method exhibited good stability and accuracy. At 100 µg/kg, the recovery (%, n = 18) was 95.36 ± 3.83, with an inter-day precision (% RSD, n = 18) of 4.02%.

**Evaluation of various drug residues in samples provided by project-partnering centers (CIBA, CIFA, CIFE, CMFRI, CIFRI, DCFR, WBUFAS, NAU)**

Different antibiotic drug residues viz., Clotrimazole, florfenicol and its amine, Emamectin, Oxytetracycline Enrofloxacin (as sum of enrofloxacin and ciprofloxacin) and Oxolinic acid in fish tissue, gill, bile, plasma, intestine, liver and kidney portions were extracted and analysed using 4000 QTRAP mass spectrometry. Withdrawal and pharmacokinetic analysis of different antimicrobials and anti-parasitic agents in different fish species *Pangasianodon hypophthalmus, Oncorhynchus mykiss, Trachinotus blochii, Oreochromis niloticus, Cyprinus carpio* were carried out. Sample extraction, method development/ standardization for estimation of drug residues and LC-MS/MS data integration were carried out at ICAR-CIFT, Cochin. Using QTRAP mass spectrometry, a total of 1460 treated samples including internal organs were extracted and examined.




Extracted ion chromatogram (XIC) of spiked Clotrimazole at 200 µg/kg concentration from fish

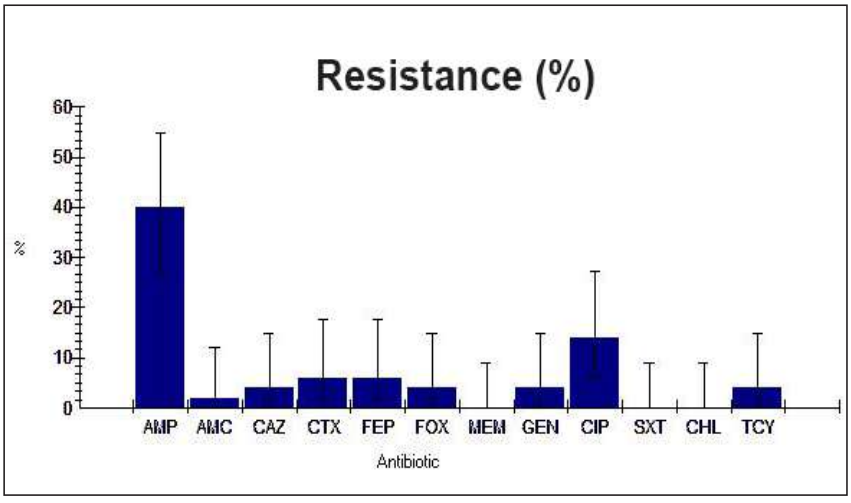
## 8. Network programme on Assessment of Antimicrobial Resistance (AMR) in microorganisms associated with fisheries and aquaculture in India

*Principal Investigator:* **Dr. M.M. Prasad**

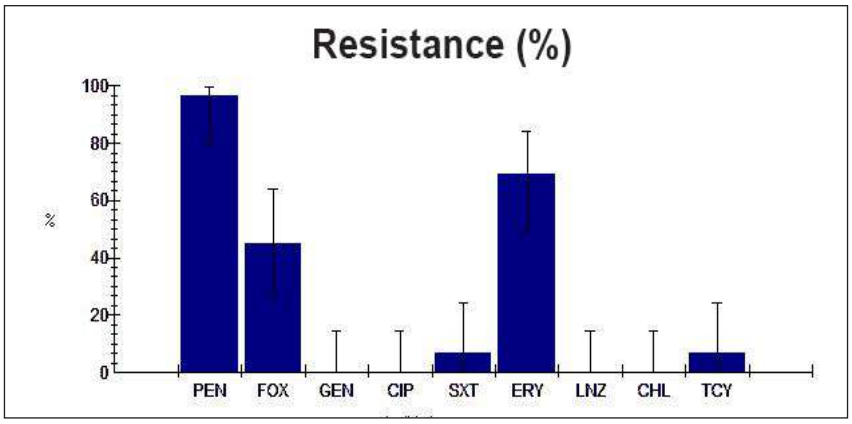
*Funding Agency:* **ICAR**

***Total Budget: ₹ 10.00 lakhs***

- A total of 50 *Penaeus vannamei* samples and 16 water samples from shrimp farms of East Godavari district (n=27) and West Godavari district (n=23) of Andhra Pradesh were screened for antibiotic resistance in *E. coli*, coagulase negative Staphylococci and *Vibrio* spp.
- *E. coli* isolated from farmed *P. vannamei* showed resistance towards Nalidixic Acid (43%), Ciprofloxacin (33%) and cefpodoxime (25%). On similar lines, the *E. coli* isolates from shrimp pond water showed resistance to Nalidixic acid (100%), Ciprofloxacin (50%) and cefpodoxime (50%).




Resistance profile of *Vibrio* spp. isolated from farmed *Penaeus vannamei* procured from shrimp farms of Andhra Pradesh




Resistance profile of S. *aureus isolated* from farmed shrimp from Kerala

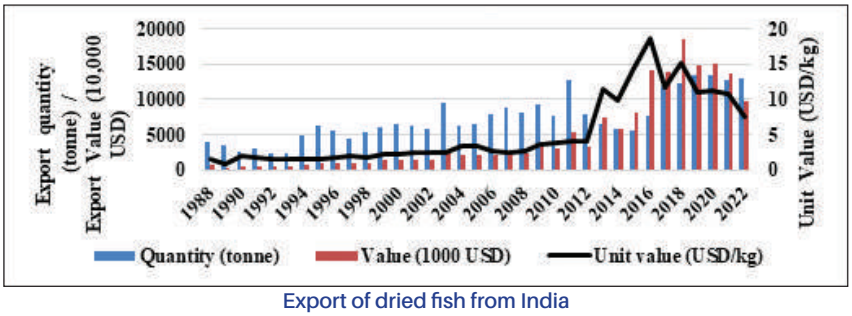
- Coagulase negative Staphylococci (CoNS) isolated from farmed *P. vannamei* shrimp showed resistance towards Penicillin G (74%), Cefoxitin (44%) and Oxacillin (44%). Similarly, the CoNS isolates from pond water showed resistance towards Penicillin G (86%), Cefoxitin (71%) and Oxacillin (71%).
- *Vibrio* spp. were found to resistant only towards Ampicillin (40%) and Ciprofloxacin (14%). *Vibrio* spp. isolated from shrimp pond water showed resistance to Ampicillin (13%).
- In Kerala, out of 29 shrimp aquaculture farms screened during the reporting period, 100%, 51.7%, and 34.8% of the farms harboured Staphylococcus sp., E. coli and Vibrio sp. Cefotaxime resistance was found to be predominant in E. coli. Penicillin and erythromycin resistance were found to be predominant in S. aureus. Ciprofloxacin, Amoxycillin clavulanic acid and cefotaxime resistance were found to be predominant in Vibrio isolates.

## 9. Production systems, Agribusiness and Institutions , component- 1 Impact of Agricultural Technology- Fishery Technology

*Principal Investigator:* **Dr. A. Suresh**

*Funding Agency:* **ICAR-NIAP**

***Total Budget: ₹ 5.18 lakhs***




Export of dried fish from India

**Analysis of dried fish production and exports**

A study was undertaken on the dried fish economy of India. The primary data on dried fish was collected from 4 states- viz. Visakhapatnam (Andhra Pradesh), Veraval (Gujarat), Cochin (Kerala) and Mumbai (Maharashtra) from 25 dried fish making firms following snowball sampling, a non-probability sampling.

The total dried fish production declined from 0.6 million tonnes (mt) in 1999-2000 to 0.5 mt during 2020-21. The export volume surged from 4,056 tonnes in 1995 to 12,908 tonnes in 2022. Correspondingly, the export value increased from US $ 6.3 million to 9.6 million.

The status of dried fish industries in India was analyzed by using data from national agencies. The sun drying fish processing industries has increased in India between 2010-11 and 2015-16.

| | Sun-drying of fish | |
|---|---|---|
| | **2010-11** | **2015-16** |
| Rural | 3540 | 7576 |
| Urban | 529 | 6439 |
| **Total** | **4069** | **14015** |

Estimated number of sun-drying fish processing industries in India under in formal sector, 2010-11 to 2015-16.

## 10. A detailed foodomics study for food authentication and exploration of nutraceutical potential

*Principal Investigator:* **Dr. Niladri Sekhar Chatterjee**

*Funding Agency:* **ICAR-NASF**

***Total Budget: ₹ 84.00 lakhs***

**Chemometric modelling for authentication of seafood**

Chemometric classification models for discriminating various species of squid using high-resolution mass spectrometry-based untargeted lipidomics were developed. Species-specific lipid biomarkers were also identified for accurate squid species discrimination. Additionally, a method for real-time discrimination of shrimp species identity was developed using high-resolution mass spectrometry-based lipidomics (Rapid evaporative ionization mass spectrometry). Different chemometric models based on untargeted lipidomics were established to authenticate the geographical origin of *Litopenaeus vannamei* sourced from different regions. To address the need for rapid and non-destructive food authentication methods, chemometric classification models were developed to detect species mislabeling in economically important shrimp species in India. These models utilize a portable or miniaturized FT-NIR spectral fingerprinting approach.

## 11. Green, clean and affordable energy for fishermen Community: Development of a multipurpose solar thermal conversion system with gasifier/biomass heater backup

*Principal Investigator:* **Dr. Murali S**

*Funding Agency:* **DST, GoI**

***Total Budget: ₹ 24.71 lakhs***

**Techno-economic analysis of multipurpose solar conversion unit**

The economic evaluation was performed for drying 50 kg of shrimp in the solar-gasifier hybrid dryer. The economic analysis was carried out on two aspects *i.e.* life cycle savings and payback period methods. The economic analysis assumed that the hybrid dryer dried shrimp sells at a price comparable to that of a branded product. The annual savings of $10983.06 was observed to be significant for the hybrid mode of operation indicating that the developed solar-gasifier hybrid dryer is economically viable to prepare 12.5 kg of dried shrimp per batch. Also, it obtained the lowest payback period of 0.62 years implying the cost-effectiveness of the solar-gasifier hybrid dryer designed for the shrimp drying process under this study.

Launching of multipurpose solar conversion unit at Chennur, Kadamakudy grama panchayath, Ernakulam

**Installation and demonstration of multipurpose solar conversion unit**

A fisherwoman group under the care of Korampadam Service & Co-Operative (KSC) Bank Limited, Kothad, Ernakulam installed a 50 Kg solar-gasifier hybrid dryer as part of multipurpose solar thermal conversion unit for the production of hygienic and quality dry fish.

## 12. Development of a foldable smart live fish transportation system for distant trade of table fish

*Principal Investigator:* ***Dr. Parvathy U.***

*Funding Agency:* **Department of Science and Technology**

***Total Budget: ₹ 48.77 lakhs***

Cold Anaesthetization of P.vannamei shrimps

Revitalization of P.vannamei shrimps

- Based on the standardization of conditioning procedure for live transportation of *Litopenaeus vannamei,* a prototype for hyperbaric waterless live transportation was developed.
- The standardization procedures for the live transportation of GIFT, focusing on its physiological responses and meat quality was carried out.

## 13. Development of millet-based novel ready-to-eat (RTE) smart functional foods fortified with fish protein and lipid for entrepreneurship development in the state of Kerala

*Principal Investigator:* ***Dr. Bindu J.***

*Funding Agency:* **DST-SHRI**

***Total Budget: ₹ 67.49 lakhs***

- One day workshop on Entrepreneurship development on Aquamillets–Fish and millet-based products for farmers and entrepreneurs was conducted on 01st March, 2024.

## 14. Developing a biorefinery workflow for high value nutraceuticals from seaweed by green chemistry approach

*Principal Investigator:* ***Dr.Lekshmi R.G. Kumar***

*Funding Agency:* **DST-SERB**

***Total Budget: ₹. 39.62 lakhs***

- An extraction condition of temperature - 59.66°C, Pressure-350 bar, Time-158.92 min was optimized for recovering phlorotannins from *Padina gymnospora* using flow rate of $CO_2$: 28g/min, Co-solvent: 2 g/min (6%)
- A high pressure assisted extraction method was developed for obtaining bioactives from *Sargassum polycystum.* A high pressure of 140 bar with water as solvent was used for extraction for a duration of 2 h. A high yield of 30% was recorded with excellent bioactivities.
- The enzyme assisted extraction of *Sargassum polycystum* resulted in an extraction yield varying from *15.64 to 72.63%.* Further studies demonstrated that the extracts demonstrated excellent radical scavenging activity and phenolic contents.

## 15. FSSAI-National Reference Laboratory

*Principal Investigator:* **Dr. Niladri Sekhar Chatterjee**

*Funding Agency:* **FSSAI**

***Total Budget: ₹ 75.00 lakhs***

**Analytical method development and training of the stakeholders**

A multiresidue analytical method for LC-amenable pesticides as per FSSAI regulation for meat and poultry was developed and provided for FSSAI methods manual for pesticide residues. Another multiresidue analytical method for GC-amenable pesticides as per FSSAI regulation for meat and poultry was developed and provided for FSSAI manual for pesticide residues. Under this project, five trainings were organised for FSSAI state food laboratory personnel on Uncertainty measurement, Proficiency testing, Antibiotic residue analysis, Pesticide residue analysis, and Advanced microbiological techniques, with more than 60 beneficiaries.

## 16. NETScoFAN-Food Testing Group

*Principal Investigator:* **Dr. Niladri Sekhar Chatterjee**

*Funding Agency:* **FSSAI**

***Total Budget: ₹ 15.00 lakhs***

**Horizon scanning and database management**

The FSSAI Manual of Methods of Analysis for Fish and Fish Products was prepared and submitted to FSSAI. FSSAI published the manual, which is in the public domain. The Food-'O'-Copoeia portal of FSSR food code was developed for fish and fish products at ICAR-CIFT and is available online. Further, horizon scanning was performed for emerging food safety issues such as food authenticity and risk assessment, and the results have been submitted to FSSAI. The PI has participated in FSSAI scientific panel meetings on "Methods of sampling and analysis" and provided expert opinion on relevant issues. Through this project, we also contributed to the revision of the manual for pesticide residue analysis in various products.

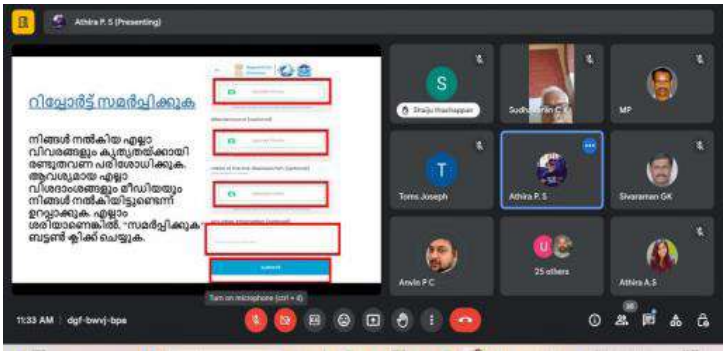
## 17. National surveillance programme for aquatic animal diseases - Phase II

*Principal Investigator:* **Dr. Toms C Joseph**

*Funding Agency:* **DoF, PMMSY, Govt. of India**

***Total Budget: ₹ 47.70 lakhs***

- Actively surveillance of shrimp samples from 230 different farms covering Tamil Nadu, Orissa, Karnataka and Kerala were conducted in collaboration with MPEDA. WSSV, EHP, AHPND, IHHNV, TSV, YHD were screened for all the samples and two samples from Ernakulam were positive for WSSV positive, while rest of the samples were negative for all the pathogens tested.
- 23 tilapia samples collected from the local fish markets were screened for TiPV and TiLV. All the samples were tested negative.




Online awareness programme on ReportFishDiseaseApp

- Several awareness classes and skits were conducted to popularize the Report Fish Disease App among fish farmers, about the new updates and importance of the app in aquaculture.
- Online awareness on Report Fish DiseaseApp given to fish farmers

## 18. Development & popularization of fuel-efficient long-lasting otter boards for greening the trawl fishing sector in India

*Principal Investigator:* **Dr. M.P. Remesan**

*Funding Agency:* **NFDB/PMMSY**

***Total Budget: ₹ 100.09 lakhs***

- Preliminary results of the comparative trials of CIFT-VSOB and Norwegian double slotted otter board revealed that fuel efficiency is slightly better for CIFT-VSOB. Further weight requirement and bridles length were less for the former. Since, CIFT-VSOB was made of IS 2062 steel, service life was expected to be double with minimum maintenance.
- Modified CIFT-VSOB (SS 304 gr) trials are under progress.

Hon. Cabinet Minister of Fisheries, Animal Husbandry and Dairying Shri. Parashottam Rupala distributing CIFT-VSOB in Gujarat during Viksit Bharat Yatra

- The acceptance level of the new design among trawlers was very good and many fishers adopted the design for fabrication and marketing.

## 19. Pilot scale implementation Smart Packaging Technology Fish Freshness Indicator at field level to enhance domestic fish consumption

***Principal Investigator: Dr C. O. Mohan***

*Funding Agency:* **NFDB**

***Total Budget: ₹ 40.50 Lakhs***

- Electrical drying resulted in better yield for red cabbage and anthocyanic content was maximum compared to sun and solar drying methods
- 3D printing based fabrication of freshness indicator holder was developed

## 20. The Pilot-scale demonstration of seaweed based feed production for fish and shrimp

*Principal Investigator:* **Dr. Ashish Kumar Jha**

*Funding Agency:* **NFDB**

***Total Budget: ₹ 36.00 Lakhs***

- Standardized the method of incorporation of seaweed (freshly grind and dried powder) enhancing the protein availability in seaweed for aquafeed
- Developed seaweed extract based foliar spray / plant growth promoter
- Prepared aquafeed using *Sargassum wightii* at 5% incorporation level
- Feeding trials with the seaweed incorporated feed was initiated

Experimental / lab scale demonstration facility created under the project

## 21. Marine mammal stock assessment in India

*Principal Investigator:* **Dr. Prajith K.K.**

*Funding Agency:* **Ministry of Fisheries, Animal Husbandry & Dairying, Department of Fisheries, Govt. of India**

***Total Budget: ₹ 147.20 lakhs***

Extra cover to prevent dolphin bite in trawl

Iron ring and weight, bamboo poles used to deter dolphins from fishing grounds

- Marine mammal fishery interaction was relatively higher on the west coast of India, especially in the states of Kerala, Tamil Nadu, Karnataka and Goa.
- Indo-pacific humpback dolphin, Spinner dolphin, Finless porpoise, Risso dolphin, Indo pacific bottlenose dolphin, common dolphin and whale are the most common species interacting with fishing systems.
- Gillnets and ring scenes are high-risk fishing gears which have more interaction and entanglement probability.
- Use of Dolphin Wall Net (DWN), Feeding dolphins with bait fishes, using coloured twines/mesh, scaring dolphins by jumping into the water, vessel chasses to distract the attention of dolphins, producing sounds from boats avoiding fishing grounds etc. are some of the indigenous methods adopted by the fishers.
- Use of modern mitigation measures, dolphin pingers was reported from location in the state of Kerala.
- The indigenous mitigation measures followed by the fishers are simple and effective and do not cause any harm to the mammals. Fishers were aware of the importance of marine mammals and conservation needs.
- Whale totem was evident in the state of Gujarat.

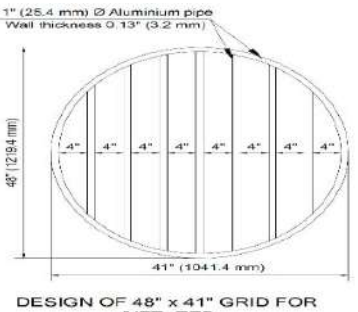
## 22. Fine tuning of CIFT-TED for adoption in the trawl fisheries for certification of marine shrimp harvested from India

*Principal Investigator:* **Dr. M.P. Remesan**

*Funding Agency:* **Marine Products Export Development Authority**

***Total Budget: ₹ 38.95 lakhs***

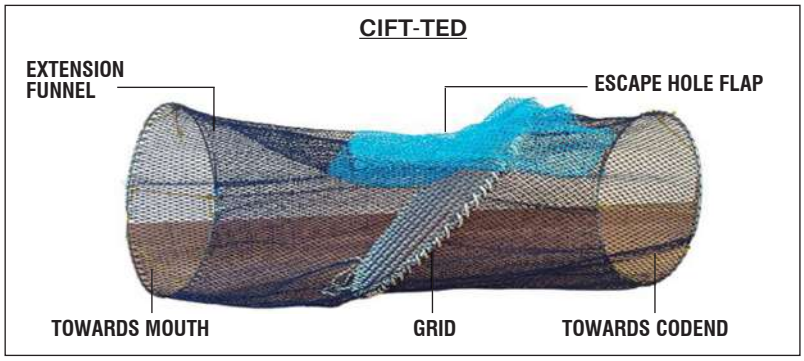
- New grid was fabricated with aluminium pipes 6082 T6 with 1" diameter and 3.2 mm wall thickness through TIG welding.
- HDPE braided netting 40mm mesh size & 2mm twine size was used for grid fabrication of TED extension funnel of size 60x160 mesh. Grid was fixed in the funnel




DESIGN OF 48" x 41" GRID FOR CIFT- TED

Grid for the fine tuned - TED

Photograph showing the trawlnet operation with TED in Mandapam, Tamil Nadu




using polyamide/nylon rope of 10 mm diameter between 50-55 angle. TED opening was made by cutting 45x15 mesh in the funnel in front of the grid. TED cover flap 30x90 mesh was made with HDPE hard twisted webbing of 2.5 mm diameter.

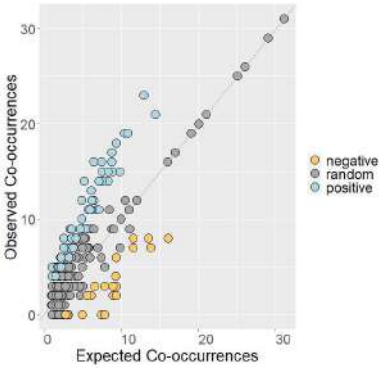
- CIFT-MEDA-TED onboard trials in MK-II revealed that there is no catch loss from trawl fitted with the new TED.
- Trials of CIFT-MPEDA-TED was carried out onboard commercial vessels at Mandapam, Tamil Nadu, Vizag, AP and Dhamra, Orissa.

## 23. Deployment and maintenance of Wave Rider Buoy off Veraval and development of Jellyfish and sardine advisories

*Principal Investigators:* **Dr. Madhu V. R. / Dr. S Chinnadurai**

*Funding Agency:* **(INCOIS- ESSO - INCOIS)**

***Total Budget: ₹ 74.00 lakhs***




Observed - Expected Plot

Interaction workshop with fishers at Chellanam, Ernakulam

***Studies on the abundance of Jellyfishes along Cochin coast***

- Catch rates, composition and seasonal trend in the abundance of jellyfish and other species were studied.
- The highest catch was observed in the month of October (368.9 tonnes per square km).
- The lowest overall catches were observed in the month of July (9.5 tonnes per square km).
- It was observed that the contribution of species other than jellyfish ranged from 51.1% to 70.0% during the months from July to September, however the percentage contribution of commercial fishes to the total catches were only 38.6 and 25.9 percentage respectively during the months of October and November.
- Probabilistic co-occurrence model showed no significant association of jellyfish with any of the species encountered in the catches. However, there were significant correlations between the occurrence of *Leiognatus* sp. and *R. kanagurta* with other species occurring in the catches.
- Interaction workshops were co nducted for the fishers for the uptake of the mobile app for recording the species information. The workshop was conducted on 23-24th February 2023.

Wave rider Buoy- maintenance and re-deployment at Veraval

Experimental onboard Jellyfish surveys, Dec. 2023

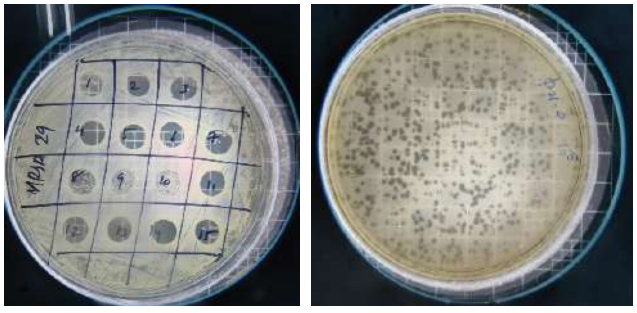
- Experimental onboard jellyfish sampling was conducted off Veraval, Porbander, Okha and Jakhau of Gujarat coast.
- Seasonal Jellyfish swarming was noted along the Saurashtra Coast of Gujarat during the November and December months.
- The Jellyfish *Catostylus perezi* (23%) was found to be associated with crustaceans and juvenile fish.
- The extent of economic loss due to jellyfish bloom was estimated with a structured questionnaire for the trawl fishing sector of India.
- Successfully deployed and maintained the Wave Rider Buoy off Veraval for ocean state forecast.

## 24. Matrix specific phage formulations for the bio-control of enterotoxigenic Methicillin sensitive and resistant *Staphylococcus aureus* of safety concern

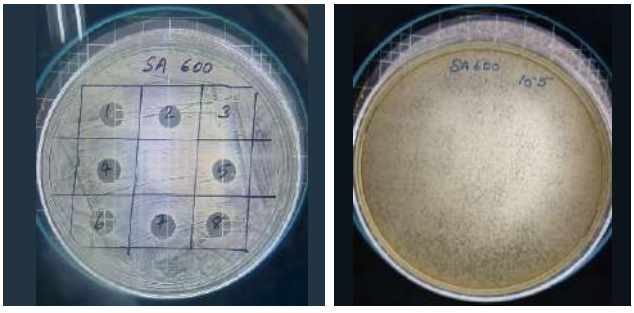
*Principal Investigator:* **Dr. V. Murugadas**

*Funding Agency:* **Board of Research in Nuclear Sciences (BRNS), Department of Atomic Energy (DAE), Govt. of India**

***Total Budget: ₹ 27.54 lakhs***



Host range determination against MRSA host s and plaque purification




Host range determination against MSSA hosts and plaque purification

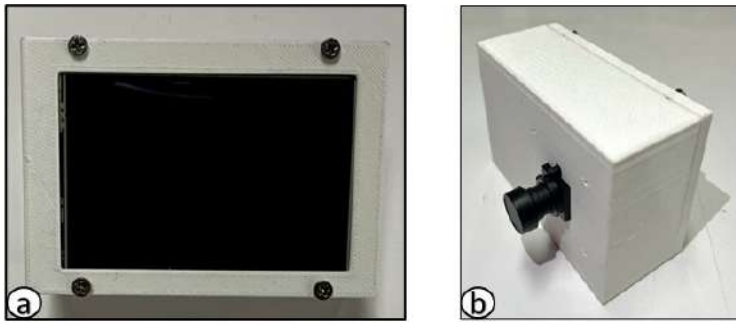
- A total of 103 samples that included river, water from hospitals, dam, canals, ice from market, fish market water samples, backwater samples, and lake samples collected from seven districts of Kerala were screened by modified enrichment process against Methicillin-resistant *Staphylococcus aureus* (MRSA) and Methicillin-sensitive *Staphylococcus aureus* (MSSA) for isolation of lytic phages.
- A modified process for host range analysis of multiple host's enriched MRSA-phage lysate spots was developed. The enriched phage lysates were able to lyse 90% of the MRSA hosts and 71% of the MSSA hosts tested.

## 25. Development of portable fish freshness assessment sensor

*Principal Investigator:* **Dr. George Ninan**

*Funding Agency:* **MoFPI, GoI**

***Total Budget: ₹ 26.00 lakhs***




Device for non-destructive assessment of fish quality and freshness a) Display board b) Camera module

**Non-destructive freshness assessment of Indian Mackerel using Convolutional Neural Network**

Implemented an algorithm capable of grading the freshness of Indian Mackerel fish using Convolutional Neural Networks (CNNs).

The training, validation and test accuracies of the model were 84.5%, 74.72% and 74.28% respectively.

**Long Short-Term Memory-based Regression Approach for Freshness Assessment of Genetically Improved Farmed Tilapia**

Implemented an algorithm which is capable of predicting the shelf-life and freshness of genetically improved farmed tilapia (GIFT) using shape-based feature descriptors and a deep learning technique.

The test results showed that the algorithm with the optimized model exactly predicted the remaining shelf-life and classified the freshness level of fish into Extremely Fresh, Fresh or Spoiled with an average prediction accuracy of 83.21%.

The methodology can be adapted to different fish species and can provide practical solutions to consumers for the freshness assessment of fish.

## 26. Marine fishery in Kerala: A Study on Evolution of Policy, Cost and Earnings of Fishing Units and Income of Fisher Households

*Principal Investigator:* **Dr. A. Suresh**

*Funding Agency:* **Kerala State Planning Board**

***Total Budget: ₹ 62.41 lakhs***

**Institutional analysis in Fisheries Governance through IAD framework**

Coastal fishing is subjected to continuous technological advancements, capital infusion and consequent improvement in fish catch. However, there are concerns of equity and resource sustainability. Various organizations representing different stakeholders have emerged in marine fisheries. The political state responds to these emerging situations by developing policies and guidelines. The evolution of fishery policy in Kerala was examined through institutional analysis and development framework.

**Data collection from fishers on cost and earnings**

Data on cost and earning from fishing vessels from selected harbours in Kerala is being carried out by using structured interview schedule. High frequency data, that records cost and earning of every fishing trip is collected, from 15 harbours/ landing centres. As part of the data collection, training and workshops for enumerators of all the harbors/ landing centers were conducted. Also, awareness meeting regarding data collection were made to the fishers in all the landing centers

Interaction with fishers in Kannur District, Kerala

## 27. Replacement of Kerosene OBM with experimental inboard/Outboard diesel propulsion in small-scale fishing boats of Kerala

*Principal Investigator:* **Dr. M.V. Baiju**

*Funding Agency:* **Department of Fisheries, Kerala**

***Total Budget: ₹ 16.78 lakhs***

Diesel outboard with Z-drive

- The system was developed to solve the fuel crisis due to high price and unavailability of subsidy for kerosene, in the motorized non mechanical boats numbering about 33,950 in Kerala.
- Designed a propulsion system with diesel engine and transmission gear through Z drive system.
- Diesel engine of 58 hp was chosen for the power.
- Assembled this engine with the transmission system. This will replace a combined 25 + 40hp petrol OBM with a high fuel efficiency.

# INSTITUTE BUILDING ACTIVITY

# COLLABORATION WITH OTHER INSTITUTES

## International Institute

- Borlaug Institute for South Asia (BISA), New Delhi
- CODEX Alimentarius Commission, Rome
- Food and Agriculture organization (G), Rome
- Green Climate Fund (GCF), South Korea
- Interdisciplinary Centre of Marine and Environmental Research (CIIMAR), University of Porto, Portugal
- International Rice Research Institute, Philippines
- Leibniz Institute for Agricultural Engineering and Bioeconomy (ATB), Potsdam, Germany
- National Oceanic and Atmospheric Administration (NOAA), Washington, D.C., USA
- Norwegian University of Science and Technology (NTNU), Norway
- Office International des Epizooties (OIE), France
- University of Arts London, UK
- University of Bradford, UK
- University of California, California
- University of Cambridge, UK
- University of Edinburgh, UK
- University of Liverpool, UK
- University of Southampton, UK
- World Federation of Chiropractic (WFC), Malaysia
- World organization for Animal Health, France
- World Wildlife Fund (WWF), India

## National Institutes

- BARC- Babha Atomic Research Centre, Mumbai
- Birla Institute of Technology and Science (BITS), Pilani
- Board of Radiation and Isotope Technology, Navi Mumbai
- Bureau of Indian Standards (BIS), New Delhi
- C-CAMP, Bengaluru
- Central Institute of Fisheries Nautical and Engineering Training (CIFNET), Kochi
- Cochin Shipyard Limited (CSL), Cochin
- CSIR-Indian Institute of Toxicological Research, Lucknow
- Department of Biotechnology, New Delhi
- Entrepreneurship Development Institute (EDII) of India, Ahmedabad
- Export Inspection Agency (EIA), Veraval and Porbandar
- Export Inspection Council (EIC), New Delhi
- Fishery Survey of India (FSI), Kochi
- Food Safety and Standards Authority of India (FSSAI), New Delhi
- Guwahati Medical College and Hospital, Guwahati
- ICAR- Central Institute of Temperate Horticulture, Lucknow
- ICAR- Indian Veterinary Research Institute, Izatnagar, Uttar Pradesh
- ICAR- National Dairy Research Institute, Karnal, Haryana
- ICAR- National Institute of Veterinary Epidemiology and Disease Informatics, Bengaluru
- ICAR- Research Complex for NEH, Umaim
- ICAR Research Complex for NEH Region, Meghalaya
- ICAR-Central Institute of Fisheries Education (CIFE), Mumbai

- ICAR-Central Institute of Freshwater Aquaculture (CIFA), Bhubaneswar
- ICAR-Central Marine Fisheries Research Institute (CMFRI), Kochi
- ICAR-Central Marine Fisheries Research Institute (CMFRI), Veraval
- ICAR-Indian Agricultural Research Institute (IARI), Delhi
- ICAR-National Research Centre for Grapes, Pune, Maharashtra
- ICAR-National Rice Research Institute (NRRI, CRRI), Cuttack
- ICMR-National Institute of Epidemiology, Chennai
- ICMR-National Institute of Virology, Alappuzha Unit, Kerala
- Indian Council of Medical Research, New Delhi
- Indian Institute of Science (IISc), Bangalore
- Indian Institute of Technology (IIT), Delhi
- Indian Institute of Technology (IIT), Hyderabad
- Indian Institute of Technology (IIT), Madras
- Indian Institute of Technology, Gandhinagar
- Indian National Center for Ocean Information Services (INCOIS), Hyderabad
- Krishi Vigyan Kendra (KVK), Lakshadweep (for Swachhta Action Plan)
- Krishi Vigyan Kendra, Kumarakom, Kerala
- Marine Products Export Development Authority (MPEDA), Kochi
- National Bank for Agriculture and Rural Development (NABARD), Mumbai
- National Fisheries Development Board (NFDB), Hyderabad
- National Institute of Fisheries Post Harvest Technology and Training (NIPHATT), Kochi
- National Institute of Food Technology, Entrepreneurship and Management (NIFTEM), Tamil Nadu
- Naval Physical and Oceanographic Laboratory (NPOL), Kerala
- National Center for Cell Science, Pune, Maharashtra
- Network for Fish Quality Management and Sustainable Fishing (NETFISH), MPEDA
- Petronet LNG, Kochi
- Raja Ramanna Center for Advanced Technologies, Indore, Madhya Pradesh
- Steel Authority of India Limited (SAIL), Maharashtra
- Silchar Medical College, Silchar, Assam
- Udyabhansinhji Regional Institute of Cooperative Management, Gandhinagar
- Raja Ramanna Center for Advanced Technologies, Atomic Energy Department
- Naval Physical and Oceanographic Laboratory, DRDO, Kerala
- Central Institute of Petrochemical Engineering and technology, CIPET-IPT, Kochi
- CSIR-National Institute for interdisciplinary science and technology (NIIST)
- The SAIL, Salem Steel, Coimbatore
- Coconut Development Board
- ICAR-Directorate of Medicinal and Aromatic Plants Research, Anand
- National Centre For Cell Science, Pune, Maharashtra
- National Institute of Fisheries Post Harvest Technology and Training, Kochi
- Marine Products Export Development Authority, (MPEDA) Veraval and Porbandar
- MPEDA Regional division, Mumbai
- Export Inspection Agency- Mumbai
- Seafood Exporters Association, FSSAI, Mumbai
- Fishery Survey of India (FSI), Colaba, Mumbai
- Automobile Research Association of India, Pune
- ICAR-Central Institute for Research on Cotton Technology, Mumbai

## State Departments

- Agency for Development of Aquaculture Kerala (ADAK), Kerala
- Commissioner of Fisheries Office, State Fisheries Department, Taraporwala Aquarium, Charni Road, Mumbai, Maharashtra
- Department of Fisheries, Diu, Gujarat
- Department of Forestry, Tamil Nadu
- Dept of Fisheries of (i) Kerala (ii) Odisha (iii) Goa (iii) Andhra Pradesh
- District Youth Fishers Welfare Association, Visakhapatnam
- State Planning board, Thiruvananthapuram, Kerala
- Kerala Antimicrobial Resistance State Action Plan (KARSAP), Thiruvananthapuram, Kerala
- Kerala Pollution Control Board, Thiruvananthapuram, Kerala
- Kerala state Coastal Area Development Corporation (KSCADC), Thiruvananthapuram, Kerala
- Kerala State Co-Operative Federation For Fisheries Development Ltd. (Matsyafed), Kerala
- Maharashtra State Rural Livelihood Mission (MSRLM), Maharashtra
- Perunthalaivar Kamaraj Krishi Vigyan Kendra (PKKVK), Puducherry
- Pushpagiri Institute of Medical Sciences and Research Centre, Thiruvalla, Kerala
- State Laboratory for Livestock, Marine and Agri Product (SLMAP), Ernakulam, Kerala
- Society for Assistance to Fisherwomen (SAF), Kerala
- State fisheries department, Gujarat and Uttarkhand
- State Fisheries Department, Himachal Pradesh
- State fisheries Department, Puducherry
- State Fisheries Department, Tamil Nadu
- State Institute of Fisheries Technology, Kakinada, Andhra Pradesh
- State Referral Institute for Water Quality (SRI), Nettoor, Ernakulam
- Govt. of Kerala Planning Board
- Meat Products of India, Edayar
- Kerala Water Authority (KWA)
- State Referral Institute, Kerala Water Authority, Govt. of Kerala; CWRDM, Govt. of. Kerala.
- Kerala State Planning Board
- Department of Fisheries, Kerala
- I-Hub, Gujarat Government Enterprise
- State Department of Fisheries, Maharashtra
- Mumbai Port Authority (MbPA), Sassoon Dock, Colaba, Mumbai
- Brihanmumbai Municipal Corporation, Mumbai

## Universities/ Colleges

- Andhra University, Visakhapatnam
- Anjuman I Islam's Abdul Azim Khatkhatay Secondary School, Vashi, Navi Mumbai
- Annamalai University, Chidambaram, Tamil Nadu
- Assam Agriculture University (AAU), Johat, Assam
- Assam University, Silchar, Assam
- Azim Premji University, Bangalore
- Birsa Agricultural University (BAU), Ranchi, Jharkhand
- Central Agricultural University (CAU), Imphal, Manipur
- Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh
- Christ College, Rajkot, Gujarat
- Cochin University of Science and Technology (CUSAT), Kochi, Kerala

- College of Fisheries Science, Veraval
- College of Fisheries, NAU, Navsar, Gujarat
- College of Fisheries, Ratnagiri, Maharashtra
- College of Veterinary and Animal Sciences, Thrissur, Kerala
- Dr. J Jayalalithaa Fisheries University, Nagapattinam, Tamil Nadu
- Dr. Rajendra Prasad Central Agriculture University, Pusa, Bihar
- Dr.V.S. Krishna Govt. PG college GADVASU, Visakhapatnam, Andhra Pradesh
- Guru Angad Dev Veterinary Animal Science University, Ludhiana, Punjab
- Gandhi Institute of Technology and Management (GITAM), Andhra Pradesh
- Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttarakhand
- Indira Gandhi Krishi Vishwavidyalaya (IGKV), Chhatisgarh
- Jawaharlal Nehru Krishi Vishwavidyalaya (JNKVV), Jabalpur, MP
- Junagadh Agricultural University, Junagadh, Gujarat
- Kamadhenu University, Gandhi Nagar, Gujarat
- Karnataka Veterinary, Animal and Fisheries Sciences University (KVAFSU), Bidar, Karnataka
- Kendriya Vidyalaya, Mankhurd, Mumbai, Maharashtra
- Kendriya Vidyalaya, ONGC, Panvel, Navi Mumbai, Maharashtra
- Kerala Agricultural University, Mannuthy, Kerala
- Kerala University of Fisheries and Ocean Studies (KUFOS), Panangad, Kerala
- Mahendra College of Engineering, Namakkal, Tamil Nadu
- Motilal Jhunjhunwala college of Arts, Science & Commerce, Vashi, Navi Mumbai, Maharashtra
- Navi Mumbai Municipal secondary school, Vashi, Navi Mumbai, Maharashtra
- Odisha University of Agriculture & Technology (OUAT), Bhubaneswar, Odisha
- Postgraduate Institute of Fisheries Education and Research, Rajpur (Nava), Madhya Pradesh
- Sainath Hindi High school and Jr. College, Navi Mumbai, Maharashtra
- Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu (SKUAST), Jammu
- Sri Venkateswara Veterinary University, Tirupati, Andhra Pradesh
- SRM Institute of Science and Technology, Chennai, Tamil Nadu
- University of Agricultural Sciences, Karnataka
- Veterinary College, Bengaluru, Karnataka
- Veterinary College, Hassan, Karnataka
- Tamil Nadu Dr. J. Jayalalithaa Fisheries University (TNJFU), Nagapattinam, Tamil Nadu
- Kerala Veterinary and Animal Sciences University
- JSA College of Agriculture and Technology, Cuddalore
- Karunya Institute of Technology and Science, Coimbatore
- Kamdhenu University, Gandhi Nagar, Gujarat
- SIES College of Arts, Science & Commerce (Autonomous), Sion (West), Mumbai
- University of Calicut, Malappuram

## Other agencies

- Coconut Development Board Institute of Technology (CIT), Aluva
- Cheredev Macchimar Sevabhavi Santha, Ghansoli, Navi Mumbai, Maharashtra
- Coir Board, Kochi, Kerala
- Haritha Farmer's Club, Perumbalam, Alappuzha
- ICICI Foundation
- Indian Coast Guard, Veraval and Porbandar
- Kerala Water Authority, Ernakulam

- Koparkhairane Macchimar Seva Bhavi Sanstha, Koparkhairane, Navi Mumbai, Maharashtra
- Korampadam Service & Co-Operative (KSC) Bank Limited, Kothad, Ernakulam
- Koratty, Service Coop Bank
- Kerala State Coastal Area Development Corporation (KSCADC), Thiruvananthapuram
- M/s Bhimrao Matsya Udyog Seva Sahkari Mandali, Veraval
- M/s Mahavir Machchhimar Sahkari Mandali Ltd. Mangrol
- M/s. Anandi, NGO, Ahmedabad, Gujarat
- M/s. Sagar Manthan Machhimar Utthan Mandal, Veraval
- Mariaai Macchimar co.op. Society, Vashi Gaon, Navi Mumbai, Maharashtra
- Marine National Park (MNP), Jamnagar, Gujarat
- Mumbai Port Authority
- NABARD, Regional office, Gujarat
- National Cooperative Development Corporation (NCDC), Ahmedabad, Gujarat
- NIFTEM, Sonpat, Haryana
- RGCA, MPEDA, Mayiladurai, Tamil Nadu
- Sagari Seema Manch and Sahakar Bharati, Navi Mumbai.
- Snehakuja Trust, Kasarkod, Kerala
- Wildlife Trust of India (WTI)
- Wildlife Trust of India (WTI), Noida, Uttar Pradesh

## Private Sector

- ABAD Fisheries Pvt. Ltd., Ernakulam
- Amarsagar Seafoods Pvt. Ltd., Porbandar
- AVT Natural Products Limited, Aluva
- Blooming Boon, Ernakulam
- Cherthala Block Krishisree Sangam, Alappuzha
- Epicure Innovative LLP, Cheranalloor
- Garden Reach Shipbuilders & Engineers Limited, Kolkata
- Gaumco Multipurpose Co-operative Society Ltd.
- Global Food Processing Technologies and Exporters, Kottayam
- Home Green Foods Pvt. Ltd., Kanjirapally
- Horeb Business Enterprise, Mizoram
- Jamna Sagar Export, Jafarabad
- Kitchen Mate, Ernakulam
- KOHLER Power India Pvt. Ltd., Maharashtra
- Mahavir Machchhimar Sahakari Mandali Ltd., Gujarat
- Mizala Biovet India (OPC) Private Ltd., Madhya Pradesh
- Mr. A. Selvan, Thoothukudi
- Mr. Sudheesh A., Malappuram
- Muthoot Institute of Technology and Science (MITS), Kochi
- Pallipuram Service Co-operative Bank Ltd. No. 760
- Parayil Bio Farm Pvt. Ltd., Ernakulam
- Peruvannamuzhy SC/ST Fishermen Co-operative Society Ltd., Kozhikode
- Poondi Govindapuram Grama Ikya Sangham
- Puakai Agriaqua, Rajahmundry
- Rumpot Snacks, Kollam
- Samudra seafoods, Kollam
- SASHMIRA (The Synthetic and Art Silk Mills' Research Association), Worli, Mumbai

- Suresh Stephan, Trivandrum
- Tomson Enterprises, Idukki
- Trophic Biosystems Pvt. Ltd., Ernakulam
- Universal Green Foods Pvt. Ltd., Kanjirapally
- Upper Sribadam Trout Rearing Co-operative Society Limited,

## Extension and Development Agencies

- 'Bhaisahab Mahila Bachat gat' Buddhanagar, Pen, Raigad, Maharashtra
- 'Pancsheel Mahila Bachat gat', Bhimanagar, Vavoshi, Khalapur, Raigad, Maharashtra
- 'Ramabai Mahila Bachat Gat' Umbarde, Pen, Raigad, Maharshtra
- 'Savitri Mahila Bachat Gat' Umbarde, Pen, Raigad, Maharshtra
- 'Sujatha Swayamsahayata Mahila Bachat Gat', Buddhanagar, Pen, Raigad, Maharashtra
- Assistant Commissioner of Fisheries Office, Nagpur, Maharashtra
- Bay of Bengal Programme (BOBP), Tamil Nadu
- Fisheries development Officer, Khalapur, Raigad dist., Maharashtra
- Fishermen co.op.spcoeties:
- Karanja Machimaar VKS society, Uran, Raigad, Maharashtra
- Krishi Vigyan Kendras (KVKs)
- KVK, Kodinar, Gujarat
- Local Women Self Help Groups
- Mariaai Macchimaar co.op.spciety, Vashi
- National Institute of Agricultural Extension Management (MANAGE), Hyderabad, Telangana
- NETFISH, MPEDA and Fisheries Development Officials, Vaikkom
- NETFISH-MPEDA, Veraval
- Panchayat office and SHG of Navagaon of Alibaugh, Raigad, Maharashtra
- Plan@Earth (NGO), Aluva
- Pragati fishermen co-op. society, Sassoon Dock, Colaba, Mumbai
- Savitribai Phule Mahila Bachat gat' Wadkhal, Pen, Raigad, Maharashtra
- Shirvanje Aadivasi Vyavasayik Co-operative Society, Shirvanje, Shahapur, Rural Thane, Maharashtra
- Stakeholders Meet on '*Value Chain Nutrition*' under World Fish Project (WFC-ICAR W3) in Wayanad
- The Dalit Indian Chamber of Commerce and Industry (DICCI), Maharashtra

# TECHNOLOGY MANAGEMENT

## Incubatees registered for Agribusiness Incubation

| S No. | Name of the incubatee / entrepreneur | Type of Constitution (Corporate/ Individual / Start Up / Co-op / Producer Company, etc) | Date of Membership |
|---|---|---|---|
| 1 | Dr. Preetha Shenoy | Nutraceutical food products from microalgae | 31-01-2023 |
| 2 | Mr. Jiswin Joseph | Data consultancy and technical inputs for ornamental fisheries, aquaponics and aquaculture | 01-02-2023 |
| 3 | Mr. Suresh Stephen, Trivandrum | Dry fish processing | 12-02- 2023 |
| 4 | Mr. Sudheesh A. | Dry fish processing | 02-03-2023 |
| 5 | Global Food Processing Technologies and Exporters, Kottayam | Dry fish processing | 15-03-2023 |
| 6 | Mr. Joy Chirayath | Value-added products from Murrel fish | 04-05-2023 |
| 7 | Universal Green Foods Pvt. Ltd. | Masala dry shrimp roast, chutney powder (with and without coconut), and fish feed | 17-05-2023 |
| 8 | Parayil Bio Farm Pvt. Ltd., Ernakulam (Mr.Hari Gopinadh) | Vegan mayonnaise from chickpea isolates and hydrolysate | 01-08-2023 |
| 9 | Kitchen Mate (Ms. Rintu, Ernakulam) | Cooked prawns | 12-09-2023 |
| 10 | Mr. William Puthenparambil Pious | Dry fish | 31-10- 2023 |

## Intellectual property rights (Granted/ Filed)

| Application/ Registration No. | Name of Innovation/ Technology/ Product/ Variety | Date of application filing | Date of Registration | Innovators/ Authors/ Contributors |
|---|---|---|---|---|
| | | PATENTS | | |
| Patent No: 455647 (Jointly filed by ICAR-National Research Centre for Grapes and ICAR-CIFT) | **Method for extraction of Grape seed oil comprising bioactive compounds from a Manjari Medika variety of Grapes.** | 31.03.2020 | 29.09.2023 | Dr. Banerjee Kaushik<br>Dr. Shabeer Ahammed T.P.<br>Dr. Khan Zareen<br>Dr. Chatterjee Niladri Shekhar |
| Patent No: 485252 | **Hybrid Solar Dryer for Drying of Agricultural Commodities** | 03.10.2020 | 19.12.2023 | Dr. Ravishankar C.N.<br>Dr. Manoj P. Samuel<br>Dr. Murali S.<br>Dr. Aniesrani Delfiya D.S.<br>Dr. Alfiya P.V. |
| Application No. 202311004140 | **A Process for Simultaneous Recovery of Multiple Bacteriophages** | 20.01.2023 | - | Dr. Murugadas V.<br>Dr. Visnuvinayagam S.<br>Dr. Karthika R.<br>Dr. Madhusudana Rao B.<br>Dr. Ravishankar C.N.<br>Dr. Toms C. Joseph |
| Application No. 202311016117 | **Integrated Bycatch Reduction Device** | 10.03.2023 | - | Dr. Remesan M.P. |

| | | | | |
|---|---|---|---|---|
| Application No. 202311063383 | **Seaweed extract-based amino acids fortified foliar spray for plant growth.** | 21.09.2023 | | Dr. Ashish Kumar Jha<br>Dr. Pankaj Kishore<br>Dr. L. Narasimha Murthy<br>Shri. S. Sreejith<br>Dr. Sarika K.<br>Shri. Kriplani Yogesh Kumar Dharamdas |
| | | **COPYRIGHTS** | | |
| Diary No. 15612/2022-CO/SW | **Web Based Information System on Biochemical and Nutritional Composition of Food Fish in India** | 20.07.2022 | 06.04.2023 | Dr. Joshy C.G.<br>Dr. George Ninan<br>Smt. Shyla N.C.<br>Smt. Lizbeth Roshin<br>Dr. Sankar T.V.<br>Dr. Bindu J.<br>Dr. Zynudheen A.A.<br>Dr. Anandan R.<br>Dr. Suseela Mathew |
| Diary No. 15217/2023-CO/SW | **Program for hypothermic anesthetizing device for aquatic species** | 08.06.2023 | 21.08.2023 | Dr. Parvathy U.<br>Dr. Binsi P.K.<br>Dr. Murali S.<br>Dr. Sathish Kumar K.<br>Shri. Jithin T.J.<br>Shri. Vishnu R. Nair |
| Diary No. 15218/2023-CO/SW | **Data Acquisition and Logging System for Analysis of Water Quality Parameters** | 08.06.2023 | - | Dr. Parvathy U.<br>Dr. Binsi P.K.<br>Dr. Murali S.<br>Dr. Sathish Kumar K.<br>Shri. Jithin T.J.<br>Shri. Vishnu R. Nair |
| Diary No:18442/2023-CO/SW | **SHRIMPQCHeQ: A Web-Based Shrimp Quality Index (SQI) to Assess the Freshness of Shrimp** | 13.07.2023 | 12.09.2023 | Dr. Joshy C.G.<br>Dr. Zynudheen A. A.<br>Dr. Elavarasan K.<br>Dr. Binsi P.K.<br>Dr. Bindu J.<br>Dr. George Ninan |
| Diary No:23263/2023-CO/SW | **Recurrent Neural Network-based Regression Analysis for Fish Freshness Grading in Genetically Improved Farmed Tilapia** | 31.08.2023 | - | Dr. S. Murali<br>Kum. B. Sreelekshmi<br>Smt. P.R. Reshma<br>Dr. D.S. Aniesrani Delfiya<br>Dr. V. Murugadas<br>Dr. P.K. Binsi<br>Dr. George Ninan |
| Diary No: 23264/2023-CO/SW | **Non-destructive Freshness Assessment of Indian Mackerel using Convolutional Neural Networks** | 31.08.2023 | 12.12.2023 | Dr. Murali S.<br>Kum. Sreelekshmi B.<br>Smt. Reshma P.R.<br>Dr. Aniesrani Delfiya D.S.<br>Dr. Murugadas V.<br>Dr. Binsi P.K.<br>Dr. George Ninan |

| INDUSTRIAL DESIGNS | | | | |
|---|---|---|---|---|
| Design No. 358858-001 Class:22-05 | **Collapsible Fish Trap** | 19.02.2022 | 22.02.2023 | Dr. M.P. Remesan<br>Dr. Prajith K.K.<br>Dr. Chinnadurai S.<br>Dr. Manjulakshmi N.<br>Dr. Dhiju Das P.H. |
| Design No: 390553-001 Class: 30-99 | **Foldable Fish Drying Rack** | 17.07.2023 | 12.10.2023 | Dr. Nikita Gopal<br>Dr. Madhu V.R.<br>Dr. Sandhya K.M.<br>Dr. Rejula K.<br>Shri. Sreejith S. Kumar<br>Dr. Dhiju Das P.H.<br>Smt. Sethulakshmi C.S.<br>Smt. Sharanya Manilal |
| Design No: 395180-001 Class: 23-01 | **Onboard Water Collection Chamber** | 15.09.2023 | 30.10.2023 | Dr. Nikita Gopal<br>Dr. Madhu V.R.<br>Dr. Sandhya K. M.<br>Dr. Rejula K.<br>Smt. Sethulakshmi C.S.<br>Shri. Sreejith S. Kumar<br>Smt. Sharanya Manilal<br>Shri. Sreejith T. S. |
| Design No: 396148-001 Class: 10-05 | **Freshness Indicating Device** | 26.09.2023 | - | Dr. Mohan C.O.<br>Dr. Remya S.<br>Dr. Pankaj Kishore<br>Shri Ananthu Prasad<br>Dr. Bindu J. |
| Design No: 402040-001 Class: 15 - 15-99 Miscellaneous | **Solar Gasifier Hybrid Dryer** | 13.12.2023 | - | Dr. Murali S.<br>Dr. Aniesrani Delfiya D. S.<br>Dr. Alfiya P. V.<br>Dr. Manoj P. Samuel<br>Dr. George Ninan |

# Technology transfer/professional service functions

## *Collaborative research*

| SNo: | Technology | Date of Agreement signing | Name of the Client | Total Budget |
|---|---|---|---|---|
| 1 | Development of hydroxyapatite-based products | 17-01-2023 | Muthoot Institute of Technology and Science (MITS), Kochi | NA |
| 2 | Joint research activities in the areas of fish processing, post-harvest operations, quality assurance, socioeconomics, improvement of textile-based products utilized in the fishing industry and microplastic study | 21-06-2023 | SASMIRA, Mumbai | NA |
| 3 | Management of marine plastic litter along the coast of Kerala | 05-10-2023 | Plan@Earth (NGO), Aluva | NA |

| | | | | |
|---|---|---|---|---|
| 4 | Evaluation of the efficacy of CIFTEQ priming solution and effect on the growth and biochemical parameters in crops of economic importance | 13-11- 2023 | University of Calicut, Malappuram | NA |
| 5 | Development of fisheries value chain | 07-12-2023 | The Dalit Indian Chamber of Commerce and Industry (DICCI), Maharashtra | NA |

## Consultancy

| SNo | Technology | Date of Agreement signing | Name of the Client | Total Budget |
|---|---|---|---|---|
| 1 | Design of fishing vessels and boats | 15-02-2023 | Garden Reach Shipbuilders & Engineers Limited, Kolkata | NIL |
| 2 | To conduct a comprehensive study to improve the handling and processing practices of fish and prawn waste at Sassoon Dock and suggesting the best fish processing technology to eradicate foul smell emanating from Sassoon Dock, Colaba in Mumbai | 20-04-2023 | Mumbai Port Authority | Rs. 23,50,000 |
| 3 | Technical Guidance for getting NABL accreditation | 28-07-2023 | ICAR-National Rice Research Institute (ICAR-NRRI), Odisha | Rs. 2,00,000 |
| 4 | Technical guidance to obtain NABL accreditation for the microbiological laboratory at AQUASRI | 14-09-2023 | Kerala Water Authority, Ernakulam | Rs. 3,00,000 |
| 5 | Development of nutraceuticals and cosmetic products with collagen peptide and algal chlorophyll | 04-10-2023 | Blooming Boon | Rs. 25,000 |
| 6 | DPR for establishing a production and processing unit for ready-to-eat fish products in retortable pouches at Karikode fish market facility, Kollam | 13-10-2023 | KSCADC, Thiruvananthapuram | Rs. 2,00,000 |

## Contract service

| SNo: | Technology | Date of Agreement signing | Name of the Client | Total Budget |
|---|---|---|---|---|
| 1 | Use of extruder facility | 01-03-2023 | Trophic Biosystems Pvt. Ltd., Ernakulam | Rs. 15000 |
| 2 | Validation of ELISA based antibiotic detection kit for fish and shrimp | 01-04-2023 | Mizala Biovet India (OPC) Private Ltd., Madhya Pradesh | Rs. 1,25,000 |

| | | | | |
|---|---|---|---|---|
| 3 | Engine validation and design approval | 01-06- 2023 | KOHLER Power India Pvt. Ltd., Maharashtra | Rs, 1,11,000 |
| 4 | Use of extruder facility | 26-09-2023 | M/s Trophic Biosystems Pvt. Ltd., Kochi | Rs. 15,000 |
| 5 | Conducting an internal audit of chemical and biological disciplines | 23-11-2023 | CDB Institute of Technology, Aluva | Rs. 20,000 |

## Contract Research (Grant-In-Aid / Sponsored)

| SNo: | Technology | Date of Agreement signing | Name of the Client | Total Budget |
|---|---|---|---|---|
| 1 | **Sponsored Contract Research** Evaluate and validate the efficiency of the dietary supplement as IMMUNITY enhancer in shrimp | 12-02-2023 | AVT Natural Products Limited, Aluva | Rs. 5,00,000 |
| 2 | **Sponsored Contract Research** Development of nutraceuticals and functional food formulations from seaweed | 28-04-2023 | Puakai Agriaqua, Rajahmundry | Rs. 1,00,000 |

## Commercialization of technologies

| SNo: | Technology | Date of Agreement signing | Name of the Client | Total Budget |
|---|---|---|---|---|
| 1 | Production of masala dry shrimp roast and fish feed | 17-01-2023 | Home Green Foods Pvt. Ltd., Kanjirapally | Rs. 10,000 |
| 2 | (**machine transfer**) Transfer of shredder (1 unit) and mixer (1 unit) | 12-02-2023 | Cherthala Block Krishisree Sangam, Alappuzha | NIL |
| 3 | (**machine transfer**) Transfer of shredder (1 unit) and mixer (1 unit) | 12-02-2023 | Pallipuram Service Co-operative Bank Ltd. No. 760 | NIL |
| 4 | 1. Coated products like fish finger, balls, cutlet, samosa, sausage, lollipop<br>2. Fish wafers<br>3. Fish/ shrimp pickles | 12-02-2023 | Samudra seafoods, Kollam | Rs. 75,000 |
| 5 | Dry fish processing in CIFT solar dryer (40 kg) | 12-02-2023 | Suresh Stephan, Trivandrum | Rs. 5000 |
| 6 | Production of fish-based value-added products | 12-02-2023 | Mahavir Machchhimar Sahakari Mandali Ltd., Gujarat | Rs. 25,000 |
| 7 | (**machine transfer**)<br>Technological guidance and handing over of small-scale fish processing aids related to the hygienic handling and value addition of fish and fishery products | 13-02-2023 | Gaumco Multipurpose Co-operative Society Ltd. | NIL |

| | | | | |
|---|---|---|---|---|
| 8 | (**machine transfer** )<br>Technological guidance and handing over of Small-Scale Fish Processing Aids related to the hygienic handling and preparation of dried fish and convenient fishery products | 16-02-2023 | Poondi Govindapuram Grama Ikya Sangham | NIL |
| 9 | a) Fish handling, processing, and packaging<br>b) Vacuum packing of fish | 10-03-2023 | Epicure Innovative LLP, Cheranalloor | Rs. 40,000 |
| 10 | Seaweed based poultry feed additive | 14-03-2023 | Tomson Enterprises, Idukki | Rs. 10,000 |
| 11 | Dry fish processing | 15-03-2023 | Global Food Processing Technologies and Exporters, Kottayam | Rs. 3500 |
| 12 | (**machine transfer**)<br>Technological guidance and handing over of Small-Scale Fish processing Aids related to the hygienic handling and value addition of fish and fishery products developed/ recommended by ICAR-CIFT, Cochin | 22-03-2023 | Upper Sribadam Trout Rearing Co-operative Society Limited, | NIL |
| 13 | Production of masala dry shrimp roast, chutney powder (with and without coconut) and fish feed | 17-05-2023 | Universal Green Foods Pvt. Ltd., Kanjirapally | Rs. 10,000 |
| 14 | Production, packaging and quality evaluation of dried Bombay duck | 13-06-2023 | Jamna Sagar Export, Jafarabad | Rs. 75,000 |
| 15 | (**machine transfer**)<br>Transfer of extruder | 21-06-2023 | Peruvannamuzhy SC/ ST Fishermen Co-operative Society Ltd., Kozhikode | NIL |
| 16 | Technical guidance for different market forms of freshwater fish, battered fish products, fish powder and dried fish | 28-06-2023 | Horeb Business Enterprise, Mizoram | Rs. 10,000 |
| 17 | Production of protein isolate and hydrolysate from chickpeas, microencapsulation of sesame oil, vegan mayonnaise using microencapsulated sesame oil and chickpea protein isolate and hydrolysate | 01-08-2023 | Parayil Bio Farm Pvt. Ltd., Ernakulam | Rs. 1,45,000 |
| 18 | Technical support and guidance for the upgradation of microbiological laboratory | 04-08-2023 | M/s Amarsagar Seafoods Pvt. Ltd., Porbandar | Rs. 1,00,000 |
| 19 | Optimization of cooked prawns | 12-09-2023 | Kitchen Mate, Ernakulam | Rs. 10,000 |
| 20 | Production of chitosan from chitin | 14-09-2023 | Mr. A. Selvan, Thoothukudi | Rs. 50,000 |
| 21 | (**Tripartite agreement**)<br>Dry fish processing and Establishment of solar-electric hybrid dryer (250kg capacity) | 14-09-2023 | Mr. Sudheesh A., Malappuram and Kraftwork Solar Pvt. Ltd., Cochin | Rs. 20,000 |

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| 22 | Dried and semi-dried products from fish | 25-09-2023 | M/s Rumpot Snacks, Kollam | Rs. 35,000 |
| 23 | Collagen peptide from fish skin, bones, and scales | 27-10-2023 | ABAD Fisheries Pvt. Ltd., Ernakulam | Rs. 4,00,000 |
| 24 | Hydroxyapatite from fish bones and scales | 27-10-2023 | ABAD Fisheries Pvt. Ltd., Ernakulam | Rs. 2,00,000 |
| 25 | Collagen supplement for pets | 27-10-2023 | ABAD Fisheries Pvt. Ltd., Ernakulam | Rs. 1,00,000 |

# ISO 17025:2017 Activities

ICAR-CIFT is accredited to ISO 9001:2015 in the field of Research and Development Services to promote Sustainable and Responsible Harvest and Post-Harvest Technologies in Fisheries Sector, including Consulting, Training, Testing, Business Incubation and Transfer of Technologies since 2014.

Dr. Nikita Gopal, Principal Scientist served as the Team Leader, ISO along with Dr. P. Muhamed Ashraf, Principal Scientist; Dr. Sajeev M. V., Senior Scientist; Dr. C.O. Mohan, Senior Scientist; Dr. V. Murugadas, Senior Scientist; Smt. Priya E. R., Scientist; Shri Anas K. K., Scientist; Dr. Aniesrani Delfiya D. S., Scientist as the team members and Assistant Administrative Officer , Co-ordination section served as Member Secretary. Internal audits are regularly conducted by the ISO team for the smooth functioning of the ISO activities in the institute.

During the year 2023, the recertification audit was duly completed and the institute was successfully recertified for ISO 9001:2015.

# WORKSHOPS / SEMINARS / CONFERENCES

| Sl. No. | Title of the Programme | No. of participants | Venue, Date and Duration |
|---|---|---|---|
| 1. | Hindi Workshop on Official Language Implementation & Challenges | 14 | 31-03-2023 (Online) Veraval Research Centre of ICAR-CIFT |
| 2. | Special Session on "Co-Creating Sustainable Technological Solutions for Small-Scale Fisheries: An Interdisciplinary Approach" as a part of 30th Swadeshi Science Congress | 30 | 25-05-2023 to 27-05-2023 National Institute of Technology (NIT), Calicut |
| 3. | National technical workshop Indian Perspective on Food Safety, Security and Standards organized by ICAR-CIFT, SOFTI, FSSAI and AOAC India Section from | 200 | 07-06-2023 to 08-06-2023 ICAR-CIFT, Kochi |
| 4. | High end workshop on "Advanced food packaging techniques and quality evaluation of packaging materials | 26 | 19-06-2023 to 27-06-2023 ICAR-CIFT, Kochi |
| 5. | Hindi Workshop on Official Language policy, rules & act | 18 | 30-06-2023 (Online) Veraval Research Centre of ICAR-CIFT |

**Hindi Scientific Workshop (हिन्दी वैज्ञानिक कार्यशाला) at MRC, ICAR-CIFT Vashi, Navi Mumbai.**

**Two-user interaction workshop on 'INCOIS Advisory Services' for fisherfolk and fishery industry at (a) Mangrol and (b) Veraval region of Gujarat**

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| 6. | A multipurpose solar thermal conversion unit with biomass gasifier heater backup was installed at Chennur, Ernakulam for the benefit of the Samrudhi a fisherwoman group under the care of Korampadam Service & Co-Operative (KSC) Bank Limited, Kothad, Ernakulam in connection with the DST funded project. | 50 | 30-06-2023, Kochi |
| 7. | B2B meet with solar dryer manufacturing firms and entrepreneurs | 16 | 06-07-2023<br>ICAR-CIFT, Kochi |
| 8. | Hindi Workshop on Official Language implementation in office | 18 | 06-07-2023 (Online)<br>Veraval Research Centre of ICAR-CIFT |
| 9. | B2B meet with solar dryer manufacturing firms and entrepreneurs | 23 | 14-07-2023<br>ICAR-CIFT, Kochi |
| 10. | Organized a two-user interaction workshop on 'INCOIS Advisory Services' for fisherfolk and fishery industry | 40 | 07-08-2023<br>Veraval and Mangrol, Gujarat |
| 11. | Workshop on Value added fish products organized by MRC, ICAR-CIFT | 30 | 20-09-2023<br>Mumbai Research Centre of ICAR-CIFT |
| 12. | Scientific talk on "Fish and Shrimp Allergy: An important Health Concern" | 50 | 22-09-2023<br>Visakhapatnam Research Centre of ICAR-CIFT |
| 13. | Hindi Scientific Workshop (हिन्दी वैज्ञानिक कार्यशाला): Dr. Abhay Kumar, Scientist conducted the workshop for the staff of the centre. | 25 | 09-10-2023<br>Mumbai Research Centre of ICAR-CIFT |
| 14. | Hindi Workshop on Official Language implementation & e-tools | 18 | 26-10-2023 (Online)<br>Veraval Research Centre of ICAR-CIFT |
| 15. | National Seminar "AquaMillets : Innovations in Millet and Fish-Based Products" | 100 | 15-12-2023<br>ICAR-CIFT, Kochi |
| 16. | National Workshop "Microplastic in Seafood Value Chain :Challenges & Way Forward" | 85 | 19-12-2023<br>ICAR-CIFT, Kochi |

# TRAINING / AWARENESS PROGRAMMES

| Sl. No | Topic | No. of beneficiaries | Venue and date |
|---|---|---|---|
| 1 | ISO 22000/ HACCP for Fish Processing Establishments Under ITEC, MEA, New Delhi | 25 | 09-01-2023 to 21-01-2023 ICAR-CIFT, Kochi |
| 2 | Advanced analytical techniques in nutrient profiling of seafood (proximate composition analysis, fatty acid profiling using GCMS, HPLC, UV-vis spectrophotometer | 1 | 10-01-2023 to 08-02-2023 ICAR-CIFT, Kochi |
| 3 | Harvest and Post-Harvest Technologies in Fisheries for BFSc students of College of Fisheries, Dholi (RPCAU, Bihar) | 21 | 17-01-2023 to 06-02-2023 ICAR-CIFT, Kochi |
| 4 | *Matsya samskaranathile samrambakathwa parisheelanam* | 50 | 27-01-2023 to 28-01-2023 Agricultural University, KVK Palakkad, Pattambi |
| 5 | Hygienic handling and preparation of value-added products from fisheries resources for two interested entrepreneurs | 2 | 31-01-2023 to 02-02-2023 Vashi, Mumbai, ICAR- CIFT |
| 6 | Analysis of Formaldehyde, Antibiotics and Pesticides in Fish and Fish Products' Jointly organized by FSSAI, NewDelhi & ICAR-CIFT, Kochi | 15 | 06-02-2023 to 10-02-2023 ICAR-CIFT, Kochi |
| 7 | Adhoc training in Biochemical analysis | 1 | 01-03-2023 to 14-03-2023 Visakhapatnam Research Centre of ICAR-CIFT |
| 8 | Value addition in fisheries for ntrepreneurship | 50 | 02-03-2023 to 03-03-2023 Mannuthy, KVK, Kannur |
| 9 | Value added fishery products | 25 | 06-03-2023 to 07-03-2023 Mattathur, Thrissur |
| 10 | Pre-processing and drying of fish for fishermen/ entrepreneurs from different parts of Kerala | 18 | 07-03-2023 to 08-03-2023 ICAR-CIFT, Kochi |
| 11 | Fish value addition and waste utilization | 9 | 13-03-2023 to 17-03-2023 ICAR-CIFT, Kochi |
| 12 | Internship training programme for microbial quality analysis of fish for the student from Christ college, Rajkot | 1 | 13-03-2023 to 18-03-2023 Veraval Research Centre of CIFT |

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| 13 | Value added fish products | 50 | 17-03-2023 to 18-03-2023, Pattambi, KVK Palakkad |
| 14 | Microbial and biochemical quality analysis of fish for students from Christ college, Rajkot | 3 | 20-03-2023 to 22-03-2023 Veraval Research Centre of CIFT |
| 15 | Preparation of fish feed, foliar spray and manure from fish processing waste | 28 | 21 -03-2023 ICAR-CIFT, Kochi |
| 16 | Nutritional development through fish and fish based products in Wayanad | 150 | 25-03-2023 Nadavayal, Wayanad |
| 17 | Identification of Bacteria of Public Health | 18 | 11-04-2023 to 18-04-2023 ICAR-CIFT, Kochi |
| 18 | Good Aquaculture Practices and Good Handling Practices | 10 | 12-04-2023 Cherpu , Thrissur |
| 19 | 'Field trial, demonstrations, and popularization programme of the CIFT-V form double slotted Otter Board' organized by MRC, ICAR-CIFT in collaboration with Pragati fishermen co-op. society, Mumbai, Maharashtra | 22 | 20-04-2023 Sassoon Dock, Kolaba, Maharashtra |
| 20 | Laboratory Techniques in Microbiological Examination of Seafood | 2 | 09 -05-2023 to 22-05-2023 ICAR-CIFT, Kochi |
| 21 | Fish drying techniques and fish pickle preparation to the staffs of Fish Processing Centre, Kollam. | 25 | 16-05-2023 ICAR-CIFT, Kochi |
| 22 | Fish processing hands on training for MSc.Food Technology students of Silver College, Perambra | 8 | 22-05-2023 to 31-05-2023 ICAR-CIFT, Kochi |
| 23 | Fish Processing and Value Addition | 8 | 22-05-2023 to 31-05-2023 ICAR-CIFT, Kochi |
| 24 | Antimicrobial Resistance | 6 | 29-05-2023 to 02 -06-2023 ICAR-CIFT, Kochi |
| 25 | Training on drying of *Acetes* spp. and Bombay duck delivered to the entrepreneur as part of transfer of technology | 1 | 01-06-2023 and 14-06-2023 MRC, ICAR-CIFT |
| 26 | Carbon dot Sensors | 1 | 01-06-2023 to 03-07-2023 ICAR-CIFT, Kochi |
| 27 | Modern Analytical Techniques in Biochemical Analysis of Fish and Fishery Products | 4 | 01-06-2023 to 30-06-2023 ICAR-CIFT, Kochi |
| 28 | Awareness programme on Beat Plastic Pollution in InlandWaters | 50 | 05-06-2023 Aroor Ezhupunna Inland Fishermen Development Co-operative Society, Alappuzha, Kerala |

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| 29 | Modern Analytical Techniques in Biochemical Analysis of Fish and Fishery Products | 6 | 12-06-2023 to 30-06-2023 ICAR-CIFT, Kochi |
| 30 | Advanced analytical techniques in nutrient profiling and nutritional labelling of marine aquaculture products | 1 | 12-06-2023 to 12-07-2023 ICAR-CIFT, Kochi |
| 31 | Advanced analytical techniques in nutrient profiling and nutritional labelling of marine aquaculture products | 4 | 14-06-2023 to 14-07-2023 ICAR-CIFT, Kochi |
| 32 | Internship in Extension, Information and Statistics | 3 | 15-06-2023 to 14-07-2023 ICAR-CIFT, Kochi |
| 33 | High-end Workshop ('KARYASHALA') on 'Advanced food packaging techniques and quality evaluation of packaging materials' funded by SERB(DST), New Delhi under Accelerate Vigyan Scheme. | 26 | 19-06-2023 to 27-06-2023 ICAR-CIFT, Kochi |
| 34 | Analysis of antibiotics in fish and fish products by LC-MS/MS | 6 | 20-06-2023 to 21-06-2023 ICAR-CIFT, Kochi |
| 35 | Skill development program on Evaluation of chitosan quality | 1 | 26-06-2023 to 29-06-2023 ICAR-CIFT, Kochi |
| 36 | Evaluation of Chitosan Quality for the technical personnel of Matsyafed | 4 | 26-06-2023 to 30-06-2023 ICAR-CIFT, Kochi |
| 37 | Value addition of freshwater fishes | 3 | 26-06-2023 to 30-06-2023 Visakhapatnam Research Centre of ICAR-CIFT |
| 38 | Hands on training on AMR to the staff of Kerala State Pollution Control Board | 6 | 29-06-23 to 02-07-2023 ICAR-CIFT, Kochi |
| 39 | Macro and micro nutrient profiling of marine fish and fishery products (GC-FID-ECD, HPLC-FLD-PDA, GC-MS, Particle size analyzer, FT-NIR, UV-Vis spectrophotometer and Rheometer ) | 1 | 03-07-2023 to 03-10-2023 ICAR-CIFT, Kochi |
| 40 | Pre-Processing and Drying of Fish | 15 | 05-07-2023 to 06-07-2023 ICAR-CIFT, Kochi |
| 41 | Pre-processing and drying of fish for fishermen/entrepreneurs | 16 | 05-07-2023 to 06-07-2023 ICAR-CIFT, Kochi |
| 42 | Fish Processing and Quality assurance | 1 | 10-07-2023 to 24-07-2023 Visakhapatnam Research Centre of ICAR-CIFT |
| 43 | Advanced microbiological and Molecular Techniques for Improving the competence of students in Biological Sciences | 19 | 17-07-2023 to 22-07-2023 ICAR-CIFT, Kochi |

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| 44 | Preparation of enrobed and marinated fish and shellfish products for Mangala Marine Exim India Private Limited, Aroor, Kerala | 10 | 24-07-2023 to 27-07-2023 ICAR-CIFT, Kochi |
| 45 | Preparation of enrobed and marinated fish and shell fish Products" | 10 | 24-07-2023 to 27-07-2023 ICAR-CIFT, Kochi |
| 46 | Advanced analytical techniques in nutritional Biochemistry | 1 | 24-07-2023 to 16-08-2023 ICAR-CIFT, Kochi |
| 47 | Hygienic Fish Drying and Value Addition of Fish | 15 | 25-07-2023 to 27-07-2023 Visakhapatnam Research Centre of ICAR-CIFT |
| 48 | HACCP Concepts | 10 | 31-07-2023 to 04-08-2023 ICAR-CIFT, Kochi |
| 49 | Biochemical Compositional Analysis of feed and seafood | 1 | 31-07-2023 to 11-08-2023 ICAR-CIFT, Kochi |
| 50 | Microbiological test methods for seafood and sterility test | 1 | 07-08-2023 to 11-08-2023 ICAR-CIFT, Kochi |
| 51 | Microbial analysis of fish and fishery Products for the technologists of Veraval, Mangrol and Porbandar region | 20 | 07-08-2023 to 12-08-2023 Veraval Research Centre of ICAR-CIFT |
| 52 | In-plant training under student ready programme for 4th year B.F.Sc students of College of Fisheries, AAU | 18 | 07-08-2023 to 29-09-2023 ICAR-CIFT, Kochi |
| 53 | Quality Assurance in Fish and Shellfish Handling | 13 | 08-08-2023 to 09-08-2023 ICAR-CIFT, Kochi |
| 54 | Entrepreneurship development training program in shrimp farming and processing for the B.F.Sc students of Gadvasu, Ludhiana, Punjab | 18 | 16-08-2023 to 30-08-2023 Veraval Research Centre of ICAR CIFT |
| 55 | In-Plant training under student ready programme for 4th year B.F.Sc students of College of Fisheries, AAU, Raha | 15 | 11-09-2023 to 15-09-2023 ICAR-CIFT, Kochi |
| 56 | Training to Kitchen Mate on 'Optimization on cooked prawns' | 3 | 12-09-2023 ICAR-CIFT, Kochi |
| 57 | Measurement of uncertainty (SOFTEL) | 40 | 18-09-23 to 29-09-2023 ICAR-CIFT, Kochi |
| 58 | ITEC Training Programme on Quality Assurance of Fish and Fishery Products | 10 | 18-09-2023 to 29-09-2023 ICAR-CIFT, Kochi |
| 59 | Awareness campaign on 'Report Fish Disease App under NSPAAD-PMMSY' (online mode) | 30 | 21-09-2023 ICAR-CIFT, Kochi |

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| 60 | Awareness programme on 'The International Day of Awareness of Food Loss and Waste 2023' as a part of activity under Special campaign 3.0 'Swacchata hi sewa' | 20 | 29-09-2023<br>Mumbai Research Center, ICAR-CIFT |
| 61 | RAWE In-Plant Training | 17 | 03-10-2023 to 06-10-2023<br>ICAR-CIFT, Kochi |
| 62 | Internship programme for B.Tech. (Agrl. Engg.) students from KAU-KCAET, Tavanur | 33 | 03-10-2023 to 06-10-2023<br>ICAR-CIFT, Kochi |
| 63 | Hygienic handling of fish and shellfish - jointly organized by MRC, CIFT & Mumbai Port Authority (MbPA) | 90 | 05-10-2023, 10-10-2023 & 12-10-2023<br>Sassoon Dock, Colaba, Maharashtra |
| 64 | Nanotechnological applications in fisheries | 13 | 16-10-2023 to 20-10-2023<br>ICAR-CIFT, Kochi |
| 65 | FSSAI sponsored workshop on "Requirement for ProficiencyTesting Provider as per ISO 17043:2023 and Statistics as per ISO 13528:2022"(SOFTEL) | 24 | 16-10-2023 to 20-10-2023<br>ICAR-CIFT, Kochi |
| 66 | Extraction and Characterization of marine lipids | 15 | 16-10-2023 to 20-10-2023<br>ICAR-CIFT, Kochi |
| 67 | Hygienic Fish Handling, Processing and Value Addition for FishFarmers in Tehri Garhwal, Uttarakhand | 21 | 17-10-2023 to 19-10-2023<br>Tehri Garhwal, Uttarakhand |
| 68 | Introduction to Responsible Fishing | 11 | 25-10-2023 to 27-10-2023<br>ICAR-CIFT, Kochi |
| 69 | Enhancing livelihood through value added product development from fish" conducted by Veraval RC of ICAR-CIFT | 25 | 01-11-2023 to 03-11-2023<br>Mangrol, Gujarat |
| 70 | Awareness workshop on FFPO for cage farmers | 62 | 04-11-2023, Kodungallur, Kerala |
| 71 | Advances in seafood processing and waste utilization | 16 | 06-11-2023 to 10-11-2023<br>ICAR-CIFT, Kochi |
| 72 | ITEC Training Programme on ISO 22000/ HACCP for Fish Processing Establishments | 21 | 06-11-2023 to 17-11-2023<br>ICAR-CIFT, Kochi |
| 73 | Adhoc training on Microbiology | 1 | 06-11-2023 to 04- 01-2024<br>Visakhapatnam Research Centre of ICAR-CIFT |
| 74 | HACCP Concepts training for Coconut Development Board | 3 | 07-11-2023 to 13-11-2023<br>ICAR-CIFT, Kochi |
| 75 | Training cum demonstration on seafood waste management | 35 | 08-11-2023<br>ICAR-CIFT, Kochi |

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| 76 | In-plant training for M.V.Sc students of Department of Livestock products Technology, Kerala veterinary and Animal Sciences University, Mannuthy, Thrissur | 6 | 08-11-2023 to 10-11-2023<br>ICAR-CIFT, Kochi |
| 77 | Mega-awareness program on 'Hygienic Handling of Fish and Shellfish' was jointly organized by Mumbai Research Centre, ICAR-CIFT, Vashi and Mumbai Port Authority (MbPA), Colaba under a Consultancy Project, with Mumbai Port Authority on 'Methodology to Eradicate Foul Smell in Sassoon Dock and to Suggest Fish Waste Processing Technology' | 150 | 09-11-2023<br>Fishery Survey of India(FSI), Colaba |
| 78 | ITEC Training Programme on "Technological Interventions in Processing, Value addition and Packaging of Aquatic Resources" | 21 | 20-11-2023 to 08-12-2023<br>ICAR-CIFT, Kochi |
| 79 | Current trends in food processing technology | 30 | 20-11-2023 to 24-11-2023<br>ICAR-CIFT, Kochi |
| 80 | Adhoc training on Microbiology | 1 | 20-11-2023 to 19-12-2023<br>Visakhapatnam Research Centre of ICAR-CIFT |
| 81 | An awareness programme on Antimicrobial Resistance (AMR) was conducted for the students of the Seventh Day Adventist Higher Secondary School in Kaloor, Ernakulam, Kerala | 100 | 22-11-2023<br>Kaloor, Ernakulam |
| 82 | An awareness programme on Antimicrobial Resistance (AMR) was conducted for the students of the Kendriya Vidhyalaya1in Naval Base, Kochi, Kerala | 70 | 22-11-2023<br>Naval Base, Kochi |
| 83 | Hygienic drying of fish and value added products preparation | 9 | 29-11-2023 to 01-12-2023<br>Visakhapatnam Research Centre of ICAR-CIFT |
| 84 | Advanced microbiological and molecular techniques | 16 | 05-12-2023 to 11-12-2023<br>ICAR-CIFT, Kochi |
| 85 | Techniques in microbiology and molecular biology | 1 | 12-12-2023 to 22-12-2023<br>ICAR-CIFT, Kochi |
| 86 | 'Advanced training on the analysis of pharmacologically active substances in fish and fish products using LC MS MS' (SOFTEL) | 14 | 18-12-2023 to 22-12-2023<br>ICAR-CIFT, Kochi |

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| 87 | World Antimicrobial Awareness Week (WAAW) from November 18–23, 2023 with the theme Preventing Antimicrobial Resistance Together | 250 | 18-12-2023 to 23-12-2023<br>ICAR-CIFT, Kochi |
| 88 | Awareness class for the farmers and other citizens of the Manjalloor Grama Panchayathat Vazhakkulam as part of the GOI Campaign program viz., VIKSIT BHARAT SANKALP YATHRA | 100 | 20-12-2023<br>Vazhakkulam, Ernakulam |
| 89 | Training cum demonstration programme on 'Hygienic handling and drying of fish and shellfish' | 1 | 27-12-2023 to 29-12-2023<br>Mumbai Research Centre of ICAR-CIFT, Mumbai |
| 90 | Fish value addition and Waste Utilization for fisher at Pazhasi | 20 | 13-03-2023 to 17-03-2023<br>ICAR-CIFT, Kochi |
| 91 | Millet & Fish-based Products | 15 | 14-12-2023<br>ICAR-CIFT, Kochi |
| 92 | Addressing hidden hunger in adolescent girls in vulnerable groups | 20 | 11-12-2023 to 13-12-2023<br>Shirvanje, Maharashtra |
| 93 | Improving the livelihood status of Vulnerable group- tribal population | 20 | 07-12-2023 to 09-12-2023<br>Shirvanje, Maharashtra |
| 94 | Hygienic handling of fish with special reference to the emergence and spread of antimicrobial resistance | 20 | 04-12-2023 to 06-12-2023<br>Shirvanje, Shahapur, Maharashtra |
| 95 | Fish Value Addition and Waste Management | 15 | 13-03-2023 to 17-03-2023<br>ICAR-CIFT, Kochi |
| 96 | Seafood Waste Management: Good Handling Practices and By-product Development | 16 | 15-01-2023 to 19-01-2023<br>ICAR-CIFT, Kochi |
| 97 | Hygienic handling and value-added product development from fish | 20 | 17-01-2023 to 19-01-2023<br>Ukai, Gujarat |
| 98 | Introduction to nanotechnology; its applications in fisheries and allied subjects | 8 | 20-11-2023 to 24-11.23<br>ICAR-CIFT, Kochi |
| 99 | Aquafeed preparation for fish and shrimp under Scheduled cast sub - plan (SCSP) for participants of SC community from Dari village, Gujarat | 20 | 09-01-2023 to 11-01-2023<br>Veraval Research Center of ICAR-CIFT |

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| 100 | Field trial, demonstrations, and popularization programme of the CIFT-V form double slotted Otter Board organized by MRC, ICAR-CIFT in collaboration with Karanja Machimaar VKS society, Raigad, Maharashtra | 30 | 31-03-2023<br>Village- Karanja,Raigad District,Maharashtra |
| 101 | Advances in food process engineering and preservation for B.Tech. students | 28 | 16-01-2023 to 20-01-2023<br>ICAR-CIFT, Kochi |
| 102 | Value added products of fish | 13 | 24-01-2023 to 25-01-2023<br>KVK, Kannur |
| 103 | Advanced food packaging techniques and quality evaluation of packaging materials | 21 | 07-08-2023 to 11-08-2023<br>ICAR-CIFT, Kochi |
| 104 | Hygienic handling and Value addition of fish and fishery product | 21 | 20-12-2023 to 22-12-2023<br>Bhimanagar, Maharashtra |
| 105 | Advanced food packaging techniques and quality evaluation of packaging materials | 20 | 07-08-2023 to 11-08-2023<br>ICAR-CIFT, Kochi |
| 106 | Pre-processing and drying of fish' for Scheduled Caste candidates | 23 | 13-09-2023 to 14-09-2023<br>ICAR-CIFT, Kochi |
| 107 | Fish feed, Foliar spray Silage, and Manure preparation | 41 | 20-03-2023 at<br>ICAR-CIFT, Kochi |
| 108 | Quality assurance of fish and fish products | 18 | 20-11-2023 to 24-11-2023<br>Visakhapatnam<br>Research Centre of ICAR-CIFT |
| 109 | Training cum demonstration of modified dolnets with square mesh and double cod end to reduce the bycatch in the dolnets with collaboration of Karanja Machhimar VKS Society Ltd. Karanja, Uran | 15 | 30-11-2023 to 02-12-2023<br>Karanja creek, Uran,Raigad |
| 110 | Trap Fabrication and Operations | 20 | 01-02-2023 to 03-02-2023<br>Valotti Village, Billimora |
| 111 | Advances in seafood processing and waste utilization | 20 | 06-11-2023 to 10-11-2023<br>ICAR-CIFT, Kochi |
| 112 | Current trends in food processing technology | 30 | 20-11-2023 to 24-11-2023<br>ICAR-CIFT, Kochi |
| 113 | Hygienic handling and Value addition of fish and fishery product | 20 | 31-10-2023 to 02-11-2023<br>Wadkhal Village, Maharashtra |
| 114 | Seafood Quality Assurance | 15 | 20-02-2023 to 24-02-2023<br>ICAR-CIFT, Kochi |

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| 115 | Hygiene and handling Value addition of fish and fishery product | 23 | 29-03-2023 to 31-03-2023 Buddhanagar, Raigad District, Maharashtra |
| 116 | Fish feed , Foliar spray, silage and manure preparation | 20 | 21-03-2023 ICAR-CIFT, Kochi |
| 117 | Good Aquaculture practices and Good Hygienic Practices | 15 | 13-04-2023 Cherpu , Thrissur |
| 118 | HACCP concepts | 28 | 31-07-2023 to 04-08-2023 ICAR-CIFT, Kochi |
| 119 | Value added product development from fish and shrimp | 20 | 18-12-2023 to 22-12-2023 Veraval Research Centre of ICAR-CIFT, Veraval |
| 120 | Hygienic handling &value-added product development from fish and shrimp | 20 | 09-10-2023 to 13-10-2023 Veraval Research Centre of ICAR-CIFT |
| 121 | Biochemical and quality analysis of fish Fisheries College, Veraval and J. M.Science College | 20 | 20-03-2023 to 24-03-2023 Veraval Research Centre of CIFT, |
| 122 | Nanotechnological applications in fisheries | 11 | 21-08-2023 to 25-08-2023 ICAR-CIFT, Kochi |
| 123 | Nanotechnological applications in fisheries | 11 | 16-10-2023 to 20-10-2023 ICAR-CIFT, Kochi |
| 124 | A training cum demonstration programme on 'Hygiene and handling Value addition of fish and fishery product | 25 | 23-02-2023 to 25-02-2023 Umbarde village, Raigad District of Maharshtra |
| 125 | Hygienic Handling and Value addition of fish and fishery products under STC component | 20 | 31-01-23 to 02-02-23 Khammam, Telangana |
| 126 | Hygienic handling and preparation of shelf stable convenient fish products and dried fish under STC component | 20 | 07-02-2023 to 09-02-2023 Poondi, pallasamandal, Srikakulam |
| 127 | Advances in fishing gear materials | 15 | 04-12-2023 to 08-12-2023 ICAR-CIFT, Kochi |
| 128 | Entrepreneurship development of Apatani tribes inhabiting ZiroValley of Arunachal Pradesh through Hygienic Fish Drying, Smoking and Value Addition under | 25 | 13-02-2023 to 15-02-2023 Ziro valley, Arunachal Pradesh |
| 129 | Introduction of New Harvesting Methods for the water bodies of Ziro valley, Arunachal Pradesh" under NEH component | 25 | 13-02-2023 to 15-02-2023 Ziro valley, Arunachal Pradesh |

Capacity building training program on hygienic handling and value-added product development from fish under tribal sub plan (TSP/STC) conducted in Ukai for the scheduled tribal fisher community of Tapi region, Gujarat on 17-19 Jan, 2023

Training programme on Trap Fabrication and Operations under Scheduled Caste Sub Plan at Valotti village, Billimora, Gujarat. During 1-3 February 2023

Hands on training programme on "Enhancing livelihood through value added product development from fish" conducted by Veraval RC of ICAR-CIFT for the stake holders of Shree Mahavir machimar sahkari mandli Ltd, Mangrol Gujarat during 1-3 November, 2023


Mega awareness campaign on Ocean Information & Advisory Services" organised by INCOIS in collaboration with VRC of ICAR-CIFT on 13th July,2023 at Hotel Regenta Central, Gir Somnath

A training cum demonstration programme on 'Hygiene and handling Value addition of fish and fishery product' in collaboration with MPEDA Regional division, Mumbai and in association with local Women Self Help Groups viz. 'Bhaisahab Mahila Bachat gat' and 'Sujatha Swayamsahayata Mahila Bachat Gat'

Field trial, demonstrations, and popularization programme of the CIFT-V form double slotted Otter Board' in collaboration with Karanja Machimaar VKS society, Raigad, Maharashtra

Training cum demonstration programme on "Hygienic handling and Value addition of fish and fishery product" in association with local Fisherwomen society 'Savitribai Phule Mahila Bachat gat' Village-Wadkhal, Maharashtra

# NEH / DAPSC / TSP PROGRAMMES

## NEH Programme

ICAR-CIFT successfully conducted seven programmes during 2023 including training/capacity building, workshops and input distribution programmes benefiting stakeholders from the eight North Eastern states. Major programmes organized during the period were training programmes, regional workshops, establishment of mini fish processing unit, distribution of technological inputs such as gear, FRP boats, publication of leaflets etc. CIFT harvest and post-harvest technologies including value addition, hygienic fish drying, smoking, pickle making, post-harvest management, solar tunnel dryer, fish smoking kiln technology, waste management methods etc. were popularised among the North eastern states.

For the successful conduct of NEH programmes and popularisation of CIFT technologies, ICAR-CIFT established linkages with ICAR Research Complex for NEH Region, Barapani, KVKs of NE region, ATARI Guwahati, ATARI Barapani and State Fisheries Departments.

The initiative taken in this regard by ICAR-CIFT could benefit around 500 stakeholders during the year 2023.

## DAPSC/SCSP Programme

The DAPSC/SCSP programmes of ICAR-CIFT focused mainly on long-term development through

| Programmes/Activities | Number of programmes | Number of beneficiaries |
|---|---|---|
| Training cum demonstration | 4 | 100 |
| Regional workshop | 1 | 50 |
| Establishment of mini fish processing unit | 2 | 300 |
| Distribution of technological inputs | 1 | 5 |
| Publication | 1 | 100 |

education/ skill development of students of Scheduled Caste; training and capacity development of SC community, value chain development / facility creation for livelihood generation, ensuring access to inputs for fishing and fish processing, exposure visit and localised research that benefit SC community. Under the DAPSC/SCSP programme, ICAR-CIFT successfully conducted 19 trainings/ capacity building programmes for graduate and post graduate students under SC category, and 13 trainings/ capacity building programmes for SC fishers/entrepreneurs during the year 2023 covering 10 states and 1 union territory of the country. In addition, 12 programmes were conducted for value chain creation/ facility creation/ localised interventions through asset creation such as fish drying units, mini fish processing facilities, cold chain facilities covering both the inland and marine fishing sectors. Inputs for fishing such as fishing nets and accessories, and FRP boats were handed over to beneficiaries. Fish processing implements like ice boxes, fish packaging materials, mincers, grinders, processing utensils, processing table, and personal hygienic items for fish handling were also distributed. Other programmes included hygienic fish handling programmes at fishing harbor, localised intervention for mitigating the menace of invasive Armoured Catfish in freshwater bodies in Tamil Nadu and Pondicherry etc.

CIFT technologies including FRP Canoes, Fishing nets (monofilament, gill net 32mm, 34 mm), solar dryer with electrical backup, insulated fish storage boxes, mini fish processing units were distributed. The training included the domains of preparation of fish-based products (pickle, fingers, balls, cutlets), advanced fish drying and processing techniques, sustainable fisheries, fishing net mending, and entrepreneurship development for SC beneficiaries spread across the country. The institute has entered into an MoU with Dalit Indian Chamber of Commerce and Industry.

Value chain creation/ facility creation/ localised interventions through asset creation etc included Development of inland fish value Chain for reservoir fisheries, Pothundy Reservoir, Palakkad, Kerala; Development of value chain for inland fishers of SC community at Vaikom, Kerala; Localised intervention for mitigating the Menace of Invasive Armoured Catfish in freshwater bodies in Tamil Nadu and Pondicherry; Value chain development through seaweed processing in Ramanathapuram, Tamil Nadu; Fish drying facility at

**Input distribution (fishing and fish processing implements) to SC beneficiaries in Maharashtra (Left) and Vaikom, Kerala (Right)**

**Value chain creation (Cold storage facility) in Dari, Gujarat created under SCSP scheme**

KVK, Pattambi Establishment of a Pre-processing Unit at Mandali, Veraval; Livelihood generation through skill development and creation of mini pre-processing facility s at Dari, Veraval, Gujarat; Cold chain & value addition, M/s. Shree Bheemrau Matsyodhyog Seva Sehkari Mandali Limited, Veraval; Establishment of a small-scale drying unit at Nakkapalli mandal for SC fishermen community.

The various training/ capacity building programmes for graduate and post-graduate students of SC Category at CIFT Kochi and its research centres included topics viz., Entrepreneurship opportunities in fisheries sector, Basic Econometric Tools and Techniques in Data Analytics, Application of nanotechnology in fisheries, Orientation on fishing gear and bycatch reduction Devices, Advances in fishing craft & gear materials, Advanced food packaging techniques and quality evaluation of packaging materials, Fish Processing, value addition and waste utilization, Extraction and characterization of marine lipids, Seafood quality assurance, HACCP Concepts, Advanced microbiological and molecular techniques and improving the competence of students in biological sciences, Current trends in food processing technology, Advances in food process engineering and preservation, Marine biopolymers-Extraction and application etc.

Training on various harvest and post-harvest aspects were covered for the benefit of SC community fishers/ entrepreneurs viz., Dol Net fitted Bycatch Reduction Device, Inland fish value chain, Pre-processing and drying of fish, Clam processing, Value addition of fish and fishery product etc. in different parts of the country.

For conduct of the programmes and popularization of CIFT technologies, ICAR-CIFT established linkages various organizations including Alagappa University, Tamil Nadu; Pondicherry University; Dept of Fisheries Palakkad; Fisheries Department, Tuticorin and Ramanathapuram; KVKs (Palakkad, Kottayam, Pattambi, Madur, Pondichery, Kumarakam), and DICCI (Dalit Indian Chamber of Commerce and Industry), among others.

**Training/ capacity building programmes to students/ fishers/entrepreneurs**


**Solar fish drying unit created under DAPSC in KVK, Palakkad**

**Dried fish products in a training at KVK, Palakkad under DAPSC**

Director, Dr. George Ninan addressing the members of Scheduled Caste Fishermen Cooperative Societies at Pothundi Reservoir

Team from CIFT and Department of Fisheries, Kerala visiting the reservoir as part of value chain creation in inland fisheries at Pothundi reservoir

**Details of SCSP programmes conducted during January-December, 2023**

| Indicators | Number of programmes | Number of Beneficiaries |
|---|---|---|
| Trainings / Capacity building for graduate and post-graduate students | 19 | 362 |
| Training for SC community fishers/ entrepreneurs | 13 | 341 |
| Value chain creation/ facility creation/ localised interventions through asset creation etc | 12 | 350 |
| Others (Distribution of inputs such as nets, boats, pens, etc.) | 6 | 251 |
| Other facilities developed | 3 | - |

## TSP Programme

The Fishing Technology Division of ICAR-CIFT conducted a 5-day training program from 20-24 November 2023, focusing on Nanotechnology and its application for students from Kerala, Jharkhand, Meghalaya, Assam, and Lakshadweep. The course exposed the students to the application of nanomaterials in fisheries, the synthesis of nanomaterials from natural sources, the sources, properties, and applications of inorganic and organic nanomaterials, the characterization of nanomaterials, development and application of nano sensors, and the use of nano composites for biodeterioration and biodegradation.


A three-day training and demonstration program on hygienic handling of fish and shellfish, as well as the preparation of various value-added fishery products, was held at Shirvanje village, Shahapur Taluka, Thane District of Maharashtra from December 7th to 9th 2023 by the Mumbai RC of ICAR-CIFT. Organized in collaboration with the Shirvanje Machimaar Aadivasi Vyavsayik Co-operative Society, the program saw active participation from 20 society members, including both men and women. The program featured theoretical and practical demonstrations on the preparation of value-added fishery products.

An awareness program and demonstration on "Hygienic handling of fish with a focus on antimicrobial resistance" was conducted from December 4-6th, 2023, in Shirvanje Village, Shahpur Taluk, Thane District, Maharashtra by the Mumbai RC of ICAR-CIFT for 20 participants. The importance of hygiene in fish handling and the emergence of antimicrobial resistance were the topics on which awareness was created. As part of these programmes essential inputs were also distributed.

A three-day awareness and demonstration program titled "Addressing Hidden Hunger in Adolescent Girls in Vulnerable Tribal Populations of Shirvanje Village" was held from December 11th to 13th, 2023, in association with the Shirvanje Machimaar Aadivasi Vyavsayik Co-operative Society by Mumbai RC of ICAR-CIFT. Fish processing accessories, including insulated fish bags, gill nets, hemoglobinometers, fish soup powder packets were distributed.

A "Fish Value Addition and Waste Management" training cum demonstration program was held from March 13-17, 2023, by the Fish Processing Division of the Institute. The program focused on enhancing fish value addition techniques and effective waste management practices. Nine participants attended, engaging in practical demonstrations and theoretical sessions.

A preliminary Feasibility Discussion for Pretraining promoting entrepreneurship at Karikkadavu Tribal Settlement, Thrissur, Kerala was carried out on December 13, 2023. This session was specifically designed for a group of 10 entrepreneurs selected from the Karikkadavu Tribal settlement.

| Sl. No | Title of Training program | Duration | Venue | Collaboration with | Number of beneficiaries |
|---|---|---|---|---|---|
| 1. | Introduction to Nanotechnology: Its Applications in Fisheries and allied subjects | 20th – 24th Nov 2023 | ICAR-CIFT, Kochi | Fishing Technology Division, ICAR-CIFT | 8 |
| 2. | Hygienic handling of fish with special reference to the emergence and spread of antimicrobial resistance | 4th to 6th December 2023 | Shirvanje, Sha`hapur, Rural Thane, Maharashtra | Shirvanje Aadivasi Vyavasayik Co-operative Society | 20 |
| 3. | Improving the livelihood status of Vulnerable group- tribal population | 7th to 9th December 2023 | | | 20 |
| 4. | Addressing hidden hunger in adolescent girls in vulnerable groups | 11th to 13th December 2023 | | | 20 |
| 5. | National Seminar "Aqua Millets, | 15th Dec 2023 | ICAR-CIFT, Kochi | ZTM-ABI and SOFT(I) | 20 |
| 6. | Fish value addition and waste management | 13th to 17th Mar, 2023 | ICAR-CIFT, Kochi | Fish Processing | 9 |

# EXHIBITIONS PARTICIPATED

| Sl. No. | Name of the Exhibitions | Organizers | Date (Duration) |
|---|---|---|---|
| 1. | 29th Indian Convention of food Scientists & Technologists (ICFoST0, Kazhakkootam, Thiruvananthapauram | Association of Food Scientists & Technologists (India) CSIR - CFTRI Campus, Mysuru, Karnataka | 05-01-2023 to 07-01-2023 |
| 2. | National Science Exhibition related with 35th Kerala Science Congress | Kerala State Council for Science, Technology & Environment | 10-02-2023 to 14-02-2023 |
| 3. | ICES-FAO international Symposium on innovations in Fishing Technologies | Department of Fisheries, Govt. India, NFDB and ICAR | 13-02-2023 to 17-02-2023 |
| 4. | 23rd India International Seafood Show (2023), Kolkata, India | Seafood Exporters Association of India (SEAI) and the Marine Products Export Development Authority (MPEDA) | 15-02-2023 to 17-02-2023 |
| 5. | Machinery Expo 2023 (5th National Exhibition) at Jawahar Lal Nehru International Stadium Ground, Kaloor, Ernakulam | Department of Industries and Commerce, Government of Kerala | 11-03-2023 to 14-03-2023 |
| 6. | 22nd Edition of ACREX India 2023 BEC, Mumbai, India. | ISHRAE and INFORMA MARKETS | 14-03-2023 to 16-03-2023 |
| 7. | Kerala Institute foe Entrepreneurship Development Expo, Angamaly | Kerala Institute for Entrepreneurship Development (KIED), Govt. of Kerala | 21-03-2023 |
| 8. | *Kalpa Vajra* 2022-2023 | ICAR-Central Plantation Crops Research Institute | 13-05-2023 to 14-05-2023 |
| 9. | ICAR Foundation Day/Technology Day | ICAR, New Delhi | 16-07-2023 to 18-07-2023 |
| 10. | ICAR-CTCRI Foundation Day | ICAR-Central Tuber Crops Research Institute, Thiruvananthapuram | 22-07-2023 |
| 11. | XVI Agricultural Science Congress (ASC) & Agri Science Cong Expo | ASC & ICAR- Central Marine Fisheries Research Institute, Kochi | 10-10-2023 to 13-10-2023 |
| 12. | Refcold India 2023, Chennai Trade Centre | The Indian society of Heating, Refrigerating and Air Conditioning Engineers (ISHRAE), New Delhi | 12-10-2023 to 14-10-2023 |
| 13. | International Maritime Conference on Marine Conservation and Sustainability at School of Legal studies, CUSAT, Kochi. | Cochin University of Science and Technology (CUSAT), Kochi | 19-10-2023 to 20-10-2023 |
| 14. | Global Fisheries Conference 2023 at science city, Ahmedabad, Gujarat | Ministry of Fisheries, Animal Husbandry & Darying, Govt. of India | 21-11-2023 to 23-11-2023 |
| 15. | Millet and Fish mela (Distributed fish sausage enriched with Millet) | ICAR- Central Marine Fisheries Research Institute, Kochi | 28-12-2023 to 30-12-2023 |

Honorable Union minister of Fisheries, Animal Husbandry and Dairying (FAHD) Sri. Parsottam Rupala visited CIFT stall during the Global Fisheries Conference 2023 at Science City, Ahmedabad, Gujarat


DDG ICAR, Joint Secretary Fisheries, Director DCFR and other distinguish guests visited ICAR- CIFT stall

# Television/Radio talks

| Sl. No. | Name | Topic | Broadcasted by | Date |
|---|---|---|---|---|
| 1 | Dr. George Ninan | Fisheries Sector and Swachchatha Abhiyan and entrepreneurship opportunities in fisheries sector | FM Radio Kochi | 04.01.2023 |
| 2 | Dr. George Ninan | Samakalikam: Gaveshana Kendrathinte saamuhika prathibadhathayum sadhyathakalum | FM Radio Kochi | 07.05.2023 |
| 3 | Dr.A. Suresh | Podcast on Reinventing Agricultural Extension System in India: The Road Ahead | Economic and Political Weekly Radio | 16.10.2023 |

# INVITED TALKS

## Dr. George Ninan

Innovations in Fish Harvest and Post Harvest Technology, 13th Indian Fisheries and Aquaculture Forum: Fostering Indian Fisheries and Aquaculture for attaining Sustainable Development Goals at Kolkata, 23.02.2024 to 25.02.2024

Fishery byproducts and waste utilization, NITI Aayog Workshop on Harnessing Potential of Marine Fisheries at Kochi on 05.01.2024

Cold chain Asset Creation to support primary value chain, Chintan Shivir organized by MPEDA at Goa, 27.11.2023

Fisheries for Food Security and sustainable livelihood, MARICON 2024-International Conference on Frontiers in Marine Sciences at Kochi on10.04. 2024

## Dr. M. P. Remesan

Sustainability issues in Marine Fisheries - National Training Programme on "Blue Economy: A Multi-Dimensional Overview with special focus on Marine and Coastal Ecosystem Conservation Measures" organized by ICED, at Jaipur on 24.07.2023.

## Dr. Bindu J.

Novel Processing Technologies for Jellyfish Products: Enhancing Quality, Safety and Market Value:Jellyfish Blooms Symposium 7 (JBS7) Parallel event: Jellyfish fisheries and Trade: Status, Trends and Impacts on Livelihood at Kerala Arts and Crafts Village, at Trivandrum on 24.11.2023.

Applications of High Pressure in Fish Preservation - Faculty Development Program (FDP) on "Future Foods: Embracing Cutting-Edge Technologies in Food Processing.", hosted by the Agri Business Incubator, Kerala Agriculture University under ICAR-NAHEP-CAAST project at Kerala Agriculture University, Vellanikara, Thrissur on 01.12. 2023.

Polymers for fish packaging applications - 17th International Conference on Polymer Science and Technology ("SPSI-MACRO-2023") at IIT -Guwahati from 10.12.2023 to 13.12.2023.

## Dr. T. Raja Swaminathan

Alternatives to animal models in pharmacy research - Innovation and Entrepreneurship Development Centre Nirmala College of Pharmacy, Muvattupuzha, Kerala on 18.10.2023

Shrimp Aquaculture and Antimicrobial Resistance - World AMR Awareness Week (WAAW) 2023 conducted by MPEDA, Kochi Online webinar on "Antimicrobial Resistance" on 23.11.2023.

Fish Cell culture and Finfish Virology - IDP-NAHEP project on Enhancing Entrepreneurial competence in students to address the emerging challenges in agriculture and allied sectors at College of Fisheries, Lembucherra, Tripura from 22.12.2023 to 24.12.2023.

## Dr. Nikita Gopal

Women's roles in fisheries - 1st Anniversary celebrations of Aquatalks by Jaljeevika on 27.01.2023.

ICAR-CIFT technologies for rural development - AIR Radio Kissan Divas 2023 at Chembu Village organized by AIR and Chembu Grama Panchayath, Kerala on 15.02.2023.

Employment and role of Women in fish marketing - Collaborative Training Program of MANAGE, Hyderabad & TNJFU- Fisheries college and Research Institute, Thoothukudi on Structural Status and Performance of Domestic Fish Marketing and Trade on 06.06.2023

Women in Dried Fish Production - Aquatalks, Jaljeevika on 15.09.2023.

## Dr. Suseela Mathew

Nutrition Enhancement and Health Benefits in the Culinary Amalgamation of Fish and Millets - Millet and Fish: Nutrition and Health at ICAR-CMFRI on 29.12.2023

## Dr. Toms C. Joseph

One Health: Human, Animal and Environmental well-being - National Ayurveda Day on 10.11.2023.

Preventing Antimicrobial Resistance in Aquaculture - AMR awareness week at KUFOS, on 22.11.2023.

Status of AMR in Fisheries and Aquaculture sector - AMR Workshop at College of Veterinary and Animal Sciences, Mannuthy on 24.11.2023.

## Dr. S. Ashaletha

Gender dimension in Fisheries - Gender & Fisheries session of International Fisheries Congress and Expo 2024 at KUFOS, EKM on 12.01.2023.

ICAR-CIFT technologies for rural development - AIR Radio Kissan Divas 2023 at Chembu Village orgnaised by AIR and Chembu Grama Panchayath, Kerala on 15.02.2023.

Fish farming- possibilities of Value chain interventions - State level Seminar for Agriculture & fishery stakeholders organized by Bharatheeya Kisan Sangh at CTCRI, TVM on 20.11.2023.

Livelihood enhancement strategies based on fisheries - State level Workshop for fishery stakeholders organized by Bharatheeya Malsy Pravarthaka Sangh at Calicut on 26.11.2023.

### Dr. A. Suresh

Food for Future: Perspectives on Public Agricultural Research & Development in India - Invited by the National Academy of Agricultural Sciences (NAAS) Kolkata chapter to deliver a lecture (by online) on food security issues in India. Evening lecture on topic of topical importance to the researchers and extension specialists of the country for ensuring food sovereignty Online, on 17.06.2023.

Food Security in India- Research and Development imperatives - Department of Economics of University College, Thiruvananthapuram University college, Thiruvananthapuram, on 13.12.2023.

### Dr. Pe. Jeyya Jeyanthi

Entrepreneurship development through value addition of fish and fishery products - An economic perspective - MANAGE Sponsored off-campus online collaborative training programme on 'Fishpreneurship Development' at FCRI, TNJFU, Thoothukkudi; (Online) on 03.01.2023

Managing post-harvest losses towards ensuring food security - (Keynote address) International conference on 'Innovative approaches in crop improvement for sustainable agriculture' for JSA College of Agriculture and Technology, Cuddalore, Tamil Nadu (Online) on 23.02.2023.

Entrepreneurship Opportunities in Fisheries - University Programme - MINDCRAFT 2023 Karunya Institute of Technology and Sciences, Coimbatore on 24.03.2023.

Post-Harvest Loss in Fish: How to assess? - In-plant training programme for the 4th year B.F.Sc students of College of Fisheries, Assam Agricultural University, Raha, Nagaon under student READY Programme at ICAR-CIFT, Kochi on 19.09.2023.

Economic dimensions of processing and marketing of fish - SCSP training programme on 'Current trends in food processing technology' organized at ICAR-CIFT, Kochi on 21.11.2023.

### Dr B. Madhusudana Rao

CIFT interventions in value added product development in fisheries - Aqua Goa Mega Fish Festival, organized by the Directorate of Fisheries, of Goa at Panaji, on 12.02.2023.

Introduction to Food Safety and overview of Microbial Hazards in Fishery Products - Training programme for Technologists of Seafood Processing Units, organized by Export Inspection Agency, S.O. at EIA, Visakhapatnam on 29.03.2023.

Fish and Marine Products Processing - Training programme on 'Entrepreneurship Development Programme-Food Processing organized by Federation of Andhra Pradesh Chambers of Commerce and Industry (FAPCCI), Visakhapatnam, Online on 26.04.2023

Harvest and Postharvest handling of shrimp - Certificate Course on 'Shrimp Farming and Better Management Practices' organized by Avanti-AU Aquaculture Skill Development Centre, at Visakhapatnam on 30.09.2023

ICAR-CIFT's role in Post-Harvest Fisheries: An overview of research and entrepreneurship activities - Colloquium on 'Research and Entrepreneurial Opportunities in Marine resources and Aqua culture' organized by the Department of Biotechnology, Institute of Science, GITAM (Deemed to be University) at GITAM university on 06.10.2023

Harvest and Postharvest handling of shrimp - Certificate Course on 'Shrimp Farming and Better Management Practices' organized by Avanti-AU Aquaculture Skill Development Centre, at Visakhapatnam on 02.11.2023

Antibiotic Residues and Antimicrobial Resistance – an overview of the twin issues in fisheries - Awareness Workshop on Antimicrobial Resistance program organized by National Center for Sustainable Aquaculture (NaCSA-MPEDA) at Thallarevu, Kakinada on 15.11.2023

Alternatives to antibiotics with special reference to bacteriophages for aquatic animal disease management and food safety - National Workshop on 'One Health Issues: Preventing, Antimicrobial Resistance Together' Session III: Alternatives to antibiotics use in Human, Livestock and Fishery sector, organized by ICAR-Central Institute of Freshwater Aquaculture (ICAR-CIFA) CIFA, at Bhubaneswar on 18.11.2023

Shrimp export trends and market status & shrimp farm auditing - 18th SDP Programme on 'Shrimp Processing & Quality Assurance for Export organized by Avanti-AU Aquaculture Skill Development Centre, at Visakhapatnam on 22.11.2023

Layout of shrimp processing plant and equipment used in processing plant - 18th SDP Programme on 'Shrimp Processing & Quality Assurance for Export' organized by Avanti-AU Aquaculture Skill Development Centre, at Visakhapatnam on 23.11.2023.

### Dr. U. Sreedhar

Use of Electronic Devices and Artificial Intelligence in Fisheries - Seminar on "5G mobile technology, design, development, implementation challenges and use cases" organized by Telecom Regulatory Authority of India (TRAI) at Visakhapatnam on 31.03.2023.

### Dr. Viji P.

Smoke curing of fish - Training programme on Fish Smoking Units and Fish Value addition, sponsored by the UNDP Global Climate fund in coordination with Forest Department Online on 18.03.2023.

Fish processing and quality assurance - Mega awareness campaign on "Ocean information and Advisory series" conducted by INCOIS at Machlipatnam, Andhra Pradesh on 07.07.2023

Hygienic drying practices for fish - Awareness workshop on "Modern Fish Drying Technique and Value Addition" conducted jointly by DRDA and MPEDA NEFISH at SIFT, Kakinada on 11.07.2023

Good harvesting and handling practices at farm for Penaeus vannamei - 18th SDP Programme on 'Shrimp Processing & Quality Assurance for Export' organized by Avanti-AU Aquaculture Skill Development Centre, at Visakhapatnam on 22.11.2023

Preprocessing of shrimp and product styles - 18th SDP Programme on 'Shrimp Processing & Quality Assurance for Export' organized by Avanti-AU Aquaculture Skill Development Centre, at Visakhapatnam on 24.11.2023

Value added products and by products from shrimp - 18th SDP Programme on 'Shrimp Processing & Quality Assurance for Export' organized by Avanti-AU Aquaculture Skill Development Centre, at Visakhapatnam on 27.11.2023

### Dr. Ashish Kumar Jha

Importance of Cold Chain in Fisheries Post-harvest Management - Global Fisheries Conference 2023 organised by Ministry of Fisheries, Animal Husbandry & Darying, GoIScience city, at Ahmedabad, Gujarat on 22.11.2023.

Fish meal alternative in aqua feed Entrepreneurship on Fish Feed Production as part of training programme sponsored by MSME, GoI at Sher-e- Kashmir University of Agriculture Science and Technology, Srinagar on 07.12.2023.

Responsible Fishing Methods: ICAR-CIFT initiatives - 'Mega Awareness Campaign on Ocean Information and Advisory Services' conducted by INCOIS in collaboration with ICAR-CIFT at Veraval, Gujarat on 13.07.2023.

### Dr. A. Jeyakumari

Advances in seafood processing and waste utilization (virtual mode) - World fisheries day celebration at Dr. M.G.R Fisheries college and Research Institute, Ponneri on 21.11.2023.

### Dr. Prajith K. K.

Higher education opportunities after higher secondary education in Science - *'One-day workshop on higher education'* under the title *'gyan Deepam'* ,Programme organized by UNESCO Chair on Indigenous Cultural Heritage and Sustainable Development, University of Calicut at Government Model Residential Higher Secondary School for Girls, Kasaragod on 01.07.2023

### Dr. Sandhya K. M.

Fishing Technologies for Sustainable Fisheries - Online Workshop cum Training programme organized by Faculty of Fisheries, SKUAST, Kashmir from 03.08.2023 to 09.08.2023.

### Dr. Remya S.

Packaging and labelling requirements - International training programme on 'ISO 22000/HACCP for fish processing establishments' sponsored by ITEC, Ministry of External Affairs, GOI and organized by ICAR-CIFT, Kochi on 16.01.2023.

Nanomaterials in food packaging - SCSP training programme on 'Basics of food packaging & testing of packaging materials' organized by Fish Processing Division of ICAR-CIFT, Kochi on 28.02.2023.

FSSAI regulations on food packaging and labelling - SCSP training programme on 'Basics of food packaging & testing of packaging materials' organized by Fish Processing Division of ICAR-CIFT, Kochi on 01.03.2023.

Hygienic Handling of Fish - SCSP Programme of ICAR-CIFT, Kochi at Neendakara Fishing Harbour, Kollam on 10.05.2023.

Novel Packaging Techniques - Training for Master Trainers under the Farm Plan based Production Programme Project being organized at Thiruvalla for the Officers of the State Department of Agriculture/BLAKC nodal officers of Kerala Agricultural University Online on 20.06.2023.

Testing and quality evaluation of paper-based packaging materials - High-end Workshop ('KARYASHALA') on 'Advanced food packaging techniques and quality evaluation of packaging materials' funded by SERB (DST), New Delhi under Accelerate Vigyan Scheme ICAR - CIFT, Kochi on 21.06.2023

Regulations on food packaging and labelling - High-end Workshop ('KARYASHALA') on 'Advanced food packaging techniques and quality evaluation of packaging materials' funded by SERB (DST), New Delhi under Accelerate Vigyan Scheme ICAR - CIFT, Kochi on 27.06.2023.

Quality issues in battered and breaded fishery products' & 'Packaging of battered and breaded fishery products' - Hands-on training on 'Preparation of enrobed and marinated fish and shellfish products' for Mangala Marine Exim India Private Limited, Aroor, Kerala from ICAR-CIFT, Kochi; 24.07.2023 to 27.07.2023.

Testing and quality evaluation of paper & plastic packaging materials - Training programme on 'Advanced food packaging techniques and quality evaluation of packaging materials' under SCSP on 07.08.2023.

Regulations on food packaging and labelling - Training programme on 'Advanced food packaging techniques and quality evaluation of packaging materials' under SCSP at FP Division, ICAR-CIFT, Kochi 08.08.2023.

Post-mortem changes in fish - In-plant training programme for BFSc students of College of Fisheries, Assam (Assam Agricultural University, Raha, Nagaon) under student READY Programme at ICAR-CIFT, Kochi 10.08.2023.

Non-thermal fish preservation techniques - In-plant training programme for BFSc students of College of Fisheries, Assam (Assam Agricultural University, Raha, Nagaon) under student READY Programme at ICAR-CIFT, Kochi; 16.08.2023.

Seafood processing and packaging - Value Added Course (VAC) on 'Sustainable Aquaculture Practices and Innovations in Fish Processing Technology' organized by Department of Zoology, University of Calicut Online on 14.09.2023.

Packaging of fish and fishery products - Training programme on 'Advances in Seafood Processing and Waste Utilization' under SCSP programme organized by FP Division of ICAR-CIFT, Kochi 07.11.2023.

Non-thermal processing techniques & MAP, Active and intelligent packaging - International training programme on "Technological Interventions in Processing, Value addition and Packaging of Aquatic Resources" sponsored by the Indian Technical and Economic Cooperation (ITEC) Programme under the Ministry of External Affairs, Government of at ICAR-CIFT, Kochi; on 24.11.2023.

General Packaging - In the series of online lectures for the benefit of students and innovators organized by Kalpa Agri. Business Incubator, ICAR-Central Plantation Crops Research Institute, Kasaragod Online; 30.11.2023.

### Dr. Jesmi Debbarma

Seaweeds: Scope and Potential' and 'Vacuum and modified atmospheric packaging of fish and fishery products - ToT Programme on " Advanced Value chain and business plan development for fishery enterprises" at NIRDPR, Hyderabad from 17.01.2023 to 20.01.2023

Raw Material Evaluation and Acceptance Criteria' - 18th SDP Programme on 'Shrimp Processing & Quality Assurance for Export' organized by Avanti-AU Aquaculture Skill Development Centre, at Visakhapatnam on 24.11.2023.

Freezing of shrimp: mechanism of plate freezing, individual quick freezing (IQF) and Blast freezing - 18th SDP Programme on 'Shrimp Processing & Quality Assurance for Export' organized by Avanti-AU Aquaculture Skill Development Centre, at Visakhapatnam on 27.11.2023

Packaging: types and different packaging materials and primary and secondary packaging and labelling - 18th SDP Programme on 'Shrimp Processing & Quality Assurance for Export' organized by Avanti-AU Aquaculture Skill Development Centre, Visakhapatnam Avanti-AU Aquaculture Skill Development Centre, at Visakhapatnam on 28.11.2023.

### Dr. Laly S. J.

Success and experience on product development and commercialization - World Intellectual Property Day celebration of ICAR-CIARI, Port Blair, Online on 26.04.2023.

### Dr. Martin Xavier K. A.

Micro-plastic and challenges posed along the fish value chain - Swachhta Hi Sewa Campaign talk at ICAR-CIFT on 27.09.2023.

Microplastic: A Challenge for Aquatic Environment - NAHEP Sponsored training programme on Water Quality Management: A Practical Aproach Sher-E-Kashmir University of Agricultural Sciences and Technology of Kashmir (SKUAST-K) (Online mode) on 20.10.2023.

Assessment of Plastic and Microplastic Pollution in Aquatic Resources: An overview concerning UN SDGs - National Workshop on "Harnessing emerging techniques for sustainable fisheries and Aquaculture in Eastern Uttar Pradesh" College of Fisheries, ANDUAT (Online mode) on 27.11.2023.

Microplastic challenges in the context of United Nations Sustainable Development Goals (SDGs) - Talk on Sustainable Development Goals 2030 PM SHRI KV INS DRONACHARYA Kochi 30.11.2023.

Present status of microplastics level in seafood - Lead talk at National Workshop

On Microplastic in Seafood Value Chain: Challenges & Way Forward at CIFT, Kochi on 19.12.2023.

### Dr. Parvathy U.

Onboard fish handling and preservation - Expert interaction class to VHSE students GRFTVHSS, Azheekal Online, on 17.01.2023

Sea food handling and curing - Novel Techniques for fish drying and its preservation - NRLMRC, NIRDPR Training program on Advanced Value Chain and Business Development Plan for Fishery Based Enterprises" at NIRDPR, Hyderabad on 18.01.2023.

Fish processing and value addition - opportunities and incubation facility - Technology Clinic for fisheries entrepreneurs at DIC, Alappuzha on 24.01.2023.

Onboard fish handling and preservation - Expert interaction class to VHSE students GRFT VHSS at Tanur, Kerala Online, on 13-02-2023.

Preparation of ethnic fish products - In-plant training on Fish processing for MSc. Food Technology students of Silver College, Perambra at ICAR-CIFT, Kochi on 30.05.2023.

Fish Processing and Value Addition - Session on Climate Adaptive & Climate Resilient Livelihoods -

Vision Building Workshop Online, on 13.07.2023.

Value Addition in Seafood Sector - In-plant training programme for BFSc students of College of Fisheries, Assam (Assam Agricultural University, Raha, Nagaon) under student READY Programme at ICAR-CIFT, Kochi; on 08.08.2023

Handling of Fish and Fishery Products - International training programme on "Technological Interventions in Processing, Value addition and Packaging of Aquatic Resources" sponsored by the Indian Technical and Economic Cooperation (ITEC) Programme under the Ministry of External Affairs, Government of India at ICAR-CIFT, Kochi; on 21.11.2023.

Value addition of fish and fishery products International training programme on "Technological Interventions in Processing, Value addition and Packaging of Aquatic Resources" sponsored by the Indian Technical and Economic Cooperation (ITEC) Programme under the Ministry of External Affairs, Government of India at ICAR-CIFT, Kochi on 22.11.2023.

Mince and Surimi based products - International training programme on "Technological Interventions in Processing, Value addition and Packaging of Aquatic Resources" sponsored by the Indian Technical and Economic Cooperation (ITEC) Programme under the Ministry of External Affairs, Government of India at ICAR-CIFT, Kochi; on 28.11.2023.

### Dr. Sarika K.

Role of women in fisheries value chain - Global Fisheries Conference 2023 organized by Ministry of Fisheries, Animal Husbandry & Dairying, GoI at Science city, Ahmedabad, Gujarat on 21.11.2023.

### Dr. Chinnadurai S.

Recent advances in fishing technology - Theory session for final year B.FSc students Fisheries college at Veraval, on 08.07.2023.

Responsible Fishing Methods: ICAR-CIFT initiatives - 'Mega Awareness Campaign on Ocean Information and Advisory Services' conducted by INCOIS in collaboration with ICAR-CIFT at Veraval, Gujarat on 13.07.2023

### Dr. Manju Lekshmi N.

Marine pollution and its solution to the Ocean - Marine pollution and its solution to the Ocean Seminar SKAL international and udayasamudra group of Hotels at Udayasamudra hotel, Trivandrum on 08.06.2023.

Issues of marine litter and its solution to the Pollution - Issues of marine litter and its solution to the Pollution response seminar and workshop at Coast guard district Headquarters, Kochi on 09.08.2023 and 10.08.2023.

Marine litter and its impacts - Marine litter and its impacts at Kendriya Vidayala, Mudamveli, on 31.10.2023

Marine litter with special emphasis on fishing plastics – 'National workshop on micro plastic in seafood value chain: challenges and way forward' under Swachta Action Plan at ICAR-CIFT, Kochi on 19.12.2023.

### Mr. Paras Nath Jha

Energy use in fishing - In-Plant training on harvest and post-harvest technologies in fisheries for B.F.Sc students of COF, Dholi (RPCAU, Bihar) organized by ICAR-CIFT, Kochi from 17.01.2023 to 06.02.2023

Energy Optimization in fishing: A step towards responsible and sustainable fishery - Workshop-cum-training program on 'Fishing Technologies for Sustainable Fisheries' organized by Fishing Technology Division of Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu (SKUAST-Jammu) from 03.08.2023 to 09.08.2023

Carbon Credit/offset and emissions in Marine Fisheries - "International Maritime Conference on Marine Conservation and Sustainability", Celebrating 50 Years of MARPOL at School of legal Studies, CUSAT, Kochi on 19.10.2023 and 20.10.2023

### Smt. T. Muthulakshmi

Indicators of microbiological quality in fish and fishery products - B. F. Sc students of Dr. M.G.R Fisheries College and Research Institute of TNJFU Online Lecture on 12.10.2023

### Dr. Elavarasan K.

Onboard Fish Processing Techniques AKAM Mega Awareness Campaign on Ocean Information and Advisory Services organized by M.S. Swaminathan Research Foundation, in collaboration with INCOIS M.S. Swaminathan Research Foundation Taramani, in Chennai, Tamil Nadu on 11.08.2023.

Food Entrepreneurship: Support Services from ICAR-Central Institute of Fisheries Technology - Fostering Food Entrepreneurship in Kerala: Leveraging Support Services from Central Research Institutes at ICAR-CMFRI on 30.12.2023.

### Dr. Sreelakshmi K. R.

Fish Processing Methods - Half day general orientation programme organized by District Industries centre Ernakulam, Taluk Industries Office Kanayannur, and Mulavukad Grama Panchayath at Korampadam Service Cooperative Bank Hall, Pizhala, Kadamakkudy on 14.08.2023.

### Smt. Priya E. R.

Quality Assurance and HACCP in seafood - 3 days job training program for the trainees of vocational course at CIFNET, Kochi (Online mode) from 17.01.2023-19.01.2023.

### Dr. Sathish Kumar K.

Development of biodegradable packaging materials from marine and agro-waste - dvanced food packaging techniques and quality evaluation of packaging materials at ICAR-CIFT, Kochi, from 19.06.2023 to 27.06.2023.

Traditional methods of fish processing - ITEC on "Technological interventions in Processing, Value addition and Packaging of Aquatic Resources" at ICAR-CIFT, Kochi, from 20.11.2023 to 08.12.2023.

Testing of packaging materials - ITEC on "Technological interventions in Processing, Value addition and Packaging of Aquatic Resources" at ICAR-CIFT, Kochi, from 20.11.2023 to 08.12.2023.

### Dr. S. Murali

Energy and water use optimization techniques for seafood processing industries - Training programme on "Advances in food process engineering and preservation" for B.Tech. students under the SCSP programme at ICAR-CIFT, Kochi on 20.01.2023.

AI and IoT applications in food processing - Training programme on "Advances in food process engineering and preservation" for B.Tech students under the SCSP programme at ICAR-CIFT, Kochi on 20.01.2023.

CIFT dryers and success stories - National webinar on "Dryfish technologies and consumer market" organized by the Department of Fisheries, GoI (Online mode) on 20.02.2023.

Sustainable energy options for the post-harvest fisheries sector - International conference on "Sustainable materials and advances in renewable technologies" (SMART-23) as a keynote speaker organized by St. Mother Theresa Engineering College, Tamilnadu & Villa College, Maldives (Online mode) on 24.03.2023.

Good Practices and FSSAI Standards for Dried Fish Production - Inception cum Orientation Workshop of Technical collaboration between Mission Shakti Department, Govt. of Odisha and WorldFish held at Bhubaneswar on 20.05.2023.

Sustainable energy options for drying food materials - DST-SERB, Sponsored High-End Workshop organized by ICAR-CPCRI, Kasargod (Online mode) on 04.09.2023.

Equipment and instruments for small-scale fish processing industries - In-plant training for the 4th year B.FSc. students' college of fisheries, AAU, Raha during under the student-ready programme on 22.09.2023

Engineering interventions in post-harvest fisheries - In-plant training programme B.Tech. Agricultural Engineering students of the college of KAU-KCAET, Tavanur on 04.10.2023

CIFT machineries in fish processing - Training Programme on 'Technological Interventions in Processing, Value Addition and Packaging of Aquatic Resources' organized by ICAR-CIFT, Kochi and sponsored by the Indian Technical and Economic Cooperation (ITEC) Programme on 23.11.2023.

CIFT's Engineering Solutions for Post Harvest Fisheries Sector" - Training course on "Current trends in food processing and preservation" for B.Tech/M.Tech Scheduled Caste category students under SCSP on 20.11.2023.

Theory classes for the students of KAU-KCAET Tavanur - RAWE-In-plant training programme at ICAR-Central Institute of Fisheries Technology, Kochi from 13.11.2023 to 17.11.2023

### Dr. Aniesrani Delfiya D. S.

Advanced drying methods for fish and fishery products - Training programme on "Advances in food process engineering and preservation" for B.Tech. students under the SCSP programme at ICAR-CIFT, Kochi on 16.01.2023.

Community food security - International Conference on "Innovative Approaches in Crop Improvement for Sustainable Agriculture" – IACISA 2023 conducted by JSA college of Agriculture and Technology, Avatti, Tamil Nadu as keynote speaker on 23.02.2023.

Advances in seaweed drying - Training programme on "Marine biopolymers - Extraction and applications" under SCSP programme on 21.03.2023

Nanomaterials for enhanced solar thermal energy collection and storage - International conference on "Sustainable materials and advances in renewable technologies" (SMART-23) as a keynote speaker organized by St. Mother Theresa Engineering College, Tamilnadu & Villa College, Maldives on 24.03.2023 (Online mode)

IR drying of fish and fishery products - In-plant training for the 4th year B.FSc. students' college of fisheries, AAU, Raha during under the student-ready programme on 22.09.2023

A practical class on "Shrimp drying in IR dryer" - In-plant training programme under "Student Ready Programme" for B.F.Sc. students of the college of Fisheries, AAU, Raha on 22.09.2023

Nanomaterials for enhanced solar thermal energy collection and storage - In-plant training programme of B.Tech. Agricultural Engineering students of the college of KAU-KCAET, Tavanur on 04.10.2023

Theory and practical classes for the students of KAU-KCAET Tavanur - RAWE-In-plant training programme at ICAR-Central Institute of Fisheries Technology, Kochi from 13.11.2023 to 17.11.2023.

Infrared drying of foods" - Training course on "Current trends in food

processing and preservation" from 20 – 24th November 2023 for B.Tech/M.Tech Scheduled Caste category students under SCSP on 21.11.2023

### Dr. Neethu K. C.

Innovative engineering solutions for postharvest fisheries technology - Training programme on "Advances in food process engineering and preservation" for B.Tech. students under the SCSP programme at ICAR-CIFT, Kochi on 16.01.2023.

Novel Engineering Solutions for Post-Harvest Fisheries Technology - Faculty Development Program (FDP) organized by the Department of Biotechnology and Biochemical Engineering, Sree Buddha College of Engineering, Pattoor, Alappuzha on 'Novel Technological Advancement in Downstream Processing' on 01.02.2023.

Energy and exergy analysis of solar-electrical hybrid dryer - In-plant training for the 4th year B.FSc. students' college of fisheries, AAU, Raha during under the student-ready programme on 22.09.2023

Design and development of smoking kiln - In-plant training programme of B.Tech. Agricultural Engineering students of the college of KAU-KCAET, Tavanur on 03.10.2023.

Design and development of an ozone-based food processing system - Training course on "Current trends in food processing and preservation" for B.Tech/M. Tech Scheduled Caste category students under SCSP on 22.11.2023.

Theory classes for the students of KAU-KCAET Tavanur - RAWE-In-plant training programme at ICAR-Central Institute of Fisheries Technology, Kochi from 13.11.2023 to 17.11.2023.

### Dr. Ahamed Basha K.

Food borne Human pathogens - 18th SDP Programme on 'Shrimp Processing & Quality Assurance for Export' organized by Avanti-AU Aquaculture Skill Development Centre, at Visakhapatnam on 29.11.2023.

Hygiene & Standard Sanitation Protocols for Shrimp Processing Plant - 18th SDP Programme on 'Shrimp Processing & Quality Assurance for Export' organized by Avanti-AU Aquaculture Skill Development Centre, at Visakhapatnam on 03.12.2023.

### Dr. Sreepriya Prakasan

Analysis of Quality Indices of Fish - In-plant training on Fish processing for MSc. Food Technology students of Silver College, Perambra at ICAR-CIFT, Kochi on 24.05.2023.

Hygienic handling and drying of fish - In-plant training on Fish processing for MSc. Food Technology students of Silver College, Perambra at ICAR-CIFT, Kochi on 25.05.2023.

Formulation of fish ball with herbs/ spices - Hands-on training on "Preparation of enrobed and marinated fish and shellfish products" for Mangala Marine Exim India Private Limited, Aroor, Kerala at ICAR-CIFT, Kochi from 24.07.2023 to 27.07.2023.

Preparation of fish cutlet, enrobed squid rings, and octopus tentacles - Hands-on training on "Preparation of enrobed and marinated fish and shellfish products" for Mangala Marine Exim India Private Limited, Aroor, Kerala at ICAR-CIFT, Kochi from 24.07.2023 to 27.07.2023.

Cured Fishery Products - In- Plant training under student's READY programme for the 4th year B.F.Sc. students of College of Fisheries, AAU, Raha at ICAR-CIFT, on 08.08.2023.

# HUMAN RESOURCE DEVELOPMENT CELL

During the period under report, the Human Resource Development Cell of ICAR-CIFT met several times for deliberations and decision-making with regard to training requirements of staff of the Institute. Individual requests from staff members of all categories for their capacity building needs were processed for approvals. In addition, necessary approvals were obtained from the competent authority to enable staff who were specifically nominated by Secretary DARE and DG, ICAR and HRM Division of ICAR to undergo training.

As recommended by HRD Cell, staff of CIFT participated in 23 training programmes during the year. The HRD Cell ensures that every employee records the training information in the ICAR-ERP system following completion of the training. Training needs assessment and Annual Training Plan (ATP) for Scientific, Technical, Administrative and Skilled Support Staff were made for the year 2023 and the ATP 2022-23 has been uploaded on the Institute website. Upon a request from the HRM Division of ICAR, category-wise and employee-wise skill deficient areas were furnished to the Council based on which the ATP 2020-23 was revised to include staff who hadn't undergone training during the past 7 years. Impact assessment of the trainings attended during the year 2020-21 was processed and furnished to the council.

## Participation of staff in Training Programmes (Category wise)

### Scientific Staff

| Sl. No | Name(s) of Participant(s) | Training Attended | Organizer, Venue & Date |
|---|---|---|---|
| 1 | Dr. Elavarasan K. | Online International Training Programme on Millets for Global Food Security | 13-02-2023 to 16-02-2023 AARDO Headquarters |
| 2 | Dr. Remya S. | Online International Training Programme on Millets for Global Food Security | 13-02-2023 to 16-02-2023 AARDO Headquarters |
| 3 | Dr. Mohan. C. O | Online International Training Programme on Millets for Global Food Security | 13-02-2023 to 16-02-2023 AARDO Headquarters |
| 4 | Dr. G. K. Sivaraman | Competency Enhancement Programme for Effective Implementation of Training Functions by HRD Nodal Officers of ICAR | 27-02-2023 to 01-03-2023 ICAR-NAARM, Hyderabad |
| 5 | Shri. Shravan Kumar Sharma | Online training Program on Data Visualization using R ICAR-NAARM, Hyderabad, during 01-08$^{th}$ March 2023. | 01-03-2023 to 08-03-2023 ICAR-NAARM, Hyderabad |
| 6 | Shri. Ezhil Nilavan S. | Training Workshop on Molecular Cloning and Protein Expression | 15-04-2023 to 30-04-2023 Centre for Cellular and Molecular Biology (CCMB), Hyderabad |
| 7 | Dr. T.Raja Swaminathan | Training programme on Laboratory Quality Management System and Internal Audit as per ISO/IEC 17025:2017 | 04-09-2023 to 08-09-2023 National Institute of Plant Health Management (NIPHM), Hyderabad |

| | | | |
|---|---|---|---|
| 8 | Dr. Murugadas.V | Training on AMU | 14-09-2023 to 15-09-2023 FAO, Hyderabad |
| 9 | Dr. T. V. Sankar | online Orientation training programme for Retiring Government Officials [OTP-RGO-14] | 18-09-2023 to 19-09-2023 ISTM, New Delhi |
| 10 | Dr. Niladri S. Chatterjee | Training Course on ISO/ IEC17025:2017 | 03-10-2023 to 07-10-2023 NABL, Delhi-NCR |
| 11 | Dr. Ranjit Kumar Nadella | Training Course on ISO/ IEC17025:2017 | 03-10-2023 to 07-10-2023 NABL,Delhi-NCR |
| 12 | Dr. Minimol V. A. | Online Training programme on Omics Data Analysis : Genome to Proteome | 09-10-2023 to 18-10-2023 ICAR-IASRI, New Delhi |
| 13 | Dr. Femeena Hassan | Online Training on Next Generation Sequencing (NGS) Data Analysis | 16-10-2023 to 20-10-2023 ICAR-NAARM, Hyderabad |
| 14 | Dr. Joshy C.G. | Online Certificate Course on Image Processing and Deep Learning | 16-10-2023 to 20-10-2023 NIELIT, Calicut |
| 15 | Dr. Devananda Uchoi | Online Training on Next Generation Sequencing (NGS) Data Analysis | 16-10-2023 to 20-10-2023 ICAR-NAARM, Hyderabad |
| 16 | Dr. Ranjit Kumar Nadella | Online Training on Next Generation Sequencing (NGS) Data Analysis | 16-10-2023 to 20-10-2023 ICAR-NAARM, Hyderabad |
| 17 | Shri. Shravan Kumar Sharma | Training programme on Advances in Applications of Nanotechnology | 30-10-2023 to 03-11-2023 ICAR-CIRCOT, Mumbai |
| 18 | Dr. Anupama T. K. | online training programme on Metagenomics Data Analysis | 11-12-2023 to 13-12-2023 ICAR-IASRI, New Delhi |

## Technical Staff

| Sl.No | Name(s) of Participant(s) | Training Attended | Venue & Date |
|---|---|---|---|
| 1 | Dr. Dhiju Das P. H. | Remote pilot training | 08-05-2023 to15-05-2023 MIT Campus, Anna University, Chennai, |
| 2 | Ms. Arya S. Raj | Training Programme on Laboratory Quality Management System and Internal Audit as per ISO/IEC 17025: 2017 | 18-07-2023 to 21-07-2023 Sophisticated Test and Instrumentation Centre (STIC), CUSAT Campus |
| 3 | Shri. Suresh P. | Training course on Animal cell culture techniques (Module 4) | 01-10-2023 to 10-10-2023 IISER, Kolkata |
| 4 | Dr. Dhiju Das P. H. | US certified PADI (Professional Association of Diving Instructors) Dive Master course | 14-10-2023 to 15-10-2023Scuba Kochi PADI Recognized Dive Centre, Ernakulam |
| 5 | Dr. Sreejith V. N. | Certificate programme in Bio-informatics (online) Offline practical session | 01-12-2023 to 15-12-2023 Rajiv Gandhi Centre for Biotechnology (RGCB), |
| 6 | Ms. Megha G. | Training on Laboratory Quality Management System and Internal Audit as per ISO/IEC17025:2017 | 18-12-2023 to 21-12-2023 STIC, CUSAT Kochi |

## Administrative Staff

| Sl.No | Name(s) of Participant(s) | Training Attended | Venue & Date |
|---|---|---|---|
| 1 | Shri Anil Kumar P. P. | Training programme on Budget Utilization Procedure | 09-01-2023 to 13-01-2023 ICAR-NAARM, Hyderabad, at ICAR-CIFE, Mumbai. |
| 2 | Shri Subramanian R. N. | Training programme on Budget Utilization Procedure | 09-01-2023 to 13-01-2023 ICAR-NAARM, Hyderabad, at ICAR-CIFE, Mumbai. |
| 3 | Shri Mahesh B. Khubdikar | Training programme on Budget Utilization Procedure | 09-01-2023 to 13-01-2023 ICAR-NAARM, Hyderabad, at ICAR-CIFE, Mumbai |
| 4 | Smt. Mini P. R. | Prevention, Prohibition and Redressal of Sexual Harassment of Women at work place | 01-05-2023 ISTM, New Delhi |
| 5 | Shri. Syam Prasad T. R. | Prevention, Prohibition and Redressal of Sexual Harassment of Women at work place | 01-05-2023 ISTM, New Delhi |
| 6 | Shri Vinod Kumar M. N. | Prevention, Prohibition and Redressal of Sexual Harassment of Women at work place | 01-05-2023 ISTM, New Delhi |
| 7 | Shri Vinodh Kumar M. N. | Training Programme on Technical Service Rules | 10-07-2023 to 11-07-2023 NAARM, Hyderabad |
| 8 | Shri Subramanian R. N. | Training programme on Technical Service Rules | 10-07-2023 to 11-07-2023 NAARM, Hyderabad |
| 9 | Shri Mani P. | Training programme on Technical Service Rules | 10-07-2023 to 11-07-2023 NAARM, Hyderabad |
| 10 | Smt. Akhila N. R. | Online Training Programme on Reservation in Service for SC/ST/ OBC/ExSM/PWDs | 13-11-2023 to 16-11-2023 The Institute of Secretariat Training and Management ISTM, New Delhi |
| 11 | Smt. Renuka K. | Online Training Programme on Reservation in Service for SC/ST/ OBC/ExSM/PWDs | 13-11-2023 to 16-11-2023 The Institute of Secretariat Training and Management ISTM, New Delhi |
| 12 | Shri Shyam Prasad T. R. | Online Training Programme on Reservation in Service for SC/ST/ OBC/ExSM/PWDs | 13-11-2023 to 16-11-2023 The Institute of Secretariat Training and Management ISTM, New Delhi |
| 13 | Shri Vinodh Kumar M. N. | Online Training Programme on Reservation in Service for SC/ST/ OBC/ExSM/PWDs | 13-11-2023 to 16-11-2023 The Institute of Secretariat Training and Management ISTM, New Delhi |
| 14 | Smt. Ponnamma Radhakrishnan | Online Training Programme on Reservation in Service for SC/ST/ OBC/ExSM/PWDs | 13-11-2023 to 16-11-2023 The Institute of Secretariat Training and Management ISTM, New Delhi |
| 15 | Smt. Mini P. R. | Online Training Programme on Reservation in Service for SC/ST/ OBC/ExSM/PWDs | 13-11-2023 to 16-11-2023 Institute of Secretariat Training and Management ISTM, New Delhi |
| 16 | Smt. Raji V. K. | Training on Pension & Retirement benefits & National Pension System (NPS) | 15-11-2023 to 17-11-2023 ICAR-NBSS&LUP, Nagpur |
| 17 | Smt. Mini P. R. | Online Workshop on conduct of inquiry on complaints relating to Sexual harassment of women at workplace | 27-11-2023 Institute of Secretariat Training and Management ISTM, New Delhi |

## Students

| Sl.No | Name(s) of Participant(s) | Training Attended | Venue & Date |
|---|---|---|---|
| 1. | Shri Mohammed Jabir K. K. (JRF) | Nippon Foundation-POGO Regional Training Programme | 12-03-2023 to 23-03-2023 Department of Oceanography of the Shahjalal University of Science and Technology (SUST), Bangladesh |
| 2. | Dr. Rithin Joseph, (YP) | Remote pilot training | 08-05-2023 to15-05-2023 MIT Campus, Anna University, Chennai |

## Foreign visits


**Dr. George Ninan, Director, ICAR-CIFT Visited the World Fish Centre at Abbasiya, Egypt to attend the Project Workshop on Developing a 5-year joint research program between ICAR Fisheries Research Institutions and the WorldFish (Asia and Africa) (30th October 2023 to 4th November 2023).**

# ZONAL TECHNOLOGY MANAGEMENT & AGRIBUSINESS INCUBATION CENTRE

The Zonal Technology Management and Agribusiness Incubation (ZTM-ABI) Centre at ICAR-CIFT serves as a dynamic platform for the swift commercialization of technologies, enhancing public-private collaborations through a structured network connecting R&D organizations, businesses, and financial entities. The Centre is committed to fostering innovation in products, processes, and business models, thus driving the development of competitive enterprises within the fishing industry. It provides an array of proactive, value-added business services to its registered incubatees, including technology transfer, contract research, consultancy, and contract services, along with office space, access to a licensed, state-of-the-art pilot-level production facility, on-site guidance, and tailored training programs aimed at launching technology-driven businesses.

The Incubation Centre boasts multi-tenant infrastructure facilities ideal for establishing a corporate-level office for direct incubatees at the Institute's location. Its direct incubation services are designed to assist clients through their initial growth phases. The Centre actively organizes Business Meets and industry-interface programs to engage entrepreneurs, selecting promising business ideas for incubation. Registered incubatees have the opportunity to consult with scientists and business experts as needed, helping them refine product formulations and develop effective business strategies. Overall, the ZTM-ABI Centre at ICAR-CIFT is dedicated to nurturing innovation and entrepreneurship in the fishing industry by providing a comprehensive suite of business services and support.

## Achievements During January - December 2023

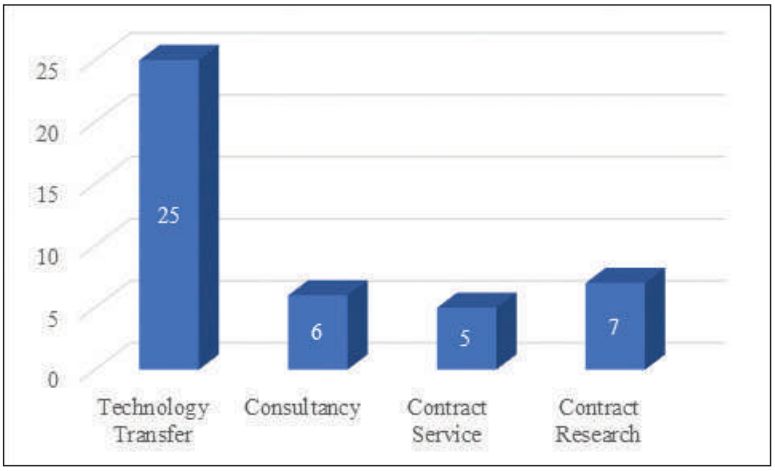
### Incubatee Registration

In 2023, the ZTM-ABI Centre registered 10 entrepreneurs for its business incubation services. The Centre provides support to a broad spectrum of clients, ranging from nascent startups needing basic technology assistance and training, to mature businesses looking for R&D support to diversify their products. Below is a list of clients who registered for various technologies at the Centre over the year:

| S. No. | Name of the incubatee / entrepreneur | Technology |
|---|---|---|
| 1 | Dr. Preetha Shenoy | Nutraceutical food products from microalgae |
| 2 | Mr. Jiswin Joseph (Dhi Research) | Data consultancy and technical inputs for ornamental fisheries, aquaponics and aquaculture |
| 3 | Mr. Suresh Stephen, Trivandrum | Dry fish processing |
| 4 | Mr. Sudheesh A. | Dry fish processing |
| 5 | Global Food Processing Technologies and Exporters, Kottayam (Mrs. Dalia Beegom K.A.) | Dry fish processing |
| 6 | Mr. Joy Chirayath | Value-added products from Murrel fish |
| 7 | Universal Green Foods Pvt. Ltd. (Mrs. Rahumathunnisa M.I.) | Masala dry shrimp roast, chutney powder (with and without coconut), and fish feed |
| 8 | Parayil Bio Farm Pvt. Ltd., Ernakulam (Mr. Hari Gopinadh) | Vegan mayonnaise from chickpea isolates and hydrolysate |
| 9 | Kitchen Mate, Ernakulam (Ms. Rintu) | Cooked prawns |
| 10 | Mr. William Puthenparambil Pious | Dry fish |
| 11 | Puakai Agriaqua, Andhra Pradesh (Mr. Donkina Santhosh) | Development of nutraceuticals and functional food formulations from seaweed |
| 12 | ABAD Fisheries Pvt. Ltd., Ernakulam (Mr. Faraz Javeed) | Collagen peptide, Hydroxyapatite from fish skin, bones, and scales |

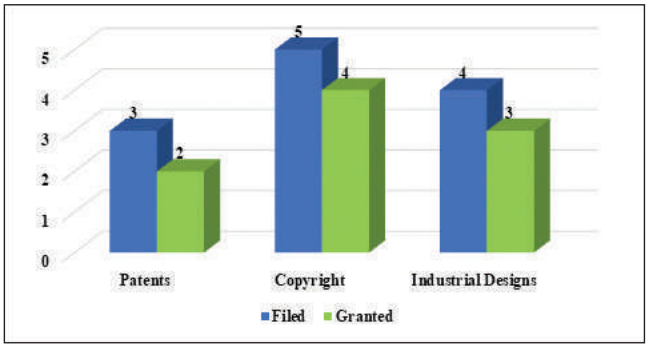
## Technology Transfer and Professional Service Functions

ICAR-CIFT has achieved notable progress in creating a range of technologies across various sectors, including energy-efficient fishing vessels, innovative gear designs, advanced processing and preservation methods, smart packaging solutions, value-added products and by-products, cost-effective food processing equipment, and healthcare/aquaceutical products. The chart below details the technology commercialization projects and professional services (such as Consultancy, Contract Research (Sponsored / Collaborative / Grant-in-Aid), and Contract Services) carried out by the ZTM-ABI Centre in 2023.



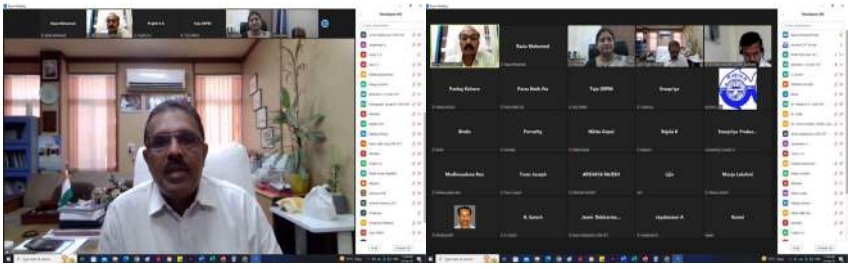

## Intellectual Property Rights

Intellectual Property Rights play a critical role in safeguarding the research output of institutes, promoting innovation, and creating a more vibrant and sustainable research ecosystem. During 2023, the ZTM-ABI Centre has facilitated the filing of 3 patents, 5 copyrights, and 4 industrial designs for ICAR-CIFT. The institute was awarded 2 patents, 4 copyrights, and 3 industrial designs.




## World Intellectual Property Day 2023

The ZTM-ABI Centre celebrated World IP Day 2023 on April 26th to recognize the critical role that intellectual property (IP) plays in promoting innovation and creativity around the world. The theme for this year's celebration was "Women and IP: Accelerating Innovation and Creativity" which aimed to honour the achievements of women who have shaped our world with their ingenuity, innovation, and creativity.



The webinar was organised with the aim of raising awareness about the critical role that IPR plays in fostering innovation and creativity, particularly in scientific institutes like ICAR-CIFT. The event was attended by 52 participants, including Scientists of ICAR Institutes and incubates of ZTM-ABI Centre. The resource person, Dr. Niharika Sahoo Bhattacharya,

Assistant Professor at Rajiv Gandhi School of Intellectual Property Law, Indian Institute of Technology (IIT), Kharagpur, spoke on the topic of "Role of IPR in promoting innovation and development" during the webinar. Dr. C.O. Mohan, Principal Investigator, ZTM-ABI Centre extended a warm welcome to the participants and Dr. George Ninan, Director, ICAR-CIFT, gave an overview of the importance of IPR and World IP day.


ICAR-CIFT considers World IP Day as a significant occasion for IP owners, policymakers, and the public to reflect on the importance of IP and the role it plays in driving economic growth and social development. The Webinar provided an opportunity to recognize the remarkable achievements of inventors, creators and innovators and to create an awareness about intellectual property rights.

## National Seminar 'AQUAMILLETS – Innovations in Millet and Fish-based Products'

The national seminar 'AQUAMILLETS – Innovations in Millet and Fish-based Products' was jointly organized by ICAR – Central Institute of Fisheries Technology, Zonal Technology Management – Agribusiness Incubation (ZTM-ABI) Centre, and Society of Fisheries Technologists (India) on December 15, 2023, in Kochi, Kerala. This event was part of the International Year of Millets (IYM2023), declared by the UN General Assembly. The seminar highlighted the potential of integrating millets with fish products.

The seminar was inaugurated by Vice Chancellor Prof. (Dr.) T. Pradeep Kumar and presided over by Dr. George Ninan, Director of ICAR-CIFT. Dr. Bindu J., Head of the Fish Processing Division, delivered the welcome address, and Dr. Nikita Gopal, Head of EIS & Secretary of SOFTI, proposed the vote of thanks. Dr. C. O. Mohan, Dr. Remya S., Senior Scientists, and Dr. K. Elavarasan, Scientist, served as the conveners of the seminar. The program included technical sessions and presentations by six eminent speakers: Dr. P.

Nisha, Principal Scientist at NIIST, Thiruvananthapuram; Shri. P. K. Lal, Chief Coordinator of the Millet Mission Kerala; Mrs. Latha R., Deputy Director of Agriculture, Thiruvananthapuram; Mr. Rahul, Assistant Manager at KIED, Kalamassery, Ernakulam; Dr. Anandavally, FAO Consultant & Trainer and Former Deputy Director, EIA, Kochi; and Dr. Remya S., Senior Scientist, ICAR-CIFT, Kochi. They explored various aspects of millet and fish-based products.

The event also featured exhibition stalls from various firms, including the Attapady Tribal Farmers Association for Millets (ATFAM) from Attapady, Drupagaya Foods in Alapuzha, Millet Factory and Farms (India) Pvt Ltd. in Attapadi, FEBC Pvt Ltd. in Kochi, Zara Biotech Pvt Ltd. in Ernakulam, Puakai Agriaqua in East Godavari, Andhra Pradesh, Amkette Analytics Ltd. in Thane, and ICAR-CIFT in Kochi. These firms showcased a diverse array of products such as millet grains, flours, mixes, instant millet and seaweed-based dosa/idly powders, millet seaweed cookies, powder mixes for various millet-based products, millet payasam, millet cookies, millet seaweed biscuits, millet fish sausage, millet extruded fish products, millet-based snacks with different flavors, millet flakes, and more.

## Workshop-cum-Exposure Visit for Entrepreneurs

The Zonal Technology Management – Agribusiness Incubation (ZTM-ABI) Centre of ICAR – Central Institute of Fisheries Technology (ICAR-CIFT), Kochi hosted a one-day Workshop-cum-Exposure Visit for Entrepreneurs in collaboration with Research Innovation Network Kerala (RINK) and Kerala Startup Mission, Govt. of Kerala, on 6th October 2023, in Kochi. The event provided a valuable platform for aspiring agribusiness entrepreneurs to explore and learn from scientists and experts.


The day commenced with an inaugural session graced by Dr. George Ninan, Director of ICAR-CIFT, who emphasized the pivotal role of innovation in fostering agribusiness growth and driving economic development. Subsequent sessions covered diverse topics, including fish processing technologies, sustainable utilization of fish processing discards, advanced packaging techniques, and engineering innovations. Engaging discussions centered on the extensive support initiatives offered by Kerala Startup Mission to empower entrepreneurs, along with the wide range of services and state-of-the-art facilities provided by the ZTM-ABI Centre. Technical sessions were conducted by Dr. C.O. Mohan, Dr. Deepu Krishnan, Dr. Remya S., Dr. Parvathy U., Dr. Sreelakshmi K.R., and Dr. Murali S.

The Workshop drew more than 100 participants who had the unique opportunity to engage in hands-on guided tours of ICAR-CIFT's facilities, including the Fish Processing Laboratories, Engineering Exhibition Hall, Pilot Plant Facility, and Agricultural Technology Information Centre. These tours enabled them to interact with scientific experts and acquire valuable insights for their agribusiness ventures.

# AWARD & RECOGNITIONS

**Smt. Greeshma S. S.,** Scientist, Mumbai Research Centre of ICAR-CIFT awarded PhD. for the Thesis **"**Occurrence and characterization of *Salmonella serotypes* from seafood and aquatic environment" from the Department of aquaculture under the guidance of Dr. Toms C. Joseph, Principal Scientist, Microbiology, Fermentation and Biotechnology Division, ICAR-CIFT, Cochin

**Shri Sathish Kumar K.,** Scientist, Fish Processing Division of ICAR-CIFT awarded PhD. for the Thesis "Fish protein hydrolysate based bioactive edible coating for preservation of fishery products" from the Department of Post Harvest Technology, ICAR-Central Institute of Fisheries Education (CIFE) under the guidance of Dr. Bindu J, Principal Scientist & HOD, Fish Processing Division, ICAR-CIFT, Cochin

**Smt. Sreelakshmi K. R.,** Scientist, Fish Processing Division of ICAR-CIFT awarded PhD. for the Thesis "Evaluation of Chitosan Capped Gold and Silver Nanoparticles as Time Temperature Indicators (TTI)" from the Department of Fish Processing Technology, Kerala University of Fisheries and Ocean Studies (KUFOS) under the guidance of Dr. Mohan C. O., Senior Scientist, Fish Processing Division, ICAR-CIFT, Cochin

**Smt. Sreepriya Prakasan,** Scientist, Fish Processing Division of ICAR-CIFT awarded PhD. for the Thesis "Prevalence, Pathogenic Potential and Genetic Diversity of *Escherichia coli* in Seafood" from the Department of Post Harvest Technology, ICAR-Central Institute of Fisheries Education (CIFE) under the guidance of Dr. Sanath Kumar H., Principal Scientist, Post Harvest Technology Department, ICAR-CIFE, Mumbai

**Smt. Jayarani R.,** Research Scholar, Biochemistry and Nutrition of ICAR-CIFT awarded PhD. for the Thesis "Fucoxanthin, Bioactive Lipids and Sulfated Polysaccharides from Brown Seaweed: Extraction and Formulation Using Sustainable Chemistry Approaches." from the Faculty of Marine Sciences, Cochin University of Science and Technology (CUSAT), under the guidance of Dr. Suseela Mathew, Principal Scientist, Biochemistry and Nutrition Division, ICAR-CIFT, Cochin

**Smt. Anju Baby,** Research Scholar in the Microbiology, Fermentation, and Biotechnology Division of ICAR-CIFT, has been awarded a Ph.D. for her thesis titled "Comparative Transcriptome Profiling of Salinicola sp. MFB021 in Response to Salinity Stress" from the Department of Biotechnology, Cochin University of Science and Technology (CUSAT), under the guidance of Dr. Toms C. Joseph, Principal Scientist, MFB Division, ICAR-CIFT, Kochi. Dr. K. V. Lalitha, Principal Scientist and former Head of the Microbiology, Fermentation and Biotechnology Division, served as the Co-Guide.

**Dr. Binsi P. K.,** Senior Scientist, Fish Processing Division, ICAR-CIFT received **Prof.H.P.C. Shetty Award** from ASIAN Fisheries Society Indian Branch in recognition for Excellence in Fisheries Research and Development during 13th Indian Fisheries and Aquaculture Forum at Kolkata on 23rd February 2024.

**Dr. Murali S.,** Scientist & In-Charge, Engineering Section, ICAR-CIFT, Cochin received the **AFST(I) Young Scientist Award** for the year 2022 in the inaugural program of the 9th International Food Convention (IFCON) 2023 held at Mysuru on 7 – 10 December 2023.

**Dr. Bindu J.,** Principal Scientist & HOD, FP Division received **Best paper award** for the paper entitled `Development of 3D printed fish product fortified with Indian Sardine oil' in the session of Engineering and Technology in the 30th Swadeshi Science Congress, jointly organized by NIIT-Calicut, ICAR-IISR, KSCSTE-Centre for Water Resources Development and Management, during May 25-27, 2023, at NIIT, Calicut.

**Dr. Remya S.**, Senior Scientist, FP Division received, **Best paper award** for the paper entitled `Development of 3D printed fish product fortified with Indian Sardine oil' authored by Rasheeda M., Mohan C. O., Remya S., Elavarasan K., and Bindu J. in the session of Engineering and Technology in the 30th Swadeshi Science Congress, jointly organized by NIIT-Calicut, ICAR-IISR, KSCSTE-Centre for Water Resources Development and Management, during May 25-27, 2023, at NIIT, Calicut.

**Dr. Remya S.**, Senior Scientist, FP Division Received **Best Abstract Award** under the session for the paper titled 'Preparation of colorimetric spoilage indicators using plant anthocyanin extracts for intelligent packaging application in fish' authored by Remya S., Mohan, C.O., Toms C. Joseph, Sreelakshmi K. R., and Bindu J. under the Technical Session Aquaculture & Fisheries-based Transformation of Food Systems in the Sub-Theme Processing, Value Addition, Quality Control & Social Sciences in the XVI Agricultural Science Congress 2023 & ASC Expo organized by the National Academy of Agricultural Sciences (NAAS), New Delhi and hosted by ICAR-Central Marine Fisheries Research Institute (CMFRI) during10-13 October 2023 at Kochi, India.

**Dr. A. Jeyakumari,** Senior Scientist FP Division received**, Best oral presentation** for the research paper entitled "Development and characterization of an antioxidant drink from spirulina hydrolysate and fish scale collagen peptide authored by Subin Abraham Vaghese, J**eyakumari A.**, Zynudheen A A, Binsi PK. and Elavarasan K. during 3rd International conference on Advancement of science and Technology for Environment, Society and People (ICASTESP-III) , Kozhikode on 13-14th October, 2023 organized by The Society for Technology, Environment, Science and People, Kozhikode, India.

**Dr. Sajeev M. V.**, Principal Scientist, EIS division, ICAR-CIFT, Cochin, received **Best oral presentation** [II Prize] for the research paper titled 'Leveraging ICTs and social media for fish marketing: A study of vendor attributes and determinants of online fish purchase' at the 'Indian Society of Extension Education Diamond Jubilee National Seminar 2023' on 24th June, 2023 at Gandhi Krishi Vignana Kendra, UAS, Bangalore.

**Dr. Ashish Kumar Jha,** Senior Scientist and SIC, Veraval received **Best oral presentation award** for the research work on "Effect of ensilation of seaweed on its physical and Nutritional Composition" in the National Technical workshop on Indian Perspective on Food Safety, Security and Standards" organized by ICAR-CIFT, SOFTI, FSSAI and AOAC during 07-08th June, 2023

**Dr. Greeshma S. S.**, Scientist received **Best oral presentation award** for oral presentation entitled "New insights into promising antibacterial activity of *Ulva lactuca* against *Pseudomonas aeruginosa*" in National Technical Workshop on Indian Perspective on Food Safety, Security and Standards" is being jointly organized by ICAR-CIFT, SOFTI, FSSAI, India section of AOAC International organized on 7th to 8th June, 2023.

**Dr. Parvathy U.,** Senior Scientist, FP Division received **Best poster presentation award** for the paper titled "Cold Anaesthetization of *Litopenaeus vannamei* for waterless transportation" authored by Parvathy U*., Vishnu R. Nair, Jithin T.J., B. Madhusudhana Rao, Binsi P.K., Sathish Kumar K. and Murali S. in the XVI Agricultural Science Congress 2023 & ASC Expo organized by the National Academy of Agricultural Sciences (NAAS), New Delhi and hosted by ICAR-Central Marine Fisheries Research Institute (CMFRI) during10-13 October 2023 at Kochi, India.

**Dr Murali S.,** Scientist & In-Charge, Engineering Section, ICAR-CIFT, Cochin, received **Best poster presentation award** for the work entitled "Long short-term memory-based regression approach for freshness assessment of Genetically Improved Farmed Tilapia" at the XVI Agricultural Science Congress and ASC Expo, Transformation of Agri-food Systems for achieving sustainable development goals jointly organized by National Academy of Agricultural Sciences, New Delhi and ICAR-Central Marine Fisheries Research Institute, Kochi, during 10-13 October 2023, Kochi, India.

**Shri Akalesh,** Ph.D Scholar, KUFOS- **Award of Prime Minister Fellowship for Doctoral Research Programme** on "*Study on distribution dynamics of antibiotic resistant bacteria (ARB) in aquaculture settings: Focus on ESBL producing Enterobacteriaceae and its resistome, virulome and biocide resistance*" under the guidance of Dr G. K. Sivaraman, Principal Scientist, MFB Division

**Ms. Meenu B.**, PhD Scholar, KUFOS, under the guidance of Dr. Parvathy U. and co-guidance of Dr. Sarika K., FP Division, selected for RAISE 2023 and a grant-in-aid of Rs. 5 lakhs, an Agripreneurship Launchpad orientation facilitated by KAU Agri-Business Incubator under the RKVY-RAFTAAR Scheme by the Ministry of Agriculture and Farmer's Welfare, Government of India.

# PRIORITY SETTING, MONITORING AND EVALUATION CELL

The Priority setting, Monitoring and Evaluation (PME) Cell of ICAR-CIFT functioned during the year 2023, primarily with the following objectives.

### Priority setting, Monitoring and Evaluation of Institute Research Projects.

PME Cell monitored and evaluated the research projects in the identified research priorities of the Institute and evaluated the projects twice in the year through conduct of meetings of Project Monitoring and Evaluation Committee of the Institute. The projects initiated during April 2023 and those to be completed by March 2023 were evaluated and graded. RPP I, RPP II and RPP III of Institute projects including Young Scientist projects on innovative areas from young scientists on a competitive mode and concluded projects were processed. Documentation of 39 projects were done.

### Externally funded projects

A total of 30 proposals for external funding were routed through the Cell after ascertaining that they fall under the mandate and priority research areas of the Institute.

### 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//PMOs Office. Quarterly reports on Output Outcome Frame Work document (OOF) and six-monthly reports on the targets and achievements of the Institute, comprising both research and financial aspects were regularly furnished to the Council. Inputs requested from the council on various points were collected, processed as per the formats given and submitted to the council from time to time. Other kind of weekly, monthly reports were also furnished as per instructions provided. Reports to DARE/ICAR like DARE Report, ICAR Reporter, ICAR News etc. were also furnished.

**Institute Research Council:** The Institute Research Council meeting was convened during 01-04 May 2023, to review the progress achieved in the ongoing research projects of the Institute during 2023-24 and to discuss the research project proposals for the year 2023-24. The Institute Research Project Document for the year 2023-24 was compiled and brought out for discussion at the meeting. The House discussed in detail the 23 ongoing research projects, 6 completed projects and 10 new projects including 3 Young Scientist projects.

**Verification of CAS Reports of Scientists:** The PME Cell verified and scrutinized Career Advance Scheme Reports submitted by six scientists for their promotion and the reports submitted to the Director.

**Participation of Staff/ Research Fellows in Conference/Seminar/ Symposia:** The PME Cell monitored & ensured the participation of staff members and other research scholars in various conferences/seminars/ symposia as per the mandate of the Institute and theme of the programmes.

### Publication of the Scientific Papers and maintenance of database:

Facilitated processing and approval for about 160 publications of/from the Institute *viz*., research papers, popular articles, books, brochures, leaflets, pamphlets, seminar/conference abstracts etc. The research papers and popular/technical articles meant for publication in journals and for presentation in Symposia/ Seminars were arranged for review and for plagiarism clearance and recommended for decision/approval by Director.

### Parliament/Lok Sabha questions/ Requests

Cell arranged to give replies to the Lok Sabha/Rajya Sabha questions/ requests from MP/MLA/Minster etc. on priority basis.

### Database on all ICAR funded and externally funded projects (completed and on-going), publications, technologies developed, patents, consultancies.

Maintained database of projects and publications of the Institute *viz*., research papers, popular articles, books, brochures, leaflets, pamphlets, seminar/conference abstracts etc.

### Knowledge Management activities of the Institute

Facilitated the Knowledge Management activities of the Institute. Publications, technologies, data etc. were uploaded in the KRISHI portal of ICAR and updated regularly.

**Other Technical Matters:** The Cell continued to answer queries on various technical matters received from other organizations and individuals. The queries received by the PME Cell in, 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.

# AGRICULTURAL KNOWLEDGE MANAGEMENT UNIT

Agricultural Knowledge Management Unit (AKMU) caters to meet the ICT needs of the institute by providing and maintaining the Internet, Email, Video Conferencing and other computer related facilities. AKMU provides internet connectivity to nearly 350 systems through LAN and wifi connectivity to nearly 300 users. ICAR-CIFT is presently connected with 1000 mbps lease line under National Knowledge Network (NKN) provided by Govt. of India and 20 mbps ILL from BSNL to provide all the ICT services around the clock for the employees of the Institute. Local Area Networking (LAN) was managed by AKMU. Wifi access facility is also provided for all divisions and conference halls.

### AKMU properly manages ICAR-CIFT Website (https://cift.res.in/ )

- It highlights overall research activities and achievements of the institute and act as an interface between institute and end users.
- 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 the transparency of the working condition.
- This unit is managing online meetings in different platforms like google meet, WebEx Microsoft teams and zoom.
- AKMU manages institute's official social media accounts like Facebook, twitter, Instagram, YouTube and WhatsApp for disseminating institute's technologies and activities to the public.
- These facilities are being used for monitoring and evaluating research programmes in the Research Centers of the institute and also other organizations.
- The contents of the Institute Website are periodically updated.

### Support to stakeholders

- 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 Manch, a public interface platform developed by ICAR for stakeholders.
- AKMU also provides input to KM Portal developed by ICAR by updating details of institute higher authorities contact information, sophisticated analytical instrumentation facility and financial transaction details of the institute.

### Institute Activities

- AKMU assisted in successfully implementing ICAR MIS & FMS, PIMS, e-Hrms, Sparrow and eoffice in the institute by providing technical and training support.
- AEBAS system for attendance of staff is also maintained by AKMU. Verifying and certifying quality of information technology equipments purchased was managed by this unit.
- 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.

# OFFICIAL LANGUAGE SECTION

## Hindi Pakhwada Celebration

Hindi Pakhwada 2023 was celebrated at ICAR- CIFT from 14th September to 29th September 2023. The valedictory function was held on 29th September 2023. Dr Varghese A.U, Associate professor (Retired), BMC college, Thrikkakara was the Chief guest for the Occasion. During the programme, Jhalak 2023 issue was released by the Chief Guest. Dr George Ninan, Director, ICAR- CIFT presided over the function.


The chief guest Dr Varghese A.U releasing the In-house Magazine, Jaladhi 2023.

Dr George Ninan, Director, ICAR-CIFT inaugurating the Hindi Book Exhibition during the World Hindi Day

## Hindi Book Exhibition

Hindi book exhibition was conducted on 10.1.24 on the occasion of World Hindi Day. Dr George Ninan, Director ICAR-CIFT inaugurated the Book Exhibition. Brochures, Pamphlets, Published books, Proceedings of National Seminars, Monographs and Bookslets published in Hindi was displayed during the Exhibition.

# LIBRARY

The Library is committed to serve the information needs of the scientific community of the Institute. Apart from strengthening collection of hard bound information, the library also focuses on the implementation of the latest information technology-based services for the benefit of users.

### Library Collection

The total number of book collection has increased to 012991volumes this year. Online databases viz., ASFA (Aquatic Science and Fisheries Abstracts), Indian Standards and patent database have also been subscribed and made available to the users.

### Koha Library Management System

The Library uses KOHA Library Management Software. The Online Public Access Catalogue (OPAC) enables users to search the library collection.

### Digital Repository of CIFT

ICAR- CIFT has been digitizing CIFT publications and placing them in the open digital repository, which is an important activity of the library. At present, CIFT Digital Repository is having 5591 digital documents.

### Mobile/ Web App

MyLOFT stands for 'My Library On Fingertips'. It is an app for accessing, organizing and sharing digital content and e-resources subscribed by the library. MyLOFT has been subscribed to facilitate remote access to library subscribed premium e-resources.

### CeRA (Consortium of e-Resources on Agriculture)

Library makes available more than 2000 online journals through CeRA (Consortium of e-Resources on Agriculture). Library has supplied copies of 78 articles under DDR (Document Delivery Request) facility of CeRA (Consortium of e-Resources on Aquaculture) to the member libraries in this current year.

### Institutional Membership

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 program, 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 the DELNET-Developing Library Network, which coordinates with other regional, national, international networks and libraries for the exchange of information and documents.

CIFT Library is an Institutional member of the Current Science Association since September 2016.

### 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.

### Plagiarism Checking

The library offers plagiarism-checking services using iThenticate to its users/ members. During this period, the library checked text similarity of 623 research articles and score reports have been generated and send to the users indicating similarity percentage.

# IMPORTANT VISITS


**Dr. Himanshu Pathak, Secretary DARE and DG ICAR, Visits ICAR-CIFT, Kochi**

On 13th October 2023, Dr. Himanshu Pathak, Secretary (DARE) and Director General (DG), ICAR, along with Dr. J. K. Jena, Deputy Director General (Fisheries Science), ICAR, visited the ICAR-Central Institute of Fisheries Technology (ICAR-CIFT), Kochi. During the visit, Dr. Pathak toured the National Referral Lab, other laboratories, pilot plants, and facilities at the Institute. He interacted with the Heads of various divisions and scientists, as well as the staff, discussing various measures undertaken by ICAR to facilitate research and development within the National Agricultural Research System (NARS). Dr. Pathak commended the Institute's scientific accomplishments and its pivotal role in fisheries research.

**Visit of Senior Executive Director, NFDB, Hyderabad to MRC, ICAR-CIFT on 17th May 2023:** Dr. L. Narsimha Murthy, Senior Executive Director, NFDB, Hyderabad visited MRC, ICAR-CIFT on 17th May 2023 and interacted with scientific and technical staffs.

**Visit of DDG (Fisheries science) to MRC, ICAR-CIFT on 23rd November 2023:** Dr. J. K. Jena, Secretary DARE & DDG (Fisheries science) along with Dr. B. B. Nayak, Principal Scientist & HoD, ICAR-CIFE, Mumbai visited MRC, ICAR-CIFT and had discussion with the scientific, technical and supporting staff of the centre.

# EVENTS & CELEBRATIONS

## Celebration of 74th Republic Day

At ICAR-CIFT headquarters and regional centres, flag hoisting ceremonies were conducted to commemorate the 74th Republic Day on 26th January 2023. On this occasion, the Director of ICAR-CIFT and the Scientists-in-Charge (SICs) of regional centers addressed the staff.

## National Science Day

ICAR-CIFT observed National Science Day at VRC on February 28th, 2023. The event, organized by the Science Club of Veraval Research Centre, included an inaugural program, tree planting in the office campus, a drawing competition, and an elocution focusing on the theme of the year 2023: "Global Science for Global Wellbeing".

## International Women's Day Celebrations

MRC, ICAR-CIFT marked International Women's Day on 8th March 2023, focusing on the theme 'Invest in women: Accelerate progress'. Dr. Roopa Vishvanathan Iyer, Founder, Chief Microbiologist, and Managing Director of Qualilife Diagnostics graced the occasion as the chief guest.

## Workshop on Science News Writing

The ZTM-ABI Centre of ICAR-CIFT conducted a workshop on Science News Writing on March 28th, 2023, organized in a hybrid mode. The event featured presentations by distinguished speakers: Shri. K. Pradeep, Senior Deputy Editor (Retd.) from The Hindu, who discussed "The Elements of Science Journalism," and Smt. Sudha Namboodiri, Senior Journalist – Science at The Times of India, who spoke on "Writing/Talking Science in All Forms of Media." The workshop was designed to equip scientists, researchers, and science communicators with the skills and knowledge necessary to effectively convey scientific concepts to a broader audience in an engaging and accessible manner.

## Foundation Day celebrations of ICAR-Central Institute of Fisheries Technology

ICAR-Central Institute of Fisheries Technology (ICAR-CIFT) along with its Regional Centres celebrated its 66th Foundation Day on 28th April 2023, marking another milestone in its dedicated service to the fisheries and aquaculture sector. At the ICAR-CIFT headquarters in Kochi, the Foundation Day meeting showcased Dr. Ajith Kumar K., Director of NPOL, DRDO, as the Chief Guest, accompanied by Dr. A. Gopalakrishnan, Director of ICAR-CMFRI, who served as the Guest of Honour. Dr. T.V. Sankar, Principal Scientist at ICAR-CIFT, delivered the welcome address, while Dr. George Ninan, Director of ICAR-CIFT, presided over the meeting. The event also included the felicitation of the senior most retired scientific, technical, and supporting staff of the Institute. The event concluded with lively cultural performances by the staff members of ICAR-CIFT. As part of the celebrations at the regional centres of ICAR-CIFT, an open house day was organized at the institutes, showcasing various research areas to students and the general public. The Open House at Visakhapatnam Centre was attended by approximately 200 students, while at Veraval Centre, 125 students participated in the event.

## World Intellectual Property Day 2023

The ZTM-ABI Centre, ICAR-CIFT celebrated World IP Day 2023 on April 26th to recognize the critical role that intellectual property (IP) plays in promoting innovation and creativity around the world. The theme for this year's celebration was "Women and IP: Accelerating Innovation and Creativity" which aimed to honour the achievements of women who have shaped our world with their ingenuity, innovation, and creativity. The resource person, Dr. Niharika Sahoo Bhattacharya, Assistant Professor at Rajiv Gandhi School of Intellectual Property Law, Indian Institute of Technology (IIT), Kharagpur, spoke on the topic of "Role of IPR in promoting innovation and development" during the webinar. The event was attended by 52 participants, including Scientists of ICAR Institutes and incubates of ZTM-ABI Centre.

## International Day of Yoga

ICAR-CIFT celebrated the 9th International Day of Yoga on 21st June 2023, focusing on the theme 'Yoga for Vasudhaiva Kutumbakam' or 'Yoga for the Welfare of All as One-World-One Family'. Sri. Acharya S. Ayyappan (DNYS) Sree Yogadarshan - Yoga Centre, Thripunithura, Kochi, was the Chief Guest. He delivered a talk on Yoga for health and wellness followed by a practical session based on the Common Yoga Protocol by AYUSH. Yoga sessions were also conducted at all three ICAR-CIFT Research Centres, highlighting its holistic benefits. At the Veraval Research Centre, Shri. Abhay Thakar, a Yoga instructor from Sanskrit University, Veraval, led both theoretical and practical yoga sessions. At the Mumbai Research Centre, Smt. Deepti Gharat, an expert in Hatha Yoga from Isha School of Hatha Yoga, Coimbatore, served as the Chief Guest and instructor. At the Visakhapatnam Research Centre, Shri M.S.V. Prabhakar Rao, L.D.C, a Post Graduate Diploma holder in Yoga from Andhra University, gave a talk and led the yoga practical session.

## World Environment Day

ICAR-CIFT celebrated World Environment Day with various initiatives aimed at promoting environmental conservation and awareness. Activities included planting trees, organizing cleanliness drives, and taking pledges to protect the environment. On 5th June, ICAR-CIFT, Cochin conducted an awareness campaign under the theme "Beat Plastic Pollution in Inland Waters" for fishers at Aroor in Alappuzha District, Kerala. An interactive session was also conducted as part of the event with members of the Ezhupunna Inland Fishermen Development Co-operative Society. MRC, ICAR-CIFT organized a cleanliness drive at Gorai Beach, Mumbai, Maharashtra, focusing on the theme 'Solution to Plastic Pollution'. At Veraval, ICAR-CIFT participated in an event organized by CMFRI, where they planted 120 tree saplings in the Thalala region

## World Ocean Day

ICAR-CIFT celebrated World Ocean Day on 8th June 2023 with various activities focused on promoting ocean conservation and sustainable practices under the theme 'Innovation for a Sustainable Ocean'. At the Visakhapatnam Research Centre, Dr. U. Sreedhar, Principal Scientist and Scientist-in-Charge, delivered a talk titled 'Plastic Pollution and Ocean Acidification' to raise awareness about these critical issues affecting our oceans.

## ICAR-CIFT supplies Solar Hybrid Dryer to Women Self-Help Group

On 30th June 2023, ICAR-CIFT) Kochi, supplied a 50kg capacity solar hybrid dryer to the Samriddhi Women Self-Help Group, operating under the Korambadam Service Co-operative Bank, Ernakulam. This initiative, part of a research program sponsored by the Department of Science and Technology, Govt. of India, New Delhi, aims to support sustainable fish processing. Designed and manufactured by ICAR-CIFT's engineering department, the solar hybrid dryer operates on solar power, minimizing operating costs. Specialized training will be provided to the group members, who will use the dryer to produce products with the distinctive flavour of Kadamakudi.

## Independence Day Celebration

ICAR-CIFT and its regional centres celebrated the 76th Independence Day of India on 15th August 2023 with a flag hoisting ceremony and a recitation of the Panch Pran Pledge.

## Vigilance Awareness Week

On 30th October 2023, all staff of ICAR-CIFT took the Vigilance Awareness Pledge as part of the Vigilance Awareness Week observed from 30th October to 5th November 2023, with the theme 'Say no to corruption, commit to the Nation'.

## World Fisheries Day

ICAR-CIFT celebrated World Fisheries Day on 21st November 2023 highlighting the importance of sustainable fisheries management and marine conservation. A series of talks was organized by Visakhapatnam Research Centre highlighting innovation, sustainability, and the invaluable contribution of fisheries to global food security. MRC, ICAR-CIFT conducted a fisher folk meet and demonstration on "Value added Fishery Products' at Karanja, Raigad District as part of World Fisheries Day 2023 for 50 participants. Preparation of value-added was demonstrated to fisherfolks.

## Mega Awareness Program on the 'Hygienic Handling of Fish and Shellfish

On 9th November 2023, ICAR-CIFT and Mumbai Port Authority organized a Mega Awareness Program on the 'Hygienic Handling of Fish and Shellfish' at the Auditorium of the Fishery Survey of India (FSI), Colaba. This event, a part of a consultancy project with the Mumbai Port Authority, focused on eradicating foul smells in Sassoon Dock and suggesting fish waste processing technology. Initiated in May 2023, the project aims to improve hygiene and environmental conditions in the area. It aimed to educate the community about the importance of proper fish and shellfish handling practices. This collaborative effort underscores the commitment to fostering a cleaner and healthier environment.

## Kisan Diwas (National Farmers Day)

Kisan Diwas 2023 was celebrated by MRC, ICAR-CIFT on 22nd December 2023 at Bhimanagar, Vavoshi Village in Khalapur taluk of Raigad District, Maharashtra, as part of Swacch Pakhawada. The event successfully engaged 21 fisherwomen from Bhimanagar, Vavoshi Village, with lectures by center scientists on hygienic handling and value addition of fish and shellfish.

## World Antimicrobial Resistance Awareness Week

ICAR-CIFT celebrated World Antimicrobial Awareness Week with the theme "Preventing Antimicrobial Resistance Together" on 21st November 2023. Dr. Anil Kumar, Professor and Head of the Microbiology Department, Amrita Viswa Vidhyapeetam gave an awareness talk on "AMR in Indian Scenario. Mr. P.G. Jayakumar, President Njarackkal Fishermen Co-operative Society was honored for popularising sustainable practices in mitigating AMR. To sensitize the school students about the impact of AMR, MFB Division Scientists, and technical staff conducted special awareness campaigns for the school students of Kendriya Vidhyala-1, Naval Base, Cochin, and Seventh Day Adventist School, Kaloor, Ernakulam. Scientists and technical staff enacted a "Nukkad Natak" in the Hindi language. ICAR-CIFT Visakhapatnam Centre organized World Antimicrobial Resistance Awareness Week from November 18th to 24th, 2023, with participation from students of the Department of Marine Living Resources at Andhra University. The program aimed to educate students about responsible antibiotic usage and raise awareness about the impact of AMR on both the aquatic ecosystem and human health.


## World Soil Day

ICAR-CIFT commemorated World Soil Day on 5 December 2023. Dr. Sandeep S., Principal Scientist and Head, Department of Soil Science, Kerala Forest Research Institute addressed ICAR-CIFT staff and delivered a talk on "Soils beyond crop productivity: Emerging perspectives" in Soil Health Management.


## Input distribution-cum-awareness program

ICAR-CIFT conducted an input distribution-cum-awareness program on 'Hygienic Fish Handling' under the Scheduled Caste Sub Plan at Neendakara Fishing Harbour, Kollam. This initiative, held in collaboration with MPEDA-NETFISH on 10th May 2023, included the distribution of 18 trolleys to fish head of load workers aimed at reducing their workload and enhancing work quality. Dr. George Ninan, Director of ICAR-CIFT, along with Shri. T. Manoharan, Chairman of Matsyafed, Kollam, presented authentication certificates to the workers.

## Awareness Programme

Visakhapatnam Research Centre of ICAR-CIFT has organized a scientific talk on "Fish and Shrimp Allergy: An important Health Concern" by Dr. Sankar, Head, PME cell & Principal Scientist, at ICAR-CIFT, Visakhapatnam on 22.09.2023. Students from Andhra University and officials from FSI, CIFNET, MPEDA, NIFPHET, Dept. of fisheries, AP. and Scientists from CMFRI, Visakhapatnam participated in the programme.

## Awareness Campaign

On August 3rd, 2023, MRC, ICAR-CIFT participated in the 'Mega Awareness Campaign on Ocean Information and Advisory Services' under Azadi Ka Amrit Mahotsav (AKAM), organized by INCOIS and Reliance Foundation at JioTalks Auditorium, Navi Mumbai. Dr. Asha K. K., Principal Scientist and SIC, MRC, ICAR-CIFT, delivered a short address as Guest of Honour, and Shri. Shravan Kumar Sharma, Scientist, gave an invited talk on 'Technology Interventions for Responsible Fisheries'. MRC, ICAR-CIFT also installed a scientific stall to exhibit its technological interventions.

## Training cum exposure visit

Training cum exposure visit was organized by Veraval Research Centre on 07.03.2023 for 130 farmers from Farmers Producer Company of Nashik district, Maharashtra selected under SMART project.

## Sports Tournaments *ICAR-Inter Zonal Sports Tournament at Karnal*

ICAR-CIFT participated in ICAR Inter-zonal Sports Tournament -2022 which was organised by ICAR-NDRI, Karnal during 9-12 September, 2023. ICAR-CIFT won in Carroms and Long Jump. Shri. Rajasaravanan received the Carroms (Gold medal). Dr. Pe. Jeyya Jeyanthi won silver medal in long jump.


ICAR-CIFT contingents during ICAR Inter-zonal sports meet at ICAR-NDRI, Karnal (9-12 September, 2023)

## Sports Tournaments

***ICAR-South Zone Sports Tournament at Bengaluru:*** The ICAR South Zone Sports Meet-2023 was organised by ICAR- IIHR, Bengaluru between 13-16 December, 2023. ICAR-CIFT has paricipated and won in atheletic events, carroms and relay (4*100m-women). Dr. Pe. Jeyya Jeyanthi won longjump (Gold medal), 100m (Silver medal) and 200m (Bronze medal). Shri. Rajasaravanan won carroms (men singles) and mixed doubles along with Smt. Tessy Francis. The ICAR-CIFT relay team won silver medal for the second consecutive year. In addition, ICAR-CIFT sports team won the best march-past award.


## Conquers Everest Base Camp, Hoists National Flag

Dr. Dhiju Das P.H., STA, ICAR-CIFT achieved a remarkable feat by conquering the Everest Base Camp peak (17,598 ft), a rigorous challenge that tests both physical and mental endurance. On October 2, 2023, commemorating Mahatma Gandhi Jayanti, Dr. Das proudly raised the National flag at the summit, symbolizing resilience and national pride.

# Swachh Bharath Activities

ICAR-CIFT undertook regular cleanliness activities as part of the Swachhta Abhiyan celebrations in laboratories, office premises, and corridors. All staff members actively participated in these initiatives.

## ICAR-CIFT Signs MoU with Peruvannammuzhy SC/ST Fishermen Co-op Society

On 21st June 2023, ICAR-Central Institute of Fisheries Technology (ICAR-CIFT) signed a Memorandum of Understanding (MoU) with the Peruvannammuzhy SC/ST Fishermen Co-operative Society, Kozhikode. The MoU entails the provision of an extruder machine to the society as part of the Swachatha Action Plan. This machine will be used for the preparation of fish feed from fish meal, with the society responsible for its operation and maintenance. Prior to the MoU signing, members of the society had undergone training at CIFT on the preparation of fish feed from fish waste. This collaboration aims to enhance sustainable practices and support the economic development of SC/ST fishermen in the region.

## Swachhata Pledge

On 22nd September 2023, the staff of MRC, ICAR-CIFT took the 'Swachhata Pledge' as part of the 'Swachh Bharat Abhiyan'. The pledge aimed to inspire the staff to uphold Mahatma Gandhi's vision of a Clean India.

## Special Campaign 3.0

Under Special Campaign 3.0 'Swacchata hi Sewa', MRC, ICAR-CIFT conducted the following activities:

- Cleanliness activity at Vashi sea shore on 'World Tourism Day' on 27th September 2023.
- Cleanliness activity at MRC, ICAR-CIFT on 'World Awareness Day on Food Waste' – 29th September 2023.



## Cleanliness drive

In connection with Swacch Pakhawada 2023, MRC, ICAR-CIFT conducted a cleanliness drive at the MRC campus on 28th December 2023. On October 20, 2023, the Veraval Research Centre of ICAR-CIFT conducted a clean-up program in its office premises to identify and dispose of redundant scrap materials, manage space effectively, and ensure thorough cleaning.

## Swachhata Hi Seva Campaign - Ghost Net Retrieval Programme

In connection with the Swachhata Hi Seva Campaign (Ek Tarikh Ek Ghanta Ek Sath), ICAR-Central Institute of Fisheries Technology, Veraval, in collaboration with the Wildlife Trust of India (WTI), initiated a cleanliness drive and awareness programme on "Ghost Nets and Their Impact on Marine Life and Ghost Net Retrieval" for fisherfolk in Mithapur, Arambada, Okha, and regions of North Gujarat. The programme began on 1st October 2023 in Mithapur and continued on 27-29th October, 13-14th November, and 3-4th December 2023 in Mithapur, Arambada, and Bet Dwarka Island. Thirty fisherfolk participated in each event, along with volunteers from Marine National Park (MNP) Jamnagar, the Indian Coast Guard Okha Station, WTI, and Tata Chemicals. About 90 bags of ghost nets, weighing approximately 1200 kg, were successfully removed by participants using knives from the intertidal and reef areas of the region.

## Coastal cleanup drive

As part of the Swachhata Hi Seva program, the Regional Centre of ICAR-CIFT and the Indian Coast Guard Veraval station organized an International Coastal Cleanup at Chowpatty Beach, Veraval, Gujarat, on September 16, 2023. Students from various colleges and volunteers participated, collectively collecting approximately 20 gunny bags of plastics. On October 1st, 2023, another coastal cleanup drive was carried out in Okha in collaboration with the Indian Coast Guard North Gujarat station, accompanied by students from the NCC wing of Kendriya Vidyalaya. Commander Sri Krishna Kumar from the Coast Guard and Dr. Ashish Kumar Jha, Scientist-in-Charge of the Veraval Regional Centre of ICAR-CIFT, officially launched the Swachhata program. Concurrently, CIFT staff conducted a coastline cleanup at Veraval Somnath Beach on the same day.

# INSTITUTE JOINT STAFF COUNCIL


**Shri.Vinod G. Member CJSC, attending 41th CJSC meeting at NASC, ICAR, New Delhi on 13th April 2023**

IJSC was re-constituted through election. Shri.Vipin Kumar V., Shri. Vinod G., Shri Mani P., Shri. Nikhil Das P. N. Shri. Rajasharavanan and Shri. Deepak Vin were elected unopposed in Technical, Administrative and Skilled Supporting Staff categories. Shri. Vipin Kumar V. was nominated as Secretary (staff side) IJSC and Shri. Vinod G. as member to Central Joint Staff Council.

The new committee organised two staff meetings to collect agenda for the IJSC meetings. The relevant concerns raised by the staff were discussed during the management meetings.

The secretary staff side or his nominees raised the concerns of employees in various committees.

IJSC members were committed with vital roles in various management committees of the institute, *viz.,* Compassionate Appointment, Quarters Allotment, Recreation Club, Departmental Canteen, Standing Sports Committee, Staff Welfare fund, Award Utilisation, etc.

# RECREATION CLUB

ICAR-CIFT Recreation Club strives to play a role in bringing together all the members of the CIFT family to common platforms by organizing different programmes. The staff welfare is assured at physical and mental levels and equip them to contribute to the Institute in a comfortable way in a stress-free and happy working environment.

The following are the programmes the club had conducted to meet its social obligations under the guidance of the Patron & the Director of CIFT and the Executive committee of the Club.

## New Year Celebration

The Club celebrated New Year 2023 at CIFT by greeting and welcoming the staff offering cake pieces sponsored by the Director, Dr. George Ninan on 01st of January 2023 in the front lobby of the institute. In this connection, office entrance was decorated attractively and distributed the Recreation Club designed wall calendar 2023 to all club members.

## Onam Celebration

Onam, 2023 was celebrated by conducting a series of competitions on arts and sports few days in advance of Thiruvonam and prizes to winners were distributed on 24th of August in a majestic formal function held at A.N. Bose Auditorium. Chief Guest for the function was **Mr. Krishnakumar. K.T., MD, M/s. Oleevia Group of Companies (Actor, Satirist and professional banker)**. The gorgeous *Pookkalams* done for competition, *Onasadya*, prize distributions of various competitions and cultural programme were the main attractions of the day.









## Awareness Generations

Recreation Club facilitated setting up of information kiosks of State Bank of India for displaying and introducing their products to the staff members of this Institute.

Similarly, Club facilitated setting up of information kiosk of ICICI Bank as well as HDFC Bank for displaying and introducing their products to the staff members of this Institute.

## Birthday celebration

Executive committee members of the club as team visit the club members on their birthdays, greet them and offer birthday gifts.

# REPRESENTATION IN COMMITTEES

## Dr. George Ninan

### As Chairman

- Committee for formulation of Standard Operating Procedures/ Guidelines for the deployment of LPG kit retrofitted on fishing vessels, Ministry of Fisheries, GoI.
- Nodal authority for technical vetting for the construction of deep-sea fishing vessels under PMMSY, Ministry of Fisheries. GoI.

### As Principal Member

- FAD 15-Food Hygiene, Safety Management and Other Systems Sectional Committee, Bureau of Indian Standards.

### As Member

- MPEDA Board, Ministry of Commerce, Govt. of India
- Board of Directors, Lakshadweep Development Corporation.
- Scientific Panel on Fish and Fisheries Products (SP-10) FSSAI, India.
- Committee of the State Level Agency for Export Development of Aquaculture & Fisheries (SAEDAF)
- Standardization Cell, Ministry of Fisheries, GoI.
- Research Advisory Council, Kerala Agricultural University

## Dr. Suseela Mathew

### As Member

- Institute Management Committee, ICAR-NBFGR
- Academic Council, KUFOS

## Dr. M.P. Remesan

### As Chairman

- BIS Sectional Committee TXD 18 on fishing gear materials

### As Member

- Expert committee on Purse Seine Fisheries, DoF, Govt. of India based on Hon'ble Supreme Court w.r.t. SLP (C) 8442 of 2021

## Dr. Bindu J.

### As Member

- Committee on Value addition & Infrastructure for marine products export promotion at MPEDA, Cochin.

## Dr. T. Raja Swaminathan

### As Member

- Assessment Committee meeting for the promotion of Scientists under CAS at ICAR-CMFRI, Kochi

### As Chair

- Technical session 8 in International Conference on Aquatic Animal Epidemiology (Aqua Epi III) during 30.11.2023

## Dr. Nikita Gopal

### As Chair

- Gender in Aquaculture & Fisheries Section of the Asian Fisheries Society

## Dr. Ashaletha S.

### As External Examiner

- Examination board of PhD student of Kerala Agricultural University

## Dr. A. Suresh

### As Member

- Member of Governing Council and Member of Senate of Kerala University of Fisheries and Ocean Studies, Pananagad, Ernakulam.
- Standing Committee of Governing Council of KUFOS on Planning, Development and Research
- Sub-committee of GC of KUFOS to revise the statute of KUFOS in accordance with the Amended Act
- Executive Committee of Indian Society of Agricultural Economics, Mumbai.
- Editorial Board of the Journal "Fishery Technology", by Society of Fisheries Technologists (India)
- Member in a study group constituted by Planning Board of Government of Kerala, to study and suggest measures to improve the income statistics estimates of the state in primary sector.

## Dr. G. K. Sivaraman

### As Member

- Standing Committee of the Syndicate on Academic Matters, Cochin Univ. of Sci & Tech (CUSAT), Cochin, Kerala

### As Research supervisor

- Veterinary College, KVAFSU, Bengaluru.
- Veterinary College, KVASU, Mannuthy

**As Research Supervisor & Post Graduation teaching faculty**

- ICAR- CIFE, Mumbai

**As IBSC, DBT Nominee**

- Veterinary College, Mannuthy
- ICAR- CMFRI, Kochi

## Dr. K. K. Asha

**As APE Panel member**

- Assessment Panel of Experts, Export Inspection Council

**As Panel member**

- Panel discussion on the theme "Sustainability, Circular Economy including Recycling issues and Global Benchmarks" in National conclave on Agrotech - "Accelerating Productivity of Agriculture & Horticulture Products" organized by Ministry of Textiles, Govt of India, Indian Technical Textile Mission, and SASMIRA, Worli on 6th October 2023 at India Habitat Centre (New Delhi)

## Dr. B. Madhusudhan Rao

**As Member**

- Surveillance Audit of M/s Srinidhi Biotechnologies, Palmanpeta Village, Visakhapatnam-district under the SHAPHARI hatchery certification scheme of Marine Products Export Development Authority (MPEDA) conducted on 19.04.2023
- Annual Board of Studies (BoS) meeting in Food, Nutrition and Dietetics of Department of Food, Nutrition and Dietetics, Andhra University, Visakhapatnam on 28.08.2023
- Viva-voce for the trainees of the 18th SDP Programme on 'Shrimp Processing & Quality Assurance for Export' on 20.12.2023
- Assessment Panel of Experts, Export Inspection Council, Andhra Pradesh

**As external examiner**

- Viva-voce examination of a Ph.D. scholar of ICAR-CIFE, Mumbai on 27.09.2023

**As executive committee member**

- 69th Executive committee meeting of Rajiv Gandhi Centre for Aquaculture (MPEDA- RGCA) on 17.07.2023

**As panel member**

- Selection of Programme Asst (Computer Science) at BCT–Krishi Vigyan Kendra, Eco Rejuvenation Centre, Haripuram, Anakapalli (Dt) on 08-12-2023

## Dr. U. Sreedhar

**As member**

- Selection Committee meeting for recruitment for one post of Scientist – B on direct recruitment (regular mode) at INCOIS, Hyderabad on 03.05.23.
- Walk in interview to select candidates pertaining to SMS (Agrometeorology) and Agromet Observer for KVK, Amadalavalasa – DAMU Project on 19.07.2023

## Dr. Madhu V. R.

**As Member**

- FICCI taskforce 3.0 on blue economy

## Dr. Sajeev M.V.

**As external expert**

- SAC Meeting, KVK Thrissur

**As nodal officer**

- PM Krishi Samman
- OBC Grievances committee

## Dr. M.V. Baiju

**As Member**

- Bureau of Indian Standards-Fishing Vessel Sectional committee
- Technical evaluation committee for procuring VHF under the Project "Sea Safety Equipment to Traditional Fishing Crafts", Govt. of Kerala
- Conversion of Kerosene OBM to LPG –OBM, Govt. of Kerala
- Department of Fisheries, Odisha-Implementation of PMMSY scheme for deep sea fishing vessels
- Nodal Authority to issue Approved Standardized Deep-Sea Fishing Vessels (DSFV) Design & Specifications (ASDDS)-PMMSY scheme-Govt. of India

## Dr. Pe Jeyya Jeyanthi

**As member**

- Managing Committee, Central Government Officers Association, Kochi.

## Dr. Murugadas V.

**As Judge**

- Elocution contest on "One Health" is being organized for the scholars of CMFRI on 24-11-2023 being celebrated on "The World AMR Awareness Week" at CMFRI

**As Member**

- Conduct of Orientation programme of CAA (Amendment) Act, 2023 and drafting of Guidelines for notification at ICAR-CMFRI, during 07.09.2023
- Deputy technical manager for biological section of the NABL Cell

## Dr. Visnuvinayagam S.

### As Member

- Institute Biosafety Committee of ICAR-CMFRI, Cochin
- Assessment Panel of Experts, Export Inspection Council

## Dr. A. Jeyakumari

### As Member

- Assessment Panel of Experts, Export Inspection Council

## Dr. Prajith K.K

### As Chairman

- Judgement panel for the evolution of project works of 31st National Children Science Congress 2023 (district level) competition at St. Mary's College, Thrissur on 13th November 2023

### As Judge

- To evaluate science project in connection with Regional Level Science, Mathematics and Environmental Exhibition for children of Kendriya Vidyalaya, held on 09-06-2023 at Kochi

## Dr. Niladri Sekhar Chatterjee

### As Convenor

- FAD 27 of BIS, the subgroup on analytical method for pesticides residues in fish, meat, and poultry

## Dr. Sandhya K. M.

### As Member

- TXD18:Textile Materials for Marine/ Fishing Purposes Sectional Committee of Bureau of Indian Standards.
- Technical committee member of Matsyafed , Kochi for the establishment of newly proposed yarn twisting unit at Paravoor, Alappuzha.

### As Judge

- To evaluate science project in connection with Regional Level Science, Mathematics and Environmental Exhibition for children of Kendriya Vidyalaya, held on 09-06-2023 at Kochi

## Dr. Viji P.

### As evaluator

- Skill test conducted by MPEDA on preparation of value added shrimp products conducted in connection with the training programme on "Seafood value addition" on 09.12.2023

### As member

- Assessment Panel of Experts, Export Inspection Council, Andhra Pradesh

## Dr. Jesmi Debbarma

### As Member

- Scientist Advisory Committee (SAC) meeting of BCT-KVK, Anakapalle
- Assessment Panel of Experts, Export Inspection Council, Andhra Pradesh

## Dr. Laly S. J.

### As Member

- Sectional Committee, FAD 28 of BIS (Bureau of Indian Standard) Test Methods for Food Products
- Seafood HACCP Alliance's Aquaculture Training Workgroup, Association of Food and Drug Officials, USA

## Dr. Martin Xavier

### As Member

- Assessment Panel of Experts, Export Inspection Council

### As External expert

- M.G. University BSc Fisheries syllabus revision committee 2023 at St Alberts College, Ernakulam on 22/11.2023
- 51st Rashtriya Bal Vaigyanik Pardarshini 2023 at PM SHRI KV INS Dronacharya on 30.11.2023

## Dr. Parvathy U.

### As Member

- Assessment Panel of Experts, Export Inspection Council

### As Committee member

- Departmental promotion committee being constituted for considering promotion to the post of Zonal Director Gr. I (Level-11) at Coir Board, Kochi on 10.08.2023.
- XVI Agricultural Science Congress and ASC Expo, Transformation of Agri-food systems for achieving sustainable development goals organized by National Academy of Agricultural Sciences, New Delhi and ICAR-Central Marine Fisheries Research Institute, Kochi from 10-13 October 2023
- National technical workshop on 'Indian perspective on food safety, security and standards' jointly organized by ICAR-CIFT, SOFTI, FSSAI, and India Section of AOAC International

### As Judge

- Evaluation of science project in connection with Regional Level Science, Mathematics and Environmental Exhibition for children scheduled to be held on 09-06-2023, (subtheme: Health & Cleanliness and Historical development with current innovation) at Kendriya Vidyalaya, Kochi

## Dr. Manju Lekshmi N.

### As Member

- GLOLITTER – FAO-IMO National Task force member

### As Judge

- Evaluation of science project in connection with Regional Level Science, Mathematics and Environmental Exhibition for children scheduled to be held on 09-06-2023, (subtheme: Health & Cleanliness and Historical development with current innovation) at Kendriya Vidyalaya, Kochi

## Dr. Pankaj Kishore

### As Member

- FAD 31-Microbiology Sectional Committee (BIS, India)
- Review committee for periodical review of officials in MPEDA under FR 56(.]) I FR 56 (I) and Rule 48 (I) (B) of CCS (Pension) Rules 1972, at MPEDA, Kochi
- Steering Committee with Chemical NetSCoFAN Group, FSSAI, New delhi

### As Committee Member

- ISO/TC 34/SC 9/WG 8
- ISO/TC 34/SC 9/AHG 6
- ISO/TC 34/SC 9/WG 30
- organizing committee of 16 ASC held at Kochi by CMFRI 10-13 oct 2023

### As External expert

- Framing the specifications of instrument of EIA for the year 2023-24
- A panel member for selection of apprentices in MPEDA Quality Control laboratory, Kochi.

### As Judge

- Evaluation of science project in connection with Regional Level Science, Mathematics and Environmental Exhibition for children scheduled to be held on 09-06-2023, (subtheme: Health & Cleanliness and Historical development with current innovation) at Kendriya Vidyalaya, Kochi

## Dr. Anupama T. K.

### As Member

- Invitation committee in XVI agricultural Science Congress
- Assessment Panel of Experts, Export Inspection Council
- Registration Committee in National technical workshop on "Indian Perspective on Food Safety, Security and Standards "

## Dr. Tejpal C. S.

### As Passing Board Member

- KUFOS Academics Passing board Member

## Shri Paras Nath Jha

### As Member

- Technical Committee of XVI Agricultural Science Congress and ASC Expo, organized by the National Academy of Agricultural Sciences, New Delhi, and hosted by ICAR-Central Marine Fisheries Research Institute, Kochi, from 10 to 13 October 2023.

### As Judge

- To evaluate science project in connection with Regional Level Science, Mathematics and Environmental Exhibition for children of Kendriya Vidyalaya, held on 09-06-2023 at Kochi

## Smt. Priya E.R

### As Member

- Assessment Panel of Experts, Export Inspection Council
- Seafood HACCP Alliance's Segment One Update Workgroup, Association of Food and Drug Officials, USA
- Assessment Panel of Experts, Export Inspection Council

### As alternate Member

- BIS-FAD27Organizing Committee XVI Agricultural Science Congress 2023 & ASC Expo.

## Dr. Ahamed Basha

### As member

- Assessment Panel of Experts, Export Inspection Council, Andhra Pradesh

## Dr. Ashish Kumar Jha

### As chairman

- Town Official Language Implementation committee, Veraval

### As Member

- Assessment Panel of Experts, Export Inspection Council
- Board of Studies for Fisheries Science Faculty at Kamdhenu University

### As external examiner

- Thesis evaluation for College of Fisheries, Kamdhenu University

## Dr. Greeshma S. S.

### As member

- Assessment Panel of Experts, Export Inspection Council

## Shri Sreejith S.

**As member**

- Assessment Panel of Experts, Export Inspection Council

**As external examiner**

- For Thesis Viva voce examination of MFSc students of College of Fisheries Science, Kamadhenu University

## Dr. Sarika K.

**As member**

- Assessment Panel of Experts, Export Inspection Council

**As external examiner**

- For Thesis Viva voce examination of MFSc students of College of Fisheries Science, Kamadhenu University

## Dr. Rehana Raj

**As member**

- Assessment Panel of Experts, Export Inspection Council

## Dr. Abhay Kumar

**As Member**

- Assessment Panel of Experts, Export Inspection Council

## Shri. Ezhil Nilavan S.

**As Member**

- Assessment Panel of Experts, Export Inspection Council

## Dr. Murali S.

**As Sectoral expert**

- Innovative Idea Contest – 'Dreamvestor' for the young/ student Entrepreneurship organized by the Department of Industries & Commerce, Government of

**As Judge**

- 51st Rashtriya Bal Vaigyanik Pardarshini 2023 held at INS Dronocharya, Kochi on 30th November 2023

## Dr. Aniesrani Delfiya D.S.

**As committee Member**

- National technical workshop on 'Indian perspective on food safety, security and standards' jointly organized by ICAR-CIFT, SOFTI, FSSAI, and India Section of AOAC International

## Dr. Neethu K. C.

**As Member**

- In the final joint inspection of the final application submitted to MPEDA under the Mini lab scheme by M/s. Byrd International LLP, KSIDC, Alappuzha

## Dr. Sreepriya Prakasan

**As Member**

- Assessment Panel of Experts, Export Inspection Council

# IMPORTANT INSTITUTE COMMITTEES

## Quinquennial Review Team (QRT)

**Chairman: Dr. K. S. M. S. Raghava Rao, Director, CSIR-CFTRI.**

Members:

1. Dr. B. Sundaramoorthy, Dean (I/c), Prof. & Head, Dr. MGR Fisheries College & Research Centre, TNJFU, Nagapattinam
2. Dr. K. C. Dora, Former Dean, Dpt. of Fish Processing Technology, KBAFS, Kolkata (WB)
3. Dr. Udey S. Annapure, Prof. & Head, Institute of Chemical Technology, Mumbai
4. Dr. V. R. Joshi, Former Prof. & Head, College of Fisheries, Ratnagiri
5. Dr. N. Bhaskar, Advisor, FSSAI

Member Secretary: Dr. Satyen Kumar Panda, Principal Scientist, QAM Division, ICAR-CIFT, Cochin

## Research Advisory Committee (RAC)

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Members:

1. Dr. E. Vivekanandan, Former Principal Scientist, CMFRI, Cochin.
2. Dr. K.C. Dora, Former Dean College of Fisheries, WBUAFS.
3. Dr. G. Bhanuprakash Reddy, Scientist-G & Head, ICMR-National Institute of Nutrition.
4. Dr. B. Ganesh Kumar, Principal Scientist, Agribusiness Management Division, ICAR-NAARM.
5. Assistant Director General (M.Fy.), KAB-II, Pusa, New Delhi.
6. Director, ICAR-CIFT, Cochin.

Member Secretary: Dr. V. Murugadas, Senior Scientist, ICAR-CIFT, Cochin.

## Institute Management Committee (IMC)

**Chairman: Director, ICAR-CIFT**

Members:

1. Shri P. I. Sheik Pareeth, MD, Kerala State Coastal Area Development Corporation Ltd.
2. Director of Fisheries, Dept. of Fisheries, Govt. of Goa.
3. Dean, Fisheries Sciences, Junagadh Agricultural University, Veraval,
4. Shri Seshan T. S., Thayattuparambil House, Kochambalam, Nayarambalam P. O., Ernakulam-682509
5. Dr. P. Shanmuganandam, Rajesh Nagar, 158 Mettupatti P.O., Madurai- 625 502.
6. Dr. E.M. Abdussamad, PS & Head-in-charge, Finfish Fisheries Division, ICAR-CMFRI, Cochin.
7. Dr. K.S. Sobhana, Scientist-in-Charge, Library and Documentation Centre, CMFRI, Cochin.
8. Dr. Rupam Sharma, Principal Scientist, CIFE, Mumbai.
9. Dr. Pravata K. Pradhan, Principal Scientist, NBFGR, Lucknow.
10. Assistant Director General (M. Fy.), ICAR, KAB-II, Pusa, New Delhi - 12
11. Senior Finance and Administrative Officer, ICAR-CMFRI, Cochin

Member Secretary: Senior Administrative Officer, ICAR-CIFT, Cochin.

## Grievance Cell

**Chairman: Director, ICAR-CIFT**

Members:

1. Dr. George Ninan, Principal Scientist & HOD(i/c), Engg. Dvn., ICAR-CIFT.
2. Shri Srinivasa Bhat W, Sr. AO
3. Shri Prashant Kumar, Chief Fin. & Accts. Officer, ICAR-CIFT
4. Dr. Ranjith Kumar Nadella, Scientist, ICAR-CIFT
5. Shri Babu K.S, Tech. Officer., ICAR-CIFT
6. Smt. Sobha K S, UDC, ICAR-CIFT
7. Smt. Mary Vineetha P.T, SSS, ICAR-CIFT.

Member Secretary: Shri R. N. Subramanian, Admn. Officer, ICAR-CIFT, Cochin

## Institute Joint Staff Council (IJSC)

**Chairman: Dr. George Ninan, Director, ICAR-CIFT**

Members (Official Side):

1. Dr. Bindu. J., Principal Scientist & HOD, FP Div., ICAR-CIFT
2. Dr. Remesan. M.P, Principal Scientist & HOD, FT Div., ICAR-CIFT
3. Dr. Nikita Gopal, Principal Scientist & HOD (A), EIS Div., ICAR-CIFT
4. Dr. R. Anandan, Principal Scientist & HOD, B&N Dvn., ICAR-CIFT
5. Head of Accounts, ICAR-CIFT

**Secretary (Official Side): Head of Administration, ICAR-CIFT**

Members (Staff Side):

1. Shri. Vinod. G., Tech. Asst., ICAR-CIFT
2. Shri. P. Mani, Assistant, ICAR-CIFT
3. Shri. P.N. Nikhil Das, LDC, ICAR-CIFT
4. Shri. Deepak Vin. V, SSS, ICAR-CIFT
5. Shri. K.R.Rajasaravanan, SSS, ICAR-CIFT
6. Secretary (Staff Side): Shri. Vipin Kumar. V., Sr. Tech. Asst., ICAR-CIFT.

## Project Monitoring & Evaluation Committee (PMC)

**Chairman: Director, ICAR-CIFT, Cochin.**

Members:

1. Head, Fishing Technology, ICAR-CIFT
2. Head, Fish Processing, ICAR-CIFT
3. Head, Biochemistry & Nutrition, ICAR-CIFT
4. Head, Quality Assurance & Management, ICAR-CIFT
5. Head, Microbiology, Fermentation and Biotechnology, ICAR-CIFT
6. Head, Extension, Information & Statistics, ICAR-CIFT
7. In-Charge Engineering, ICAR-CIFT

Member Secretary: In-Charge, PME cell, ICAR-CIFT

# LIST OF ON-GOING RESEARCH PROJECTS

## Institute Projects

| Sl. No | Name of Project | Principal Investigator | Co-Investigators/ Project Associates |
|---|---|---|---|
| 1 | Studies on Resource and Energy Conservation in Trawl Systems | Dr. M. P. Remesan | Dr. Madhu V. R.<br>Dr. Baiju M. V.<br>Dr. Raghu Prakash<br>Dr. Prajith K. K.<br>Dr. Chinnadurai S.<br>Dr. Renjth R. K.<br>Shri Paras Nath Jha<br>Shri Shravan Kumar S. |
| 2 | Studies on fish behaviour as an input for developing responsible fishing systems | Dr. Madhu V. R. | Dr. Prajith K. K.<br>Dr. Renjith R. K.<br>Dr. Chinnadurai S.<br>Dr. Tejpal C. S.<br>Shri Paras Nath Jha |
| 3 | Designing Responsible fishing Systems: Integrating Fish Morphology and Behavioral Responses to Fish Stimuli | Dr. Madhu V. R. | Dr. Prajith K. K.<br>Dr. Renjth R. K.<br>Dr. Chinnadurai S.<br>Dr. Tejpal C. S.<br>Shri Paras Nath Jha |
| 4 | Investigation on environmental burdens associated with selected small-scale fishing systems, value-added fishery product/ aquaculture system of India using LCA approach | Shri Paras Nath Jha | Dr. Baiju M. V.<br>Dr. Sandhya K. M.<br>Dr. Manju Lekshmi N.<br>Dr. Renjith R. K.<br>Shri Satish Kumar K.<br>Shri Shravan Kumar S. |
| 5 | Development of nanosensors for precision aquaculture and technologies to protect fishing materials | Dr. P. Muhamed Ashraf | Dr. Sandhya K. M.<br>Dr. Manju Lekshmi N.<br>Dr. Chinnadurai S. |
| 6 | Technological interventions for improvement of the fishing system in selected water bodies of India | Dr. Sandhya K. M. | Dr. Remesan M. P.<br>Dr. Baiju M. V.<br>Dr. Sreedhar U.<br>Dr. Prajith K. K.<br>Dr. Renjith R. K.<br>Shri Shravan Kumar S.<br>Shri Kamei G. |
| 7 | Fishing material debris assessment and studies on its degradation and aquatic faunal intakes | Dr. Manju Lekshmi N. | Dr. Muhamed Ashraf P.<br>Dr. Toms C. Joseph<br>Dr. Madhu V. R.<br>Dr. Baiju M. V.<br>Dr. Sandhya K. M.<br>Dr. Laly S. J.<br>Dr. Chinnadurai S.<br>Shri Shravan Kumar S.<br>Shri Paras Nath Jha<br>Shri Kamei G. |

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| 8 | Valorisation of marine and agro waste for development of green packaging materials | Dr. Bindu J. | Dr. Toms C. Joseph<br>Dr. Remya S.<br>Dr. Renuka V.<br>Dr. Priya E. R.<br>Dr. Sarika K.<br>Dr. Jesmi Debbarma<br>Shri Sreejith S.<br>Shri Satish Kumar<br>Smt Sreelakshmi K. R. |
| 9 | SMART PACK: Development and characterization of smart packaging films for enhancing quality and shelf life of fishery products | Dr. C. O. Mohan | Dr. Joshy C. G.<br>Dr. Visnuvinayagam S.<br>Dr. Elavarasan K.<br>Dr. S. Remya<br>Dr. Pankaj Kishore<br>Dr. Ranjit Kumar Nadella<br>Smt. Sreelekshmi K. R. |
| 10 | Development and validation of biomedical and cosmetic products from secondary fishery raw materials | Dr. Binsi P. K. | Dr. Zynudheen A. A.<br>Dr. Muhammed Ashraf P.<br>Dr. Anandan R.<br>Dr. Femeena Hassan<br>Dr. Viji P.<br>Dr. Renuka K.<br>Dr. Jeyakumari A.<br>Dr. Parvathy U.<br>Dr. Laly S. J.<br>Dr. Anupama T. K.<br>Dr. Sarika K.<br>Dr. Rehana Raj<br>Shri Ezhil Nilavan |
| 11 | Development of Efficient Statistical and Reliability Tools for Fish Products | Dr. Joshy C.G. | Dr. Zynudheen A. A.<br>Dr. Mohan C. O.<br>Dr. Binsi P. K.<br>Dr. Parvathy U.<br>Dr. Elavarasan K.<br>Dr. Geethalakshmi V. |
| 12 | Technological interventions in value addition and advanced processing techniques for fish and shell fish | Dr. Remya S. | Dr. George Ninan<br>Dr. Bindu J.<br>Dr. Toms C. Joseph<br>Dr. Mohan C. O.<br>Dr. Joshy C. G.<br>Dr. Viji P.<br>Dr. Jesmi Debbarma<br>Dr. Parvathy U.<br>Dr. Pankaj Kishore<br>Dr. Sarika K.<br>Dr. Neethu K. C.<br>Dr. Rehana Raj<br>Shri Ezhil Nilavan S.<br>Shri Sreejith S.<br>Shri Sathish Kumar K.<br>Smt. Sreelakshmi K. R.<br>Smt. Sreepriya Prakasan |
| 13 | Development of Food and Industrial products from secondary raw materials of aquatic origin | Dr. A. Jeyakumari | Dr. Zynudheen<br>Dr. Femeena Hassan<br>Dr. Binsi P. K.<br>Dr. Elavarasan K.<br>Dr. Sreepriya P. |
| 14 | Process development and scaling up of production of different molecular weight chitosan with different degree of de-acetylation and evaluation of their applications | Dr. Elavarasan K. | Dr. Mohan C.O.<br>Dr. Jeyakumari A.<br>Dr. V. Renuka<br>Dr. Tejpal C.S.<br>Dr. Sathish Kumar |

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| 15 | Development of Soft Computing Systems in Fisheries Technology for Technology Dissemination and Policy Formulation | Dr. Joshy C. G. | Dr. George Ninan<br>Dr. Zynudheen A. A.<br>Dr. Satyen Kumar Panda<br>Dr. Elavarasan K.<br>Dr. Suresh A.<br>Shri Premdev K. V. |
| 16 | Development of rapid testing platforms for quality assessment of seafood | Dr. Laly S. J. | Dr. Femeena Hassan<br>Dr. Muhammed Ashraf<br>Dr. Martin Xavier<br>Dr. Renjith Nadella<br>Dr. Devanand Uchoi<br>Smt. Priya E. R. |
| 17 | Valorization of seaweed resources for functional food, nutraceutical, biomedical, and bioremediation applications | Dr. Niladri Sekhar Chatterjee | Dr. Suseela Mathew<br>Dr. Asha K. K.<br>Dr. Devananda Uchoi<br>Dr. Minimol V. A.<br>Dr. Anisarani Delfiya<br>Dr. Rehana Raj<br>Dr. Greeshma S. S.<br>Dr. Jesmi Devbarma<br>Dr. Ahamed Basha<br>Dr. Ashish Kumar Jha |
| 18 | Ensuring safety of fish and fishery products: Framework for validating regulatory specifications | Dr. Pankaj Kishore | Dr. Laly S. J.<br>Dr. Martin Xavier<br>Dr. Renjith Nadella<br>Dr. Devanand Uchoi<br>Smt. Priya. E. R. |
| 19 | Enhancing Utilization of rest raw materials of aquatic origin for feed, Agricultural and Industrial product development | Dr. Zynudheen A. A. | Dr. Femeena Hassan<br>Dr. Binsi P. K.<br>Dr. Jeyakumari A.<br>Dr. Parvathy U.<br>Dr. Renuka V.<br>Dr. Devananda Uchoi<br>Dr. Joshy C. G.<br>Dr. K. Sathish Kumar<br>Dr. Visnu Vinayagam<br>Dr. Pankaj Kishore<br>Dr. Madhu V. R.<br>Dr. Sangeetha *(Assistant professor, KVK Kottayam)*<br>Dr. Sekhar M. *(Scientist, CMFRI, Vizag Centre)*<br>Dr. Sreenivasan V. *(IISR, Calicut)*<br>Dr. Sankar T. V. |
| 20 | Biotechnological approaches for utilization of aquatic microbial resources and their products | Dr. Toms C. Joseph | Dr. Madhusudana B. Rao<br>Dr Sivaraman G. K.<br>Dr. Murugadas V.<br>Dr. Visnuvinayagam S.<br>Shri Radhakrishnan Nair V.<br>Shri Ezhil Nilavan<br>Dr. Greeshma S. S.<br>Smt. Muthulakshmi T.<br>Dr. Minimol V. A.<br>Dr. Anupama T. K.<br>Dr. Ahamed Basha K.<br>Dr. Remya S.<br>Dr. Elavarasan K.<br>Dr. Divu D.<br>Dr. Suresh Kumar Mojjada |

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| 21 | Virulence and antibiotic resistance profiling of seafood-borne pathogens and development of control measures | Dr. Visnuvinayagam S. | Dr. Toms C. Joseph<br>Dr. Sivaraman G. K.<br>Shri Radhakrishnan V. Nair<br>Dr V. Murugadas<br>Dr. Greeshma. S. S.<br>Smt. T. Muthulakshmi<br>Dr. V. Minimol<br>Shri S. Ezhil Nilavan<br>Dr. Anupama TK<br>Dr. Abhay Kumar |
| 22 | Production of poly unsaturated fatty acids (PUFAs) from heterotrophic eukaryotes: A biotechnological approach | Dr. Anupama T. K. | Dr. Toms C. Joseph<br>Dr. Lekshmi R. G. K. |
| 23 | A Green Technology Approach on Isolation, Purification and Product Development from marine biomolecules | Dr. R. Anandan | Dr. Suseela Mathew<br>Dr. Asha K. K.<br>Dr. Renuka V.<br>Dr. Niladri Sehkar Chatterjee<br>Dr. Tejpal C. S.<br>Dr. Lekshmi R. G. K. |
| 24 | Establishing nutritional and bio-functional potential of selected fishery products through in vitro/in vivo digestibility studies | Dr. Renuka V. | Dr. Anandan R.<br>Dr. Suseela Mathew<br>Dr. Tejpal C. S.<br>Dr. Lekshmi R. G. K.<br>Dr. Ashish Kumar Jha<br>Shri Anas K. K. |
| 25 | Development of a Marine biorefinery based on tuna processing waste – A greener approach | Dr. Lekshmi R. G. K. | |
| 26 | Evaluation of anti- nutritional factors (ANFs) /secondary metabolites in fish feed and feed ingredients | Dr. Tejpal C. S. | Dr. Lekshmi R. G. K.<br>Dr. Sanal Ebnezer<br>Dr. Anas K. K. |
| 27 | Engineering interventions in post-harvest sector | Dr. Murali S. | Dr. Neethu K. C.<br>Dr. Aniesrani Delfiya D. S.<br>Dr. Lekshmi R. G. K. |
| 28 | Carbon nanodots and nanocomposite PCM based energy efficient solar dryer | Dr. Aniesrani Delfiya D. S. | Dr. Murali S.<br>Dr. Neethu K. C. |
| 29 | Modelling economic risks in fisheries and assessing existing mitigation strategies | Dr. Geethalakshmi V. | Dr. Nikita Gopal<br>Dr. Suresh A.<br>Dr. Pe. Jeyya Jeyanthi<br>Dr. Chandrasekar V. |
| 30 | A study on the entrepreneurship ecosystem in fisheries and the cybernetics of Women Initiated Enterprises in Fisheries (WIEF) in selected coastal states of India | Dr. Ashaletha S. | Dr. Mohanty A. K.<br>Dr. Suresh A.<br>Dr. Viji P.<br>Dr. Anupama T. K.<br>Dr. Sajesh V. K.<br>Dr. Greeshma S. S.<br>Dr. Rejula K. |
| 31 | A study of digital fish marketing ecosystem in India | Dr. Sajeev M. V. | Dr. Joshy C. G.<br>Dr. Abhay Kumar<br>Dr. Jesmi Debbarma |

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| 32 | Assessment of post-harvest losses in the fish value chain | Dr. Pe. Jeyya Jeyanthi | Dr. Nikita Gopal<br>Dr. Geethalakshmi V.<br>Dr. Ashaletha S.<br>Dr. Viji P.<br>Dr. Chandrasekar V.<br>Dr. Rejula K.<br>Smt. Muthulakshmi T. |
| 33 | Impact assessment of ICAR-CIFT Technologies. | Dr. V. Chandrasekar | Dr. Nikita Gopal<br>Dr. Suresh A.<br>Dr. Geethalakshmi V.<br>Dr. Pe. Jeyya Jeyanthi<br>Dr. Rejula K.<br>Dr. Mohanty A. K. |
| 34 | An Assessment of Extension System in Marine Fisheries Sector of Kerala | Dr. Sajesh V. K. | Dr. Ashaletha S.<br>Dr. Suresh A.<br>Dr. Pe. Jeyya Jeyanthi<br>Dr. Rejula K.<br>Dr. Renjith R. K.<br>Smt. Sreelakshmi K. R. |
| 35 | Augmenting value and safety of wild and farmed fish of the East Coast through technological approaches | Dr. Madhusudana Rao B. | Dr. P. Viji<br>Dr. Jesmi Debbarma<br>Dr. K. Ahamed Basha<br>Dr. Parvathy U. |
| 36 | Interventions for ensuring diversity and quality of products from aquatic resources of East Coast through innovative technologies | Dr. Viji P. | Dr. Madhusudana Rao B.<br>Dr. Jesmi Debbarma<br>Dr. K. Ahamed Basha |
| 37 | Development of Smart Trawls Systems for the North East maritime states of India. | Dr. Sreedhar U. | Dr. R. Raghu Prakash<br>Shri Kamei G. |
| 38 | Harvest and post-harvest interventions in marine resources available along Saurashtra coast | Dr. Ashish Kumar Jha | Dr. Anupama T. K.<br>Dr. Sarika K.<br>Dr. Chinnadurai S.<br>Shri Sreejith S. |
| 39 | Assessment of fish harvest and post-harvest technological aspects and mitigation measures for problems with special reference to Maharashtra | Dr. Asha K. K. | Dr. Nikita Gopal<br>Dr. Abhay Kumar<br>Dr. Rehana Raj<br>Shri Shravan Kumar Sharma<br>Dr. Greeshma S. S. |

# Externally Funded Projects

| International Projects | | | |
|---|---|---|---|
| **Sl. No** | **Name of Project** | **Principal Investigator** | **Co-Investigators/ Project Associates⁎** |
| 1 | Food, gender, enterprise: Leveraging interdisciplinary for sustainable small-scale fisheries. | Dr. Nikita Gopal | Dr. Madhu V. R.<br>Dr. Sandhya K. M.<br>Dr. Rejula K.<br>Dr. Bethan O'Leary, University of Exter, UK<br>Dr. Deepayan Bhowmik, Newcastle University, UK<br>Shri Richard James MacCowan, Biomimicry Innovation Lab<br>⁎Sethu<br>⁎Saranya Manilal<br>⁎Sreejith Sreekumar |
| 2 | Future Refrigeration India: INDEE+ | Dr. George Ninan | Dr. Manoj P. Samuel<br>Dr. Murali S.<br>Dr. Baiju M.V.<br>Dr. Jeyakumari A.<br>⁎Dr. Arun B. S. |
| 3 | Establishing value chain for fish: Towards nutritional security for rural population | Dr. Suseela Mathew | Dr. Mohanty A. K.<br>Dr. Anandan R.<br>Dr. George Ninan<br>Dr. Murali S.<br>Dr. Panda S. K.<br>Dr. Asha K. K.<br>Dr. Sajeev M. V.<br>Dr. Mohan C. O.<br>Dr. Murugadas V .<br>Dr. Joshy C. G.<br>Dr. Chatterjee N. S.<br>Dr. Elavarasan K.<br>Dr. Tejpal C. S.<br>⁎Akshay P.<br>⁎Gopika R. |
| 4 | Transforming Agri-food Systems in South Asia (TAFSSA) | Dr. Suresh A. | Dr. Pe Jeyya Jeyanthi<br>Dr. Rejula K.<br>⁎Dr. Sachu Sara Sabu<br>⁎Dr. Rajesh I. D. |
| **National Projects** | | | |
| **Indian Council of Agricultural Research** | | | |
| 5 | NAIF - Zonal Technology Management Centre | Dr. C. O. Mohan | Dr. Madhusudana Rao B.<br>Dr. Remya S.<br>⁎Razia Mohamed A.<br>⁎Lijin Nambiar M. M. |
| 6 | NAIF - Agribusiness Incubation Centre | Dr. C. O. Mohan | Dr. Parvathy U.<br>Shri Sreejith S.<br>⁎Arshaya Rajesh<br>⁎Mohammed Safuwan T. A. |

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| 7 | All India Network Project on Fish Health | Dr. Ranjit Koumar Nadella | Dr. Niladri Sekhar Chatterjee<br>*Dr. Rajisha R.<br>*Sajeena K. N. |
| 8 | Network programme on Assessment of Antimicrobial Resistance (AMR) in microorganisms associated with fisheries and aquaculture in India | Dr. M.M. Prasad | Dr. B. Madhusudana Rao<br>Dr. K. Ahamed Basha |
| 9 | Network project on Production system, Agribusiness and Institutions | Dr. Suresh A. | Dr. Geethalekshmi V.<br>Dr. Ashaletha S.<br>Dr. Viji P.<br>Dr. Chandrasekar V.<br>Dr. Elavarasan K.<br>Dr. Sreepriya Prakasan<br>Dr. Murali S.<br>Shri Sreejith S.<br>Dr. Rehana Raj |
| **Department of Science and Technology (DST)** | | | |
| 10 | Green clean and affordable energy for fishermen community: Development of a multipurpose solar thermal conversion system with gasifier/biomass heater back up | Dr. Murali S. | Dr. Manoj P. Samuel<br>Dr. Aniesrani Delfiya D. S.<br>Dr. Alfiya P. V.<br>Dr. Sajesh V. K.<br>*Amal P. A. |
| 11 | Development of a foldable smart live fish transportation system for distant trade of table fish | Dr. Parvathy U. | Dr. Binsi P. K.<br>Dr. Murali S.<br>Dr. Sathish Kumar K.<br>*Vishnu R. Nair<br>*Jithin T. J. |
| 12 | Development of millet-based novel ready-to-eat (RTE) smart functional foods fortified with fish protein and lipid for entrepreneurship development in the state of Kerala | Dr. Bindu J. | Dr. Mohan C.O.<br>Dr. Remya S.<br>Dr. Elavarasan K. |
| **Food Safety and Standards Authority of India (FSSAI)** | | | |
| 13 | FSSAI-National Reference Laboratory | Dr. Niladri Sekhar Chatterjee | Dr. Pankaj Kishore<br>Dr. Ranjit Kumar Nadella<br>Dr. Devananda Uchoi<br>Smt. Priya E. R.<br>Dr. Laly S. J. |
| 14 | NETSCoFAN-Food Testing Group (FTG) | Dr. Niladri Sekhar Chatterjee | Dr. Pankaj Kishore<br>Dr. Devananda Uchoi<br>Dr. Ranjit Kumar Nadella<br>Dr. C. O. Mohan<br>Smt. Priya E. R.<br>*Asha Mary Joseph |

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| **National Fisheries Development Board (NFDB)** | | | |
| 15 | Development & popularization of fuel-efficient long-lasting otter boards for greening the trawl fishing sector in India | Dr. M. P. Remesan | Dr. Chinnadurai S.<br>Shri Parass Nath Jha<br>*Sreejith S. Kumar<br>*Subinlal A.V.<br>*Ajay Krishna |
| 16 | The pilot scale implementation of "Smart Packing Technology: Fish freshness indicator" at field level to enhance domestic fish consumption. | Dr. C. O. Mohan | Dr. Bindu J.<br>Dr. Remya S.<br>Dr. Pankaj Kishore<br>*Ananthu Prasad |
| 17 | The pilot scale demonstration of seaweed-based feed production for fish and shrimp. | Dr. Ashish Kumar Jha | Shri Sreejith S. |
| **Pradhan Mantri Matsya Sampada Yojana (PMMSY)** | | | |
| 18 | Marine Mammal Stock Assessments in India | Dr. Prajith K. K. | Shri Paras Nath Jha<br>*Dr. Rithin Joseph<br>*Hrishikesh P.<br>*Immanuel Shaji |
| 19 | National Surveillance Programme for Aquatic Animal Diseases (NASPAAD) | Dr. Toms C. Joseph | Dr. V. Murugadas<br>Shri S. Ezhil Nilavan<br>*Athira P. S. |
| **National Agricultural Science Fund (NASF)** | | | |
| 20 | A detailed Foodomics study for food authentication and exploration of nutraceutical potential" | Dr. Niladri S. Chatterjee | Dr. Pankaj Kishore<br>Dr. Minimol V. A.<br>*Pranamya C. Haridas<br>*Rajesh Ravichandran<br>*Athira A.S. |
| **Marine Products Export Development Authority (MPEDA)** | | | |
| 21 | Fine tuning of CIFT-TED for adoption in the trawl fisheries for the certification of marine shrimp harvested from India | Dr. M. P. Remesan | Dr. Madhu V. R.<br>Shri Paras Nath Jha<br>*Subinlal A.V. |
| **Indian National Centre for Ocean Information Services (INCOIS)** | | | |
| 22 | Deployment and maintenance of Wave Rider Buoy off Veraval and development of jellyfish and sardine advisories along the west coast | Dr. Madhu V. R.<br>Dr. Chinnadurai S. | *Jabar M. |
| **Board of Research in Nuclear Sciences (BRNS)** | | | |
| 23 | Matrix specific phage formulations for the bio-control of enterotoxigenic Methicillin sensitive and resistant Staphylococcus aureus of safety concern | Dr. Murugadas V. | Dr. Madhusudana Rao B.<br>Dr. Visnuvinayagam S.<br>* Dr. Vandan Nagar |

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| **Ministry of Food Processing (MoFPI)** | | | |
| 24 | Development of Portable Fish Freshness Assessment Sensor | Dr. George Ninan | Dr. Manoj P. Samuel<br>Dr. Binsi P. K.<br>Dr. Murugadas V.<br>Dr. Murali S.<br>Dr. Anierani Delfiya D. S.<br>Dr. Alfiya P. V.<br>*Reshma Ramadas |
| **Govt. of Kerala** | | | |
| 25 | Marine Fishery in Kerala: A study on evolution of policy, cost and earnings of fishing units and income of fisher households | Dr. Suresh A. | Dr. Nikita Gopal<br>Dr. Madhu. V.R.<br>Dr. Sajeev M.V.<br>Dr. Sajesh V.K.<br>*Neethu Mol Jacob<br>*Vijay Kiran |
| 26 | Replacement of Kerosene OBM with experimental inboard/ Outboard diesel propulsion in small-scale fishing boats of Kerala" | Dr. M. V. Baiju | Shri Paras Nath Jha |
| **Science and Engineering Research Board (SERB)** | | | |
| 27 | Developing of biorefinery work flow for high value nutraceuticals from seaweed by Green Chemistry approach | Dr. Lekshmi R. G. K. | Dr. Chatterjee N. S.<br>Dr. Suseela Mathew<br>*Vidya Mohanan<br>*Abhirami N. |

# LIST OF PERSONNEL IN ICAR-CIFT

## Managerial Personnel

Director: **Dr. George Ninan**

### Heads of Division

| | | |
|---|---|---|
| Fishing Technology Division | : | **Dr. M. P.Remesan**, Principal Scientist |
| Quality Assurance and Management | : | **Dr. A. A. Zynudheen**, Principal Scientist |
| Biochemistry and Nutrition Division | : | **Dr. R. Anandan,** Principal Scientist |
| Fish Processing Division | : | **Dr. J. Bindu,** Principal Scientist |
| Microbiology, Fermentation & Biotechnology | : | **Dr. Raja Swaminathan,** Principal Scientist |
| Extension Information & Statistics Division | : | **Dr. Nikita Gopal,** Principal Scientist |
| Visakhapatnam Research Centre | : | **Dr. U. Sreedhar**, Principal Scientist |
| Mumbai Research Centre | : | **Dr. K.K. Asha,** Principal Scientist |
| Veraval Research Centre | : | **Dr. Ashish Kumar Jha,** Senior Scientist |
| Chief Administrative Officer | : | **Shri Mahesh B. Khubdikar** |
| Senior Finance & Accounts Officer | : | **Shri P.P. Anilkumar** |

## HEADQUARTERS, COCHIN

### Scientific Personnel

### Principal Scientist

| | |
|---|---|
| 1 | Dr. Manoj P. Samuel (Deputation) |
| 2 | Dr. V. Geethalakshmi |
| 3 | Dr. P. Muhamed Ashraf |
| 4 | Dr. Ashaletha S. |
| 5 | Dr. Femeena Hassan |
| 6 | Dr. Toms C. Joseph |
| 7 | Dr. Suresh A. |
| 8 | Dr. G. K. Sivaraman |
| 9 | Dr. V. R. Madhu |
| 10 | Dr. Satyen Kumar Panda (Deputation) |
| 11 | Dr. Sajeev M. V. |

### Senior Scientist

| | |
|---|---|
| 1 | Dr. M.V. Baiju |
| 2 | Dr. C.O. Mohan |
| 3 | Dr. Pe. Jeyya Jeyanthi |
| 4 | Dr. Binsi P.K. |
| 5 | Shri V. Radhakrishnan Nair |
| 6 | Dr. V. Chandrasekhar |
| 7 | Dr. C. G Joshy |
| 8 | Dr. V. Murugadas |
| 9 | Dr. Visnuvinayagam S. |
| 10 | Dr. A. Jeyakumari |
| 11 | Dr. Prajith K. K. |
| 12 | Dr. Niladri Sekhar Chatterjee |
| 13 | Dr. Sandhya K.M. |
| 14 | Dr. Remya S. |
| 15 | Dr. Laly S.J. |
| 16 | Dr. V. Renuka |
| 17 | Dr. Martin Xavier |
| 18 | Dr. Parvathy U. |
| 19 | Dr. Manju Lekshmi N. |
| 20 | Dr. Pankaj Kishore |
| 21 | Dr. Anupama T.K. |

### Scientist

| | |
|---|---|
| 1 | Dr. N. Rajendra Naik (Deputation) |
| 2 | Dr. Ranjith Kumar Nadella |
| 3 | Dr. Tejpal C. S. |
| 4 | Dr. Elavarasan Krishnamoorthy |
| 5 | Dr. Rejula K. |
| 6 | Shri Paras Nath Jha |
| 7 | Smt. Muthulakshmi T. |
| 8 | Dr. Renjith R. K. |
| 9 | Dr. Sreelakshmi K. R. |
| 10 | Smt. Priya E. R. |
| 11 | Dr. Lekshmi R.G. Kumar |
| 12 | Dr. Devananda Uchoi |
| 13 | Shri Sathish Kumar K. |
| 14 | Dr. Minimol V. A. |
| 15 | Shri Anas K. K. |
| 16 | Shri Ezhil Nilavan S. |
| 17 | Dr. Murali S. |
| 18 | Dr. Aniesrani Delfiya D. S. |
| 19 | Dr. Neethu K. C. |
| 20 | Dr. Sreepriya Prakashan |

# Technical Personnel

## Chief Technical Officer

| | |
|---|---|
| 1 | Smt. P. K. Shyma |
| 2 | Dr. M. Baiju |
| 3 | Smt. T. Silaja |
| 4 | Dr. T. V. Bhaskaran |

## Assistant Chief Technical Officer

| | |
|---|---|
| 1 | Smt M. Rekha |
| 2 | Dr. Santhosh Alex |
| 3 | Smt. K. K. Kala |
| 4 | Shri Sibasis Guha |
| 5 | Shri P. S. Babu |
| 6 | Dr. P. Shankar |
| 7 | Dr. Ancy Sebastian |

## Senior Technical Officer

| | |
|---|---|
| 1 | Smt P. K. Geetha |
| 2 | Smt. N. Lekha |
| 3 | Smt. Bindu Joseph |
| 4 | Smt. N. C. Shyla |

## Technical Officer

| | |
|---|---|
| 1 | Shri C. Subash Chandran Nair |
| 2 | Shri P. S. Nobi |
| 3 | Shri Sajith K. Jose |
| 4 | Shri P. V. Sajeevan |
| 5 | Smt. P. A. Jaya |
| 6 | Shri V. K. Siddique |
| 7 | Shri G. Gopakumar |
| 8 | Shri K. S. Babu |
| 9 | Shri T. P. Saju |
| 10 | Shri P. D. Padmaraj |
| 11 | Shri P. S. Sunil Kumar |
| 12 | Shri N. Sunil |
| 13 | Shri C. K. Suresh |
| 14 | Shri Aneesh P. A. |
| 15 | Shri Noby Varghese K. A. |
| 16 | Shri Vipin Kumar V. |
| 17 | Smt. Vineetha Das |
| 18 | Shri T. Jijoy |

## Senior Technical Assistant

| | |
|---|---|
| 1 | Smt. Susmitha V. |
| 2 | Smt. Sruthi P. |
| 3 | Shri Rahul Ravindran |
| 4 | Smt. Prinetha U. P. |
| 5 | Shri Rakesh M. Raghavan |
| 6 | Dr. Dhiju Das P.H. |
| 7 | Smt. Megha G. |

## Technical Assistant

| | |
|---|---|
| 1 | Shri K. C. Anish Kumar |
| 2 | Shri Vinod G. |
| 3 | Shri Ajith V. Chellappan |
| 4 | Smt. Anu Mary Jose |
| 5 | Smt. Archana G. |
| 6 | Smt. P. J. Mary |
| 7 | Shri P. Suresh |
| 8 | Smt. Reshmi K. |
| 9 | Shri Sreejith V. N. |
| 10 | Shri Ajeesh K. |

## Senior Technician

| | |
|---|---|
| 1 | Shri M. T. Udayakumar |

## Technician

| | |
|---|---|
| 1 | Kum. Arya S. Raj |

# Administrative Personnel

## Administrative Officer

| | |
|---|---|
| 1 | Shri R.N. Subramanian |
| 2 | Smt. Ponnamma Radhakrishnan |

## Finance & Accounts Officer

| | |
|---|---|
| 1 | Smt. Sreedevi M. R. |

## Assistant Administrative Officer

| | |
|---|---|
| 1 | Shri M. N. Vinodh Kumar |
| 2 | Smt. V. K. Raji |
| 3 | Smt. K. Renuka |
| 4 | Smt. Surya G. |

## Private Secretary

| | |
|---|---|
| 1 | Shri R. D. Goswami |
| 2 | Smt. Anitha K. John |

## Assistant

| | |
|---|---|
| 1 | Smt. Akhila N. R. |
| 2 | Smt. A. R. Raji |
| 3 | Shri P. Mani |
| 4 | Smt. Jaya Das |
| 5 | Smt. E. Jyothilekshmy |
| 6 | Smt. P. R. Mini |
| 7 | Shri Santhosh Mohan |
| 8 | Smt. Shiji John |
| 9 | Shri P. G. David |
| 10 | Shri T. D. Bijoy |

### Upper Division Clerk

| | |
|---|---|
| 1 | Shri Rajeev P. |
| 2 | Smt K.V. Suseela |
| 3 | Smt. Sobha K.S. |
| 4 | Smt Subin George |
| 5 | Smt Suni Surendran |
| 6 | Shri Deu Umesh Aroskar |
| 7 | Shri Gouri Sankar Sahoo |

### Lower Division Clerk

| | |
|---|---|
| 1 | Shri. Rizwan P.M. |
| 2 | Shri. Anish T.V. |
| 3 | Smt. Bhavyamol C.G. |
| 4 | Shri K.S. Ajith |
| 5 | Shri K.Thinakaran |
| 6 | Shri P.N. Nikhil Das |

### Supporting Personnel

| | |
|---|---|
| 1 | Shri K. K. Karthikeyan |
| 2 | Smt. P. T. Mary Vinitha |
| 3 | Shri Sachida Nanda Dash |
| 4 | Shri P. Raghavan |
| 5 | Shri T. M. Balan |
| 6 | Shri V. Deepak Vin |
| 7 | Shri K. R. Rajasaravanan |
| 8 | Shri A. Vinod |
| 9 | Smt. M. G. Soudamini |

## Visakhapatnam Research Centre

### Scientific Personnel

### Principal Scientist

| | |
|---|---|
| 1 | Dr. R. Raghu Prakash |
| 2 | Dr. B. Madhusudana Rao |

### Senior Scientist

| | |
|---|---|
| 1 | Dr. P. Viji |
| 2 | Dr. Jesmi Debbarma |

### Scientist

| | |
|---|---|
| 1 | Shri Gaihiamngam Kamei |
| 2 | Shri Kusunur Ahamed Basha |

### Technical Personnel

### Senior Technical Officer

| | |
|---|---|
| 1 | Shri Bhuneshwar |

### Technical Officer

| | |
|---|---|
| 1 | Shri Himansu Sekhar Bag |
| 2 | Smt. Tessy Francis |
| 3 | Shri Medidi Prasanna Kumar |

### Senior Technical Assistant

| | |
|---|---|
| 1 | Shri Medidi Prasanna Kumar |

### Administrative Personnel

### Assistant Administrative Officer

| | |
|---|---|
| 1 | Shri Das K. |

### Upper Division Clerk

| | |
|---|---|
| 1 | Shri Amit Vengraj |
| 2 | Shri Ramesh Mirdha |

### Lower Division Clerk

| | |
|---|---|
| 1 | Shri M. Sreevishnu Prabhakara Rao |
| 2 | Smt. Nalla Naveena |

### Supporting Personnel

| | |
|---|---|
| 1 | Shri Triloknath Banchor |
| 2 | Shri Sanyasi Ganik |
| 3 | Smt Gyananetri Nag |
| 4 | Shri Sushil Kumar Mehar |
| 5 | Shri Kedar Meher |
| 6 | Shri Lalit Oram |

## Veraval Research Centre

### Scientific Personnel

### Scientists

| | |
|---|---|
| 1 | Shri Sreejith S. |
| 2 | Dr. Sarika K. |
| 3 | Dr. Chinnadurai S. |
| 4 | Shri Gattu Rudhrappa |

### Technical Personnel

### Technical Officer

| | |
|---|---|
| 1 | Shri Sida Hanif Ummer Bhai |
| 2 | Shri G. Kingsley |

### Senior Technical Assistant

| | |
|---|---|
| 1 | Smt. Nimmy S. Kumar |

### Sr. Technician

| | |
|---|---|
| 1 | Shri Jitendra Bachubhai Malamadi |

### Technical Assistant

| | |
|---|---|
| 1 | Shri Yogesh D. Kriplani |

List of Personnel in ICAR-CIFT

## Administrative Personnel

### Assistant

| | |
|---|---|
| 1 | Shri M. Arockya Shaji |

### Lower Division Clerk

| | |
|---|---|
| 1 | Smt. Joshna S. |

## Supporting Personnel

| | |
|---|---|
| 1 | Shri Ashwinkumar Mohanlal Vala |
| 2 | Shri Makwana Krasan Kana |
| 3 | Shri Narsinh K. Masani |
| 4 | Shri P. Ramakrishna |
| 5 | Shri Rohtash |
| 6 | Shri Sunil Kishan Jethwa |

## Auxiliary Staff

| | |
|---|---|
| 1 | Smt. Veena Shreedhar Narkar |

# Mumbai Research Centre

## Scientific Personnel

### Principal Scientist

| | |
|---|---|
| 1 | Dr. L Narasimhamurthy (Deputation) |

### Scientist

| | |
|---|---|
| 1 | Dr. Greeshma S.S. |
| 2 | Dr. Abhay Kumar |
| 3 | Dr. Rehana Raj |
| 4 | Shri Shravan Kumar Sharma |

## Technical Personnel

### Chief Technical Officer

| | |
|---|---|
| 1 | Smt Sangeetha D. Gaikwad |
| 2 | Smt Thriveni Gopal Adiga |

### Senior Technical Assistant

| | |
|---|---|
| 1 | Smt. Priyanka Ajay Nakhawa |

### Technical Assistant

| | |
|---|---|
| 1 | Shri Thulsiram A. Waghmare |

## Administrative Personnel

### Assistant Administrative Officer

| | |
|---|---|
| 1 | Shri Avinash N. Agawane |

## Supporting Personnel

| | |
|---|---|
| 1 | Smt. Priyanka P. Bait |

# LIST OF PUBLICATIONS

## Research Papers


Ada Zwetlana, Pooja Tanwer, Delina Evans, Vineeth Rajan, Alison Prendiville, Till Bachmann, Sivaraman, G. K. and Ravikrishnan, E. (2023) An Indian Perspective on the Infection and Diagnostic Landscape of Shrimp Aquaculture. *ACS Agric. Sci. Technol.* 3 (4): 305-317. https://doi.org/10.1021/acsagscitech.3c00040 http://krishi.icar.gov.in/jspui/handle/123456789/83376

Ahamed Basha, K., Mogilipuri, S. S., Dhamodher Moturu, Manikantha B., Murugadas, V., Panda, S. K., Joshy, C. G., Madhusudana Rao, B. (2023) Tetracycline resistance potential of heterotrophic bacteria isolated from freshwater fin-fish aquaculture system. *J. Applied Microbiol.* 134 (4): lxad060. https://doi.org/10.1093/jambio/lxad060 http://krishi.icar.gov.in/jspui/handle/123456789/80828

Ajeeshkumar, K. K., Ankita Sahu, Astha Singh, Ravindran, N. A., Niladri S. Chatterjee, Suseela Mathew and Saurabh Verma (2023) Proteoglycans in breast cancer, identification and characterization by LC-MS/MS assisted proteomics approach: A review. *Proteom- Clin. Appl.* 17: 2200046. https://doi.org/10.1002/prca.202200046 http://krishi.icar.gov.in/jspui/handle/123456789/80810

Alfiya, P. V., Rajesh, G. K., Murali, S., Aniesrani Delfiya, D. S., Manoj P. Samuel, Prince, M. V. and Sudheer, K. P. (2023) Process optimization for drying of Shrimp (*Metapenaeus dobsoni*) under hot air-assisted microwave drying technology using response surface methodology. *J. Food Process Engg.* 46(7): e14338. https://doi.org/10.1111/jfpe.14338 http://krishi.icar.gov.in/jspui/handle/123456789/82440

Amruth, P., Paul, P. T., Jacob, M. R., Joy, J. M., Anandan, R. and Suseela Mathew (2023) Influence of Salt Concentration on Alkaline Extracted Refined Kappa-carrageenan and Its Characterization. *J. Appl. Life Sci. Int.* 26 (4): 13-20. 0.9734/JALSI/2023/v26i4610 http://krishi.icar.gov.in/jspui/handle/123456789/82808

Amruth, P., Rosemol Jacob, M., Joy, J. M., Anandan, R. and Suseela Mathew (2023) In Vivo evaluation of wound healing efficacy of κ -Carrageenan blended polyvinyl pyrrolidinone films for wound dressing applications. *Int. J. Zoo. Applied Bioscie.* 8(4):16-20. https://doi.org/10.55126/ijzab.2023.v08.i04.003 http://krishi.icar.gov.in/jspui/handle/123456789/83351

Anandan, R., Anjali, N. S., Reenu, C. M., Anandhi Santhosh, Mathew, P. T., Sivaraman, G. K., Jayashree Sadasivam, Renuka, V. and Dara, P. K. (2023) Preparation of Pickering Emulsions Stabilized by Chitosan-Protein Hydrolysate Nanoparticles: In-vitro Bioavailability, Physico-chemical, Structural and Rheological Characterization. *Food Hydrocolloids for Health.* 24. https://dx.doi.org/10.2139/ssrn.4599333 http://krishi.icar.gov.in/jspui/handle/123456789/83884

Aniesrani Delfiya, D. S., Murali, S., Anju, V. S., Muhamed Ashraf, P. and George Ninan (2023) Effects of carbon nanodots coating and airflow rate on the thermal efficiency of flat plate collector. *Energy Sources A: Recovery Util. Environ. Eff.* 45(2): 5982-5993. https://doi.org/10.1080/15567036.2023.2213175 http://krishi.icar.gov.in/jspui/handle/123456789/80816

Ankita Sahu, Shaban Ahmad, Khalid Imtiyaz, Ajeeshkumar, K. K., Mojahidul Islam, Khalid Raza, Murugesh Easwaran, Asha, K. K., Moshahid A. Rizvi, Saurabh Verma (2023) In-silico and in-vitro study reveals Ziprasidone as a potential aromatase inhibitor against breast carcinoma. *Sci. Rep.* 13: 16545. https://doi.org/10.1038/s41598-023-43789-1 http://krishi.icar.gov.in/jspui/handle/123456789/82842

Anuj Kumar, Mandakini Devi, H., Pankaj Kishore, Devananda Uchoi, Panda, S. K., Mohan, C. O., Niladri S. Chatterjee, Zynudheen, A. A. and Ravishankar C. N. (2023) Exploitation of seaweed functionality for the development of food products. *Food and Bioprocess Technol.* 16:1873–1903. https://doi.org/10.1007/s11947-023-03023-2 http://krishi.icar.gov.in/jspui/handle/123456789/80558

Anuj Kumar, Sreejith, V. K., Mohan, C. O., Pankaj Kishore, Elavarasan, K., Devananda Uchoi and Bindu, J. (2023) Nutritional, Textural and Sensory attributes of Spiced Shrimp fortified Biscuits. *Fishery Technol.* 60(1):37-43. http://krishi.icar.gov.in/jspui/handle/123456789/80726

Aparna Radhakrishnan, Sajeev, M. V., Mohanty, A. K., Suseela Mathew and Ravishankar, C. N. (2023) Socio-cultural factors affecting fresh fish consumption and willingness to consume fish-based products among tribals: a study in Wayanad, Kerala. *Fish. Techol.* 60(4): 276-285. https://epubs.icar.org.in/index.php/FT/article/view/128520 http://krishi.icar.gov.in/jspui/handle/123456789/82839

Archana, C., Beena, A. K., Murugadas, V., Lijo John, Rajakumar, S. N., Sudheer Babu, Ligimol James and Rahila, M. P. (2023) Detection of lytic phage infecting flavour-producing strain of *Lacticaseibacillus*

*paracasei* in the dairy effluents of Kerala. *J. Dairy Resear.* 90(2): 178-181. https://doi.org/10.1017/S0022029923000274 http://krishi.icar.gov.in/jspui/handle/123456789/82432

Arshad, N., Aswathy Vijayan, Paul Lazarus, T., Durga, A. R., Suresh, A. and Pratheesh P. Gopinath (2023) Risk Perception of Pineapple Farmers in the Context of Covid-19 in Kerala. *Asian J. Agricul. Extens. Eco. & Sociol.* 41(2):38-46. https://journalajaees.com/index.php/AJAEES/issue/view/182 http://krishi.icar.gov.in/jspui/handle/123456789/82888

Asha, K. K., Ajith Kumar, T. T., Mohan, C. O., Charan, R., Suseela Mathew, Ravishankar, C. N. and Kuldeep K. Lal (2023) *Pangasius silasi*, a fish species endemic to Krishna River in India, reveals a healthy PUFA and nutritional profile: Could be a promising species as human food. *Indian J. Fish.* 70(4): 143-149. doi:10.21077/ijf.2023.70.4.109376-15 http://krishi.icar.gov.in/jspui/handle/123456789/83195

Baraiya, K. G., Manjanaik Bojayanaik, Taral, P. V., Surasani, V. K. R., Elavarasan, K. and Veena Shetty (2023) Utilizing Bullseye fish processing frame waste to produce edible proteins and quality assessment of the recovered proteins. *Environ. Sci. & Pollu. Res.* https://doi.org/10.1007/s11356-023-29738-5 http://krishi.icar.gov.in/jspui/handle/123456789/82806

Bardhan, A., Abraham, J., Singha, J., Rajisha, R., Krishna, E.K.N., Panda, S.K. and Patil, P.K. (2023) Impacts of Oral Florfenicol Medication and Residues on the Kidney and Liver of Nile Tilapia *Oreochromis niloticus* (L.). *Vet. Sci.* 10(1): 36. https://doi.org/10.3390/ vetsci10010036 http://krishi.icar.gov.in/jspui/handle/123456789/80727

Chinnadurai, S., Elavarasan, K., Geethalakshmi, V., Kripa, V. and Mohamed, K. S., (2023) Development of a depuration protocol for commercially important edible bivalve molluscs of India: Ensuring microbiological safety. *Food Microbiol.* 110:104172. https://doi.org/10.1016/j.fm.2022.104172 http://krishi.icar.gov.in/jspui/handle/123456789/80557

Damaris, D. B. and Saly N. Thomas (2023) Derelict fishing gear abundance, its causes and debris management practices – Insights from the fishing sector of Kerala, India. *Mar. Policy*. 148: 105429. https://doi.org/10.1016/j.marpol.2022.105429 http://krishi.icar.gov.in/jspui/handle/123456789/80811

Das, V., Niladri S. Chatterjee, Pushpakaran, P. U., Lalitha, K. V. and Toms C. Joseph (2023) Exploration of Natural Product Repository by Combined Genomics and Metabolomics Profiling of Mangrove-Derived Streptomyces murinus THV12 Strain. *Fermentation.* 9(6): 576. https://doi.org/10.3390/fermentation9060576 http://krishi.icar.gov.in/jspui/handle/123456789/82396

Devendra Sahu, Saly N. Thomas, Manojkumar, B., Renjith, R. K. and Hinopma Korram (2023) Traditional fishing traps of Mahanadi basin in Chhattisgarh. *The Pharma Innovation Journal.* 12(1): 2099-2102. http://krishi.icar.gov.in/jspui/handle/123456789/80813

Eric Gilman, Kyle Antonelis, Joan Drinkwin, Saeid Gorgin, Petri Suuronen, Saly N. Thomas and Jono Wilson (2023) Introduction to the Marine Policy special issue on abandoned, lost and discarded fishing gear: Causes, magnitude, impacts, mitigation methods and priorities for monitoring and evidence-informed management. *Mar. Policy.* 155: 105738. http://krishi.icar.gov.in/jspui/handle/123456789/82832

Gopika, R., Muhamed Ashraf, P. and Binsi, P. K. (2023) Epoxy polymers reinforced with phosphorus-doped carbon dots for enhanced corrosion protection of carbon steel in marine environments. *Mater. Corros. - Werkst. Korros.* https://doi.org/10.1002/maco.202313957 http://krishi.icar.gov.in/jspui/handle/123456789/82805

Gopika, R., Muhamed Ashraf, P., Binsi, P. K. (2023) Utilization of Tuna Fish Skin Waste: Synthesis and Application of Nanocarbon Dots for Corrosion Resistance in Epoxy Polymers. *Arabian J. Sci. and Engin.* https://doi.org/10.1007/s13369-023-08569-z http://krishi.icar.gov.in/jspui/handle/123456789/82852

Gorain, S., Philip Kuriachen, Vimal Kumar, C. and Suresh, A. (2023) Land degradation and its impact on agricultural productivity: The case of India. *Land Degrad. & Develop.* 35(1):196-212. DOI: 10.1002/ldr.4909 http://krishi.icar.gov.in/jspui/handle/123456789/83342

Hafsa Maqbool, Zynudheen, A. A., Safeena, M. P., Mudassir Azhar and Joshy, C. G. (2023) The Combined Effect of Beetroot Peel Extract, Chilling, and Vacuum Packaging on the Shelf-Life of Deccan Mahseer (*Tor khudree*) Steaks. *J. Aquatic Food Product Technol.* 32(1): 1-12. https://doi.org/10.1080/10498850.2022.2150107 http://krishi.icar.gov.in/jspui/handle/123456789/80724

Jeena, N. S., Sajikumar, K. K., Rahuman, S., Ragesh, N., Koya, K. P., Chinnadurai, S., Sasikumar, G. and Mohamed, K. S. (2023) Insights into the divergent evolution of the oceanic squid *Sthenoteuthis oualaniensis* (Cephalopoda: Ommastrephidae) from the Indian Ocean. *Integrative Zool.* 18(5):924-948. https://doi.org/10.1111/1749-4877.12705 http://krishi.icar.gov.in/jspui/handle/123456789/80732

Jeena, N. S., Sajikumar, K., Summaya Rahuman, Ragesh, N., Said Koya, K. P., Chinnadurai, S., Geetha Sasikumar and Mohamed, K. S. (2023) Insights into the divergent evolution of the oceanic squid Sthenoteuthis oualaniensis (*Cephalopoda:*

*Ommastrephidae*) from the Indian Ocean. *Integrative Zool*. 18(5): 924-948. http://krishi.icar.gov.in/jspui/handle/123456789/80732

Jeyakumari, A., Murthy, L. N., Visnuvinayagam, S., Sarma, K. S. S., Rawat, K. P. and Khader, S. K. (2023) Effect of electron beam irradiation on the quality of vacuum-packed, chilled-stored tilapia fish chunks. *Indian J. Fish.* 70(2): 109-115. 10.21077/ijf.2023.70.2.132421-14 http://krishi.icar.gov.in/jspui/handle/123456789/82400

Jeyakumari, A., Narasimha Murthy, L., Visnuvinayagam, S. and Laly, S. J. (2023) Quality and Shelf-Life Evaluation of Chitosan-coated Dried Bombay Duck (*Harpodon nehereus*). *Asian J. Dairy and Food Res*. 42(4): 511-516. 10.18805/ajdfr.DR-2097 http://krishi.icar.gov.in/jspui/handle/123456789/83354

Jeyakumri, A., Murthy, L. N. and Laly, S. J. (2023) Quality characteristics of cuttlefish (*sepia officinalis*) treated with different additives during iced storage. *Fish. Techol*. 60(2): 92-98. https://epubs.icar.org.in/index.php/FT/article/view/130013 http://krishi.icar.gov.in/jspui/handle/123456789/80815

Joshy, C. G., Elavarasan, K., Renuka, V., Madusudhana Rao, B., Premdev, K. V., Zynudheen, A. A. and George Ninan (2023) Estimation and management of shrimp processing waste in organised shrimp processing sector in India: Opportunities and challenges. *Indian J. Fish.* 70 (3): 116-121. https://doi.org/10.21077/ijf.2023.70.3.128992-15 http://krishi.icar.gov.in/jspui/handle/123456789/82831

Joy, J. M., Amruth, P., Jacob, M. R., Dara, P. K., Renuka, V. and Anandan, R. (2023) Liposome mediated encapsulation and role of chitosan on modulating liposomal stability to deliver potential bioactives-A review. *Food Hydrocolloids for Health*. 4: 100142. https://doi.org/10.1016/j.fhfh.2023.100142 http://krishi.icar.gov.in/jspui/handle/123456789/82833

Joy, J. M., Amruth, P., Paul, P. T., Stephy Rose, K.V., Akshay, P., Rosemol Jacob, M., Dara, P. K., Mathew, S., and Anandan, R. (2023) Characterization and evaluation of antioxidant properties of skipjack (*Katsuwonus pelamis*) tuna skin gelatin Hydrolysate. *Int. J. Zoo. Applied Bioscie*. 8(4):21-27. DOI: 10.55126/ijzab.2023.v08.i04.004 http://krishi.icar.gov.in/jspui/handle/123456789/83359

Joy, J. M., Dara, P. K., Amruth, P., Jacob, M. R., Nanjappan Dhandapani, Suseela Mathew and Anandan, R. (2023) Evaluation of the physicochemical and techno-functional properties of gelatin extracted from fish processing waste. *Int. J. Bio-resource and Stress Manage*. 14(5): 733-742. http://ojs.pphouse.org/index.php/IJBSM/article/view/4342 http://krishi.icar.gov.in/jspui/handle/123456789/82434

Kavitha Rajagopal, Renuka Nayar, Bindu, J., Magna Thomas and Prejit (2023) Influence of different mixtures of ingredients on the nutritional properties of a high protein extruded snack. *The Pharma Innovat. J*. 12(2): 2462-2467. http://krishi.icar.gov.in/jspui/handle/123456789/80729

Kavitha Rajagopal, Renuka Nayar, Bindu, J., Vasudevan, V. N. and Sathu, T. (2023) Effect of extrusion conditions on physical properties of an extruded snack incorporated with chicken meat, rice flour and jackfruit bulb and seed powders. *The Pharma Innovat. J.* 12(2): 2058-2062. http://krishi.icar.gov.in/jspui/handle/123456789/80728

Krishna Suresh, Visnuvinayagam, S., Murugadas, V., Radhakrishnan Nair, V., Sivaraman, G. K. and Toms C. Joseph (2023) Levels of Faecal Indicator Bacteria and Biofilm-Producing *Escherichia Coli* in Vembanad Lake, Kerala, India. *Fish. Techol.* 60(4): 262-268. https://epubs.icar.org.in/index.php/FT/article/view/137101 http://krishi.icar.gov.in/jspui/handle/123456789/82838

Kristine Cerbule, Madhu, V. R., Salini Mohanan and Bent Herrmann (2023) Gillnet colour affects catch efficiency in pearlspot (*Etroplus suratensis*) tropical estuary fishery. *Aquac. Fish*. https://doi.org/10.1016/j.aaf.2023.09.002 http://krishi.icar.gov.in/jspui/handle/123456789/82850

Kumarakannan Asokan, Paras Nath Jha, Leela Edwin, Manoj Kumar, B., Amrutha R. Krishnan and Mathew Sebastian (2023) Fuel use in small-scale fishing vessels along the southeast coast of India: a comparative study to ascertain possible reasons and potential recommendations for effective management. *Environ. Monit. Assess.* 195:345. http://krishi.icar.gov.in/jspui/handle/123456789/80808

Laly, S. J. and Sankar, T. V. (2023) Comparative Study of Biochemical Composition and Nutrient Profile of Four Species of Penaeid Shrimps. *Fish. Techol.* 60(4): 254-261. https://epubs.icar.org.in/index.php/FT/article/view/138538 http://krishi.icar.gov.in/jspui/handle/123456789/82837

Lekshmi Sivaraman., Geetanjali Deshmukhe, Martin Xavier, K. A., Hirekude, S. K., Ajay Desai, Balange, A. K. (2023) Effect of incorporation of seaweed (*Portieria hornemanii*) and Tilapia fish protein concentrate on the nutritional, physical and sensory attributes of cookies. *Int. J.Food Sci. and Technol*. 58(8): 4415-4424. https://doi.org/10.1111/ijfs.16549 http://krishi.icar.gov.in/jspui/handle/123456789/83347

Lekshmi, R. G. Kumar, Tejpal, C. S., Anas, K. K., Renuka, V., Muhamed Ashraf, P., Anandan, R. and Suseela Mathew (2023) Tailoring chitosan as a pickering emulsion stabilizer – a preliminary assessment. *Fish. Techol.* 60(4): 295-298. https://epubs.icar.org.in/index.php/FT/article/view/133465 http://krishi.icar.gov.in/jspui/handle/123456789/82841

Madhu, V. R., Anand, S. B., Kristine Cerbule and Bent Herrmann (2023) Simple

pot modification improves catch efficiency and species composition in a tropical estuary mud crab (*Scylla serrata*) fishery. *Estuar. Coast. Shelf Sci.*288: 108369. https://doi.org/10.1016/j.ecss.2023.108369 http://krishi.icar.gov.in/jspui/handle/123456789/82442

Manikantha, B., Murugadas, V., Karthika, R., Joshy, C. G., Visnuvinayagam, S. and Madhusudana Rao, B. (2023) Coliphage cocktails for controlling antimicrobial-resistant *Escherichia coli*: emphasizing polyphage and multihost interactions at different levels of multiplicity of infection. *J. Appl. Microbiol.* 134(4): lxad055. https://doi.org/10.1093/jambio/lxad055 http://krishi.icar.gov.in/jspui/handle/123456789/80830

Manikantha, B., Murugadas, V., Visnuvinayagam, S., Karthika, R., Prasad, M. M. and Madhusudana Rao, B. (2023) Genome characterization and infectivity potential of Vibriophage-ϕlv6 with lytic activity against luminescent vibrios of *Penaeus vannamei* shrimp aquaculture. *Viruses.* 15(4): 868. https://doi.org/10.3390/v15040868 http://krishi.icar.gov.in/jspui/handle/123456789/80812

Manju Lekshmi, N., Kumar, S. S., Muhamed Ashraf, P., Nehala, S. P., Leela Edwin and Andrew Turner (2023) Occurrence and characteristics of fibreglass-reinforced plastics and microplastics on a beach impacted by abandoned fishing boats: A case study from Chellanam, India. *Mar. Pollut. Bull.*192: https://doi.org/10.1016/j.marpolbul.2023.114980 http://krishi.icar.gov.in/jspui/handle/123456789/82436

Manju Lekshmi, N., Prajith, K. K. and Leela Edwin (2023) Indigenous Inland Fish Traps and Pots of Maharashtra, India. *Fish. Technol.* 60(1): 15-24. https://epubs.icar.org.in/index.php/FT/article/view/129485 http://krishi.icar.gov.in/jspui/handle/123456789/83315

Manju Lekshmi, N., Sreejith S. Kumar, Muhamed Ashraf, P., Martin Xavier, K. A., Prathish, K. P., Ajay, S. V., Leela Edwin and Andrew Turner (2023) Abandonment of fibreglass reinforced plastic fishing boats in Kerala, India, and chemical emissions arising from their burning. *Environ. Monit. Assess.* 195: 1413. https://doi.org/10.1007/s10661-023-12033-8 http://krishi.icar.gov.in/jspui/handle/123456789/82844

Maria Cisni, F., Neethu, K. C., Murali, S., Aniesrani Delfiya, D. S. and George Ninan (2023) Design and development of solar-electrical hybrid dryer and its performance evaluation using shrimps. *Biomass conversion and biorefinery*. https://doi.org/10.1007/s13399-023-04651-6 http://krishi.icar.gov.in/jspui/handle/123456789/82807

Megha, S. S., Joshy, C. G. and Mathew Sebabstian (2023) Statistical models for estimating trend and growth rate of shrimp culture and production in India. *Fish. Techol.* 60(3): 225-229. https://epubs.icar.org.in/index.php/FT/article/view/125414 http://krishi.icar.gov.in/jspui/handle/123456789/82804

Muhamed Ashraf, P., Anju, V. S., Binsi, P. K. and Toms C. Joseph (2023) A green extraction process of nanocarbon dots from prawn shells, and its reinforcement in epoxy polymers. *J. Appl. Polym. Sci.* 140(1): e53250. https://doi.org/10.1002/app.53250 http://krishi.icar.gov.in/jspui/handle/123456789/80722

Muhamed Ashraf, P., Manju Lekshmi, N., Chinnadurai, S., Anjitha, S., Archana, M., Kumar, C. M. V., Sandhya, K. M. and Gop, A. P. (2023) Impact assessment of biofouling resistant nano copper oxide–polyaniline coating on aquaculture cage nets. *Aquacult and Fish.* 8(5): 538-543. https://doi.org/10.1016/j.aaf.2022.01.002 http://krishi.icar.gov.in/jspui/handle/123456789/83377

Muneeb Hamza, Sivaraman, G. K. and Prasad, M. M. (2023) Multidrug-resistant phenotypes among biofilm-producing staphylococcal isolates from farm-raised fish: a molecular scrutiny. *J. Appl. Microbiol.* 134(7): lxad136. https://doi.org/10.1093/jambio/lxad136 http://krishi.icar.gov.in/jspui/handle/123456789/83871

Murali, S., Alfiya, P.V., Aniesrani Delfiya, D. S., Manoj P. Samuel., George Ninan (2023) Solar Hybrid Drying System for Marine Applications - A Comprehensive Review. *J. aquatic food product technol.* 32(1): 38-58. https://doi.org/10.1080/10498850.2022.2155497 http://krishi.icar.gov.in/jspui/handle/123456789/80723

Murali, S., Aniesrani Delfiya, D. S., Alfiya, P. V., Manoj P. Samuel and George Ninan (2023) Development of sensible heat storage based solar hybrid dryer with evacuated tube collector and biomass gasifier for shrimp drying. *Sol. Energy.* 262: 111836. https://doi.org/10.1016/j.solener.2023.111836 http://krishi.icar.gov.in/jspui/handle/123456789/82441

Mustafa Ahmed, Bipul Phukan, Avinash Talukdar, Imtiaz Ahmed, Jiten Sharma, Ayub Ali, Rinku Gogoi, Kankana Borah, Martin Xavier (2023) Assessment of microplastic contamination in the gastrointestinal tracts of indigenous fishes from northeastern hill regions of Bhogdoi, a tributary of River Brahmaputra, India. *Environ. Sci. & Pollu. Res.* 30: 121124-121137 https://doi.org/10.1007/s11356-023-30821-0 http://krishi.icar.gov.in/jspui/handle/123456789/82846

Nebu George Thomas, Yogesh Bharat Dalvi, Natalia Fijol, Joy Shilpa, Rekha Unni, Binsi, P. K., Mekha Grace Varghese, Reshmy, R., Aji Mathew and Anil Sukumaran (2023) Fish Scale Derived Hydroxyapatite Incorporated 3D Printed PLA

Scaffold for Bone Tissue Engineering. *New J. Chem.* https://doi.org/10.1039/D3NJ03005A http://krishi.icar.gov.in/jspui/handle/123456789/82809

Nikita Gopal, Hapke, H. M. and Leela Edwin (2023) Technological transformation and changing social relations in the ring seine fishery of Kerala, India. *Marit. Stud*. 22: 26. https://doi.org/10.1007/s40152-023-00313-5 http://krishi.icar.gov.in/jspui/handle/123456789/82430

Nitin Kanji Suyani, N. K., Mridula Rajesh, Mohan, C. O., Kottanahally Mallegowda Rajesh, Siddappaji Siddaiah (2023) Bio-chemical composition, protein quality and amino acid profile of red-toothed triggerfish (*Odonus niger*), an underutilized fish. *Int. J.Food Science & Technol.* 58(1): 53-61. https://doi.org/10.1111/ijfs.16160 http://krishi.icar.gov.in/jspui/handle/123456789/80721

Pandey, G., Niladri S. Chatterjee, Panda, S. K., Mohan, C. O., Kishore, P., Kumar, A., Devananda Uchoi, Balasundari, S., Anandan, R., Mathew, S. and Ravishankar, C. N. (2023) Scope and challenges of seaweed utilization in food and nutraceutical industry in India: a review. *J. Food Science and Technol*. 61:230-241. https://doi.org/10.1007/s13197-023-05676-5 http://krishi.icar.gov.in/jspui/handle/123456789/83872

Parthiban, F., Sugumar, G., Kavinesan, K. and Mohan, C. O. (2023) Augmentation of bioactivity with addition of clove essential oil into fish scale gelatin, agar and chitosan composite film and biodegradable features. *Polymer Bulletin*. https://doi.org/10.1007/s00289-023-04961-9 http://krishi.icar.gov.in/jspui/handle/123456789/83378

Patel, J. K., Ada Zwetlana, Dipannita Ghosh, Vineeth Rajan, Sivaraman, G. K., Vivekanandan, P. and Ravikrishnan, E. (2023) Whole genome characterization of methicillin-resistant Staphylococcus spp. isolates from aquaculture-cultivated shrimps. *Aquaculture*. 575:1-12. https://doi.org/10.1016/j.aquaculture.2023.739704 http://krishi.icar.gov.in/jspui/handle/123456789/83380

Paul, P. T., Joy, J. M., Fazil, T. S., Akshay, P., Niladri S. Chatterjee and Suseela Mathew (2023) Evaluation of the proximate composition, minerals, and heavy metals of brown seaweeds: *Sargassum wightii* and *Sargassum thunbergii* collected from the Mandapam coastal regions, Tamil Nadu. *Int. J. Zoology and Applied Biosci.* 8(6), 106-112. https://doi.org/10.55126/ijzab.2023.v08.i06.016 http://krishi.icar.gov.in/jspui/handle/123456789/83352

Pe. Jeyya Jeyanthi, Geethalakshmi, V., Sajesh, V. K., Chandrasekar, V., Mohanty, A. K. and Nikita Gopal (2023) Estimation of Revenue-Based Fishing Capacity of Trawlers Using Data Envelopment Analysis. *Fishery Technology*, 60(1):72-77. https://epubs.icar.org.in/index.php/FT/article/view/129044 http://krishi.icar.gov.in/jspui/handle/123456789/83340

Prajith, K. K., Chinnadurai, S. and Remesan, M. P. (2023) Marine Pots and Traps of the South-West Coast of India: A Review of their Design, Operation and Fisheries. *Fish. Techol.* 60(4): 231-239. https://epubs.icar.org.in/index.php/FT/article/view/134780 http://krishi.icar.gov.in/jspui/handle/123456789/82834

Ragasudha, R., Karthickumar, P., Murali, S., Pradeep, R., Rathnakumar, K., Mercy Amrita C., Babiyola, D., & Manimehalai, N. (2023) Design and performance analysis of a PV-powered solar-infrared hybrid dryer for anchovy fish drying. *Biomass Conv. Bioref.* https://doi.org/10.1007/s13399-023-03944-0 http://krishi.icar.gov.in/jspui/handle/123456789/80730

Ralphy Joseph, C. J. and Nikita Gopal (2023) An assessment of challenges faced by educators in online education for higher secondary classes in Kerala. *IJET*. 5(1):54-64. https://ncert.nic.in/pdf/publication/journalsandperiodicals/dianjournalofeducationaltechnology/IJET_January2023.pdf http://krishi.icar.gov.in/jspui/handle/123456789/83875

Ramakrishna Reddy, P., Nikesh N. Hajare, Oishi Das, Balange, A. K., Martin Xavier, K. A. and Binaya Bhushan Nayak (2023) Reduction in salt fermentation time of Indian mackerel (*Rastrelliger kanagurta*) using *Halobacterium salinarum* as a starter culture. *Ind. J. Fish.* 70(4):150-157. https://doi.org/10.21077/ijf.2023.70.4.136119-16 http://krishi.icar.gov.in/jspui/handle/123456789/83430

Rathul Remesan, Renjith, R. K., Zynudheen, A. A., Meera, M. R. (2023) Length–weight relationship of mangrove clam Anodontia edentula (Linnaeus, 1758) from Kattampally, Valapattanam River, Kerala, India. *Fish. Techol.* 60(4): 286-289. https://epubs.icar.org.in/index.php/FT/article/view/134344 http://krishi.icar.gov.in/jspui/handle/123456789/82840

Raveendran, K., Murugadas, V., Manikantha, B., Visnuvinayagam, S. and Madhusudana Rao, B. (2023) Diverse infective and lytic machineries identified in genome analysis of tailed coliphages against broad spectrum multidrug-resistant *Escherichia coli*. *Int. Microbiol.* 26(3), 459-469. https://doi.org/10.1007/s10123-022-00310-4 http://krishi.icar.gov.in/jspui/handle/123456789/83379

Rejula K., Ashaletha, S., Suresh, A., Nikita Gopal and Mohanty, A. K. (2023) Women fish vendors in Kerala, India: an analytical study of access to inputs and services. *Gender, Technol and Develop.* 27(3):387-399. https://doi.org/10.1080/09718524.2023.2260656 http://krishi.icar.gov.in/jspui/handle/123456789/83196

Rejula, K., Sajesh, V. K., Monalisha Devi, S., Ashaletha, S., Nikita Gopal, Mohanty, A. K. and Ravishankar,

C. N. (2023) Development of a scale to measure fishers' attitude towards responsible fishing. *Indian J. Fish.* 70(2): 126-132. 10.21077/ijf.2023.70.2.114696-16 http://krishi.icar.gov.in/jspui/handle/123456789/82401

Renjith, R. K., Paras Nath Jha, Chinnadurai, S., Baiju, M. V. and Saly N. Thomas (2023) Investigations on depredation by the deepsea swimming crab Charybdis smithii, during experimental gillnetting along the south-west coast of India. *Indian J. Fish.* 70(2): 133-137. doi:10.21077/ijf.2023.70.2.132266-17. http://krishi.icar.gov.in/jspui/handle/123456789/82402

Renuka, V., Elavarasan, K., Zynudheen, A. A. and Ravishankar, C. N. (2023) Antioxidant properties of chitooligosaccharides produced by enzymatic degradation of chitosan. Fish. Techol. 60(3): 221-224. https://epubs.icar.org.in/index.php/FT/article/view/127724 http://krishi.icar.gov.in/jspui/handle/123456789/82447

Renuka, V., Ravishankar, C. N., Elavarasan, K., Zynudheen, A. A. and Balasubramanian, S. (2023) Utilization of Parapeneopsis stylifera shrimp shell waste for the production of chitooligosaccharides using different non-specific enzymes and their characterization. *Polym. Bull.* https://doi.org/10.1007/s00289-023-04821-6 http://krishi.icar.gov.in/jspui/handle/123456789/82406

Rose, S. K. V., Sruthy, C. S., Niladri S. Chatterjee and Anandan, R. (2023) Assessment of Larval Health and Metamorphosis of the Giant Freshwater Prawn *Macrobrachium rosenbergii* Larvae during Acute Exposure to Imidacloprid. *IJBSM.* 14(6): 891-899. https://ojs.pphouse.org/index.php/IJBSM/article/view/4808 http://krishi.icar.gov.in/jspui/handle/123456789/82435

Rosemol Jacob, M., Amruth, P., Akshay, P., Stephy Rose, K.V., Anandan, R. and Suseela Mathew (2023) In vivo assessment of wound closure and biocompatibility of nanochitosan-polyvinylalcohol-glycerol films in experimental animal model. *Int. J. Zoology and Applied Biosci.* 8(6), 77-83. https://doi.org/10.55126/ijzab.2023.v08.i06.011 http://krishi.icar.gov.in/jspui/handle/123456789/83351

Rupali Das, Mehta, N. K., Soibam Ngasotter, Balange, A. K., Nayak, B. B., Murthy, L. N. and Martin Xavier, K. A. (2023) Process optimization and evaluation of the effects of different time-temperature sous vide cooking on physicochemical, textural, and sensory characteristics of whiteleg shrimp (*Litopenaeus vannamei*). *Heliyon.* 9(6): e16438 https://doi.org/10.1016/j.heliyon.2023.e16438 http://krishi.icar.gov.in/jspui/handle/123456789/82404

Sajeev, M. V., Ramesha, T. J., Chethan, N., Gopika, R. (2023) Factors Influencing Fish Purchase and Consumption Behaviour of Koraga and Soliga Tribes, Karnataka, India. *Indian J. Ext. Edu.* 59(4), 86–90. https://doi.org/10.48165/IJEE.2023.59418 http://krishi.icar.gov.in/jspui/handle/123456789/82845

Sajesh, V. K., Suresh, A. and Mohanty, A. K. (2023) Marine Fisheries in Kerala, India: An Extension Perspective. *Fish. Technol.* 60(1):1-7. https://epubs.icar.org.in/index.php/FT/article/view/129860 http://krishi.icar.gov.in/jspui/handle/123456789/83339

Salini Mohanan, Madhu, V. R., Kumar, B. M., Nafin, K. S. and Soumya, K. R. (2023) Impact of Coloured LED lights and Lunar Phase on Catches of Selected Shrimp Species in a Filtration Field at Kudappuram, Vembanad Lake. *Fish. Techol.* 60(4): 247-253. https://epubs.icar.org.in/index.php/FT/article/view/137583 http://krishi.icar.gov.in/jspui/handle/123456789/82836

Saly N. Thomas, Sandhya, K. M., Harsha, K., Mary Baby, K. A. and Aishwarya Ghosh, K. A. (2023) Ghost fishing capacity of lost experimental gillnets: a preliminary study from Indian waters. *Environ. Sci. and Pol. Res.* 30: 40062–40072. http://krishi.icar.gov.in/jspui/handle/123456789/80731

Sandhya, K. M., Saranya, R., Saly N. Thomas, Amruthta, R. K. and Manojkumar, B. (2023) Gillnet Selectivity Parameters for Commercially Important Species, *Labeo Rohita* in a Tropical Reservoir, Kerala, India. *J. Inland Fish. Soc. India.* 55: 299-307. http://krishi.icar.gov.in/jspui/handle/123456789/82847

Sarkar, R., Niladri S. Chatterjee, Shaikh, N., Khan, Z., Avula, B., Khan, I. and Banerjee, K. (2023) Authentication of *Tinospora cordifolia* derived herbal supplements using high resolution mass spectrometry-based metabolomics approach – A pilot study. *Ind. Crops Prod.* 200: 116835. https://doi.org/10.1016/j.indcrop.2023.116835 http://krishi.icar.gov.in/jspui/handle/123456789/82439

Sathish Kumar, K., Bindu, J., Elavarasan, K., Amjad K. Balange and Murthy, L. N. (2023) Preservative effect of ready to disperse bioactive edible coating powder from fish protein hydrolysate incorporated with chitosan and active clove oil on tuna fillets (*Thunnus albacares*) during chilled storage. *Indian J. Fish.* 70(2): 101-108. 10.21077/ijf.2023.70.2.132322-13 http://krishi.icar.gov.in/jspui/handle/123456789/82360

Sathish Kumar, K., Bindu, J., Elavarasan, K., Balange, A. K. and Murthy, L. N. (2023) Preservation of Indian Mackerel (*Rastrelliger kanagurta*) using fish protein hydrolysate based bioactive edible coating incorporated with chitosan and clove oil. *Fish. Techol.* 60(3): 181-188. https://epubs.icar.org.in/index.php/FT/article/view/137655 http://krishi.icar.gov.in/jspui/handle/123456789/82444

Sharma, S. K. and Jaiswar, A. K. (2023) The Occurrence of *Cynoglossus macrolepidotus* (Bleeker, 1851) and *Cynoglossus arel* (Bloch & Schneider, 1801) Along the

Mumbai Coast, India. *Uttar Pradesh J. Zool.* 44(19):106-116. https://doi.org/10.56557/upjoz/2023/v44i193624 http://krishi.icar.gov.in/jspui/handle/123456789/83138

Soibam Ngasotter, Martin Xavier, K. A., Layana Porayil, Balange, A. K., Nayak, B. B., Eappen, S. M., Adarsh, K. J., Sreekala, M. S., Rupam Sharma and George Ninan (2023) Optimized high-yield synthesis of chitin nanocrystals from shrimp shell chitin by steam explosion. *Carbohydr. Polym.* 316: 121040. https://doi.org/10.1016/j.carbpol.2023.121040 http://krishi.icar.gov.in/jspui/handle/123456789/82438

Sreepriya Prakasan, Sreelakshmi, K. R., Remya, S., Parvathy, U., Pankaj Kishore and Bindu, J. (2023) Nutritional facts of *Mytella strigata* collected from Cochin backwater, Kerala, India. *Fish. Techol.* 60(2): 85-91. https://epubs.icar.org.in/index.php/FT/article/view/135279 http://krishi.icar.gov.in/jspui/handle/123456789/80814

Sudha Sajeev, Muneeb Hamza, Vineeth Rajan, Ardhra Vijayan, Sivaraman, G. K., Bibek R. Shome and Mark A. Holmes (2023) Resistance profiles and genotyping of extended-spectrum beta-lactamase (ESBL) -producing and non-ESBL-producing E. coli and Klebsiella from retail market fishes. *Infection, Genetics and Evolut*. 112:1-12. https://doi.org/10.1016/j.meegid.2023.105446 http://krishi.icar.gov.in/jspui/handle/123456789/83880

Sullip Kumar Majhi (2023) Generation of surrogate goldfish *Carassius auratus* progeny from common carp *Cyprinus carpio* parents. *3 Biotech.* 13:27. https://doi.org/10.1007/s13205-022-03424-8 http://krishi.icar.gov.in/jspui/handle/123456789/80809

Suman Kumari, Lianthuamluaia, L., Sarkar, U. K., Mishal P., Gunjan K., Meena, D. K., Sandhya, K. M., Hassan, M. A., Jaiswar, A. K., Sharma, A. P. and Das, B. K. (2023) Environmental characterization of two ecologically distinct gangetic oxbow lakes using zooplankton taxonomic indices through comparative approach for wetland monitoring. *Wetlands.* 43: 14. https://doi.org/10.1007/s13157-023-01658-7 http://krishi.icar.gov.in/jspui/handle/123456789/82399

Sumit Kumar Verma, Ganesan, P., Pankaj Kishore, Remya, S., Mohan, C. O., Pandurengan Padmavathy, Nagarajan Muralidhran and Bindu, J. (2023) Effects of different cooking methods on the proximate composition and physical properties of Brown shrimp (*Metapenaeus dobsonii*) during cooking and freezing cycle. *Food Science & Technology International*. https://doi.org/10.1177/10820132231166972 http://krishi.icar.gov.in/jspui/handle/123456789/80827

Suresh, A. (2023) Contextualising credit transactions in artisanal marine fishing: insights from Kerala, India. *Rev. Fish Biol. Fish.* 33: 699–715. https://doi.org/10.1007/s11160-023-09782-7 http://krishi.icar.gov.in/jspui/handle/123456789/82433

Suresh, A. and Vijay Kiran (2023) Marine fisheries insurance in India: retrospect and prospects in the context of climate change. *Agri. Eco. Res. Review*. 36(1):43-51. DOI: 10.5958/0974-0279.2023.00010.1 http://krishi.icar.gov.in/jspui/handle/123456789/83353

Suresh, A., Panda, S. K. and Chandrasekar, V. (2023) Export of fishery products from India: status, challenges and the way forward. *Current Sci*. 124(6): 664-670. http://krishi.icar.gov.in/jspui/handle/123456789/79458

Sushri, S. B., Elavarasan, K., Safeena, M. P. and Suseela Mathew (2023) Protein isolate from brown seaweed, *sargassum tenerrimum*: extraction and characterization. *Fish. Techol.* 60(3): 189-195. https://epubs.icar.org.in/index.php/FT/article/view/134180 http://krishi.icar.gov.in/jspui/handle/123456789/82445

Sushri, S. B., Elavarasan, K., Safeena, M. P., Mandakini Devi, H. and Tejpal, C. S. (2023) Valorisation of Seaweed Waste from Agar Processing Industry. *Examines Mar Biol Oceanogr*. 5(3). 10.31031/EIMBO.2023.05.000614 http://krishi.icar.gov.in/jspui/handle/123456789/79424

Suyani, N. K., Mridula Rajesh, Mohan, C. O., Rajesh, K. M., Remya, S. and Pankaj Kishore (2023) Fatty acid profile and mineral composition of red-toothed triggerfish (*Odonus niger*) landed in Karnataka, Southeastern Arabian Sea. *Biol. Trace Elem. Res*. https://doi.org/10.1007/s12011-023-03741-w http://krishi.icar.gov.in/jspui/handle/123456789/82431

Thankam Theresa Paul, Abhirami Sajeevan, Albin Albert C., Deepa Sudheesan, Sandhya, K. M. and Das, B. K. (2023). Carbon Emissions from Kerala Reservoirs: An Estimation Study. *Bio. Res. Today*. 5(7):540-542. http://krishi.icar.gov.in/jspui/handle/123456789/83193

Vaisak, S., Prosenjit Singha, Dasgupta, M. S., Armin Hafner, Kristina Widell, Souvik Bhattacharyya, Saini, S. K., Arun, B. S., Manoj P. Samuel and George Ninan (2023) Performance analysis of a CO2/NH3 cascade refrigeration system with subcooling for low temperature freezing applications. *Int J Refrig.* 153: 140-154. https://doi.org/10.1016/j.ijrefrig.2023.05.013 http://krishi.icar.gov.in/jspui/handle/123456789/82405

Verma, S. K., Remya, S., Pankaj Kishore, Mohan, C. O., Ganesan, P., Padmavathy, P., Nagarajan, M., Bindu, J. and Soottawat Benjakuld (2023) Effects of different microwave power on the drying kinetics and physicochemical quality of brown shrimp (*Metapenaeus dobsoni*). *Sustainable Food Technol.* https://doi.org/10.1039/D3FB00144J *http://krishi.icar.gov.in/jspui/handle/123456789/82843*

Vineeth Rajan, Ardhra Vijayan, Ambili P. M., Justus Lancy and Sivaraman, G. K. (2023) Genotyping of *Acinetobacter baumannii* isolates from a tertiary care hospital in Cochin, South India. *Access Microbiology*. 5(11): 1-20. https://doi.org/10.1099/acmi.0.000662.v1. http://krishi.icar.gov.in/jspui/handle/123456789/83876

Vishnu R. Nair, Parvathy, U., Jithin, T. J., Binsi, P. K. and Ravishankar, C. N. (2023) Live transportation of food fishes: current scenario and future prospects. *Current Science*. 124(4): 418-425. http://krishi.icar.gov.in/jspui/handle/123456789/80829

Visnuvinayagam, S., Murugadas, V., Manasa Das, Radhakrishnan Nair, V., Sivaraman, G. K. and Toms C. Joseph (2023) Comparison of standard, fluorogenic and chromogenic substrate based methods for enumeration of *Escherichia coli* in Sasthamkotta lake of Kerala, India. *Fish. Techol.* 60(3): 206-211. https://epubs.icar.org.in/index.php/FT/article/view/138241 http://krishi.icar.gov.in/jspui/handle/123456789/82446

## BOOKS

Nadella, R. K., Niladri S. Chatterjee, Laly, S. J., Priya, E. R., Pankaj Kishore, Devananda Uchoi, Femeena Hassan and George Ninan (eds.) (2023) Book of Abstracts, National Technical workshop on Indian Perspective on Food Safety, Security and Standards. *ICAR-Central Institute of Fisheries Technology, Society of Fisheries Technologists India, Food Safety and Standards Authority of India and India Section of AOAC International*. 73 p. http://krishi.icar.gov.in/jspui/handle/123456789/83427

Prasad, M. M., Ravishankar, C. N., Murugadas, V., Rajesh Bhatia, Joykrushna Jena and Madhusudana Rao, B. (eds.) (2023) Handbook on Antimicrobial Resistance: Current Status, Trends in Detection and Mitigation Measures. *Springer*. pp 980. https://doi.org/10.1007/978-981-16-9723-4 http://krishi.icar.gov.in/jspui/handle/123456789/83190

Sarika, K., Sreejith, S. and Ashish Kumar Jha (eds.) (2023) Guidelines for Salting and Drying of Fish. ICAR-Central Institute of Fisheries Technology (ICAR-CIFT), 12 p. http://krishi.icar.gov.in/jspui/handle/123456789/83709

## BOOK CHAPTERS

Abhay Kumar, Murugadas, V. and Prasad, M. M. (2023) Antimicrobial Resistance in Cronobacter sakazakii. In: Prasad, M. M., Ravishankar, C. N., Murugadas, V., Rajesh Bhatia, Joykrushna Jena and Madhusudana Rao, B. (eds.) (2023) Handbook on Antimicrobial Resitance. Springer Singapore. https://doi.org/10.1007/978-981-16-9723-4_26-1 http://krishi.icar.gov.in/jspui/handle/123456789/83180

Ahamed Basha, K., Murugadas, V., and Madhusudana Rao, B. (2023) Emergence of Antimicrobial Resistance in Seafood-Borne Listeria monocytogenes: An Overview. In: Mothadaka, M.P., Vaiyapuri, M., Rao Badireddy, M., Nagarajrao Ravishankar, C., Bhatia, R., Jena, J. (eds.) Handbook on Antimicrobial Resistance. Springer, Singapore, pp 1-16. http://krishi.icar.gov.in/jspui/handle/123456789/78794

Amruth, P., Rosemol Jacob, M. and Suseela Mathew (2023) Marine Bioactive Compounds, An Alternative to Antibiotics. In: Prasad, M. M., Ravishankar, C. N., Murugadas, V., Rajesh Bhatia, Joykrushna Jena and Madhusudana Rao, B. (eds.) (2023) Handbook on Antimicrobial Resistance. Springer Singapore. pp 1-18. https://doi.org/10.1007/978-981-16-9723-4_37-1 http://krishi.icar.gov.in/jspui/handle/123456789/83182

Anas, K. K., Lekshmi R. G. Kumar, Tejpal, C. S., Anandan, R. and Suseela Mathew (2023) Supercritical extraction and its application in isolation and characterisation of marine bioactive molecules for human health. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 203-210. http://krishi.icar.gov.in/jspui/handle/123456789/83059

Aniesrani Delfiya, D. S. (2023) Advanced drying techniques for fish and fishery products. In: Jeyakumari, A., Elavarasan, K., Joshy, C.G. and Bindu, J. (eds.) (2023) Advances in Seafood Processing and waste utilization. ICAR-Central institute of Fisheries Technology, Kochi, India. pp 94-102. http://krishi.icar.gov.in/jspui/handle/123456789/82896

Aniesrani Delfiya, D. S. (2023) Advanced fish drying techniques. In: Devananda Uchoi, Pankaj Kishore, Nadella, R. K., Niladri S. Chatterjee, Priya, E. R., Laly S.J., Femeena Hassan, Minimol V.A., Paras Nath Jha, Remya, S., Jeyakumari A. and Shivendra Kumar (eds.) (2023) Treatise on Fisheries Harvest and Post-Harvest Technologies. ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 162-167. http://krishi.icar.gov.in/jspui/handle/123456789/83230

Aniesrani Delfiya, D. S. (2023) Infrared Drying of Foods. In: Aniesrani Delfiya, D. S., Murali, S. and Neethu, K. C. (eds.) (2023) Current trends in food processing technology. ICAR-Central Institute of Fisheries Technology, Kochi, India. pp 108-115. http://krishi.icar.gov.in/jspui/handle/123456789/83292

Aniesrani Delfiya, D. S. (2023) IR drying of fish and fishery products. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 221-225. http://krishi.icar.gov.in/jspui/handle/123456789/83062

Anna Sherin, P. S., Murugadas, V. and Madhusudana Rao, B. (2023) Vancomycin and Methicillin Resistance in Staphylococcus aureus: What Is the Next? In: Prasad, M. M., Ravishankar, C. N., Murugadas, V., Rajesh Bhatia, Joykrushna Jena and Madhusudana Rao, B. (eds.) (2023) Handbook on Antimicrobial Resistance. Springer Singapore. pp 1-19. https://doi.org/10.1007/978-981-16-9723-4_17-1 http://krishi.icar.gov.in/jspui/handle/123456789/83178

Anupama, T. K. (2023) Bacterial toxins of seafood importance, pathogenesis and detection. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 347-357. http://krishi.icar.gov.in/jspui/handle/123456789/83078

Anupama, T. K. (2023) Microbial toxins in seafood. In: Devananda Uchoi, Pankaj Kishore, Nadella, R. K., Niladri S. Chatterjee, Priya, E. R., Laly S.J., Femeena Hassan, Minimol V.A., Paras Nath Jha, Remya, S., Jeyakumari A. and Shivendra Kumar (eds.) (2023) Treatise on Fisheries Harvest and Post-Harvest Technologies. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 389-401. http://krishi.icar.gov.in/jspui/handle/123456789/83252

Ardhra Vijayan, Sivaraman, G. K. and Till Bachmann (2023) Prevalence of Extended Spectrum Beta Lactamase (ESBL)-Producing E. coli: A Systematic Overview. In: Prasad, M. M., Ravishankar, C. N., Murugadas, V., Rajesh Bhatia, Joykrushna Jena and Madhusudana Rao, B. (eds.) (2023) Handbook on Antimicrobial Resistance. Springer Singapore. Pp 1-19. https://doi.org/10.1007/978-981-16-9723-4_24-1 http://krishi.icar.gov.in/jspui/handle/123456789/83177

Arun, B. S., Sumit Kumar and Muralis, S. (2023) Future refrigeration systems for food processing industries. In: Neethu, K. C., Aniesrani Delfiya, D. S., Murali, S. (eds.) Training compendium on advances in food process engineering and preservation. Kochi, India, ICAR-Central Institute of Fisheries Technology, pp. 32-42. http://krishi.icar.gov.in/jspui/handle/123456789/83298

Arun, B. S., Sumit Kumar, B. and Murali, S. (2023) Refrigeration System Based on Natural Refrigerants for Fish Processing. In: Aniesrani Delfiya, D. S., Murali, S. and Neethu, K. C. (eds.) (2023) Current trends in food processing technology. ICAR-Central Institute of Fisheries Technology, Kochi, India. pp 200-204. http://krishi.icar.gov.in/jspui/handle/123456789/83298

Ashaletha, S. (2023) Women in fish-preneurship. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 451-454. http://krishi.icar.gov.in/jspui/handle/123456789/83099

Baiju, M. V. (2023) Fishing vessels of India. In: Devananda Uchoi, Pankaj Kishore, Nadella, R. K., Niladri S. Chatterjee, Priya, E. R., Laly S.J., Femeena Hassan, Minimol V.A., Paras Nath Jha, Remya, S., Jeyakumari A. and Shivendra Kumar (eds.) (2023) Treatise on Fisheries Harvest and Post-Harvest Technologies. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 1-10. http://krishi.icar.gov.in/jspui/handle/123456789/83215

Baiju, M. V. (2023) Fishing vessels of India: an update. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 27-37. http://krishi.icar.gov.in/jspui/handle/123456789/82911

Baiju, M. V. (2023) Sea safety aspects in fishing operations. In: Sandhya, K. M. and Manju Lekshmi, N. (eds.) (2023) Advances in fishing gear materials. ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 56-64. http://krishi.icar.gov.in/jspui/handle/123456789/83152

Bindu, J. (2023) An Introduction to Food Preservation and Processing. In: Bindu, J., Mohan, C.O., Remya, S. and Sathish Kumar, K. (eds.) (2023) Advanced food packaging techniques and quality evaluation of packaging materials, ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 1-6. http://krishi.icar.gov.in/jspui/handle/123456789/82861

Bindu, J. (2023) Fish Processing Methods. In: Devananda Uchoi, Pankaj Kishore, Nadella, R. K., Niladri S. Chatterjee, Priya, E. R., Laly S.J., Femeena Hassan, Minimol V.A., Paras Nath Jha, Remya, S., Jeyakumari A. and Shivendra Kumar (eds.) (2023)

Treatise on Fisheries Harvest and Post-Harvest Technologies. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 50-64. http://krishi.icar.gov.in/jspui/handle/123456789/83220

Bindu, J. (2023) Fish Processing Methods: Orientation. In: Priya, E. R., Laly, S. J., Devananda Uchoi., Nadella, R. K., Pankaj Kishore,Niladri Sekhar Chatterjee, Rejula, K.,Satyen Kumar Panda, Zynudheen, A. A., Femeena Hassan,A. K. Mohanty and George Ninan(eds.) (2023) ISO 22000/HACCP for fish processing establishments, Central Institute of Fisheries Technology, Cochin, India. pp 28-38. http://krishi.icar.gov.in/jspui/handle/123456789/78394

Bindu, J. (2023) Fundamentals of food packaging technology. In: Bindu, J., Mohan, C.O., Remya, S. and Sathish Kumar, K. (eds.) (2023) Advanced food packaging techniques and quality evaluation of packaging materials, ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 7-13. http://krishi.icar.gov.in/jspui/handle/123456789/82863

Bindu, J. (2023) Introduction to Fish Processing Techniques. In: Parvathy, U., Sathish Kumar, K., Mohan, C. O., Rejula, K., Nikita Gopal and Bindu, J. (eds.) (2023). Technological Interventions in Processing, Value addition and Packaging of Aquatic Resources. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 11-19. http://krishi.icar.gov.in/jspui/handle/123456789/83104

Bindu, J. (2023) Packaging and Labelling Requirements Fish Products as per International Regulations. In: George Ninan, Zynudheen, A. A., Nikita Gopal, Femeena Hassan, Niladri S. Chatterjee, Laly, S. J., Martin Xavier, K. A., Pankaj Kishore, Nadella, R. K., Devananda Uchoi, Priya, E. R. and Chandrasekar, V. (eds.) (2023) Quality Assurance of Fish and Fishery products, Central Institute of Fisheries Technology, Cochin, India. pp 138-148. http://krishi.icar.gov.in/jspui/handle/123456789/83274

Bindu, J. (2023) Packaging of Fish and Fishery products. In: Parvathy, U., Sathish Kumar, K., Mohan, C. O., Rejula, K., Nikita Gopal and Bindu, J. (eds.) (2023). Technological Interventions in Processing, Value addition and Packaging of Aquatic Resources. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 68-85. http://krishi.icar.gov.in/jspui/handle/123456789/83125

Bindu, J. (2023) Packaging of fish and fishery products. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 165-179. http://krishi.icar.gov.in/jspui/handle/123456789/83055

Binsi, P. K. (2023) ഉണക്ക മത്സ്യത്തിന്റെ ഗുണമേന്മാനഷ്ടം കാരണങ്ങളും പ്രതിവിധിയും. In: Manoj, P. Samuel, Murali, S., Alfiya, P. V., Aniesrani Delfiya, D. S., Menon, A. R. S. and Ragesh M. Raghavan (2023) Pre-processing and Drying of Fish (മത്സ്യ സംസ്കരണവും ഉണക്കലും) ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 19-23. (In Malayalam) http://krishi.icar.gov.in/jspui/handle/123456789/83333

Binsi, P. K. (2023) Marine biomolecules for nutraceutical and cosmeceutical industries. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 137-147. http://krishi.icar.gov.in/jspui/handle/123456789/83051

Binsi, P. K. (2023) Marine Nutraceuticals from Fishery Waste. In: Parvathy, U., Sathish Kumar, K., Mohan, C. O., Rejula, K., Nikita Gopal and Bindu, J. (eds.) (2023). Technological Interventions in Processing, Value addition and Packaging of Aquatic Resources. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 122-132. http://krishi.icar.gov.in/jspui/handle/123456789/83134

Binsi, P. K. (2023) Marine Nutraceuticals from seafood waste. In: Devananda Uchoi, Pankaj Kishore, Nadella, R. K., Niladri S. Chatterjee, Priya, E. R., Laly S.J., Femeena Hassan, Minimol V.A., Paras Nath Jha, Remya, S., Jeyakumari A. and Shivendra Kumar (eds.) (2023) Treatise on Fisheries Harvest and Post-Harvest Technologies. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 137-147. http://krishi.icar.gov.in/jspui/handle/123456789/83227

Binsi, P. K. (2023) Nano Biopolymers: Synthesisand Characterization. In: Muhamed Ashraf, P., Manju Lekshmi, N., Sandhya, K. M., Gopika, R. and Anjana, C. S. (eds.) (2023) Nanotechnological Applications in Fisheries. ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 50-64. http://krishi.icar.gov.in/jspui/handle/123456789/83388

Binsi, P. K. (2023) Nutraceutical and cosmeceutical ingredients from marine resources. In: Jeyakumari, A., Elavarasan, K., Joshy, C.G. and Bindu, J. (eds.) (2023) Advances in Seafood Processing and waste utilization. ICAR-Central institute of Fisheries Technology, Kochi, India. pp 67-79. http://krishi.icar.gov.in/jspui/handle/123456789/82886

Chandrasekar, V. (2023) Application of ICT tools in fisheries. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp

399-412. http://krishi.icar.gov.in/jspui/handle/123456789/83086

Devananda Uchoi (2023) Analysis of histamine in fish and fish products. In: Priya, E. R., Devananda Uchoi, Nadella, R. K., Pankaj Kishore, Niladri S. Chatterjee, Laly, S. J., Femeena Hassan and George Ninan (eds.) (2023) Seafood Quality Assurance. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 75-83. http://krishi.icar.gov.in/jspui/handle/123456789/83422

Devananda Uchoi (2023) Introduction to HACCP concepts in seafood industry. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 251-261. http://krishi.icar.gov.in/jspui/handle/123456789/83067

Devananda Uchoi (2023) ISO 22000/ HACCP in Seafood processing. In: Parvathy, U., Sathish Kumar, K., Mohan, C. O., Rejula, K., Nikita Gopal and Bindu, J. (eds.) (2023). Technological Interventions in Processing, Value addition and Packaging of Aquatic Resources. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 166-177. http://krishi.icar.gov.in/jspui/handle/123456789/81256

Devananda Uchoi (2023) Key elements, Terminologies and Scope of FSMS. In: Priya, E. R., Laly, S. J., Devananda Uchoi., Nadella, R. K., Pankaj Kishore,Niladri Sekhar Chatterjee, Rejula, K.,Satyen Kumar Panda, Zynudheen, A. A., Femeena Hassan,A. K. Mohanty and George Ninan(eds.) (2023) ISO 22000/HACCP for fish processing establishments, Central Institute of Fisheries Technology, Cochin, India. pp 112-122. http://krishi.icar.gov.in/jspui/handle/123456789/78406

Devananda Uchoi (2023) Orientation of HACCP Implementation in Seafood industry. In: George Ninan, Zynudheen, A. A., Nikita Gopal, Femeena Hassan, Niladri S. Chatterjee, Laly, S. J., Martin Xavier, K. A., Pankaj Kishore, Nadella, R. K., Devananda Uchoi, Priya, E. R. and Chandrasekar, V. (eds.) (2023) Quality Assurance of Fish and Fishery products, Central Institute of Fisheries Technology, Cochin, India. pp 96-109. http://krishi.icar.gov.in/jspui/handle/123456789/83271

Devananda Uchoi (2023) Quality Issues in Traditional/Ethnic Fishery Products and its Control Measures. In: George Ninan, Zynudheen, A. A., Nikita Gopal, Femeena Hassan, Niladri S. Chatterjee, Laly, S. J., Martin Xavier, K. A., Pankaj Kishore, Nadella, R. K., Devananda Uchoi, Priya, E. R. and Chandrasekar, V. (eds.) (2023) Quality Assurance of Fish and Fishery products, Central Institute of Fisheries Technology, Cochin, India. pp 35-47. http://krishi.icar.gov.in/jspui/handle/123456789/83264

Devananda Uchoi and Pankaj Kishore (2023) HACCP Principles and its implementation in seafood industry. In: Devananda Uchoi, Pankaj Kishore, Nadella, R. K., Niladri S. Chatterjee, Priya, E. R., Laly S.J., Femeena Hassan, Minimol V.A., Paras Nath Jha, Remya, S., Jeyakumari A. and Shivendra Kumar (eds.) (2023) Treatise on Fisheries Harvest and Post-Harvest Technologies. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 297-312. http://krishi.icar.gov.in/jspui/handle/123456789/83245

Devananda Uchoi, Nadella, R. K. and Pankaj Kishore (2023) Isolation and Identification of Staphylococcus aureus. In: Devananda Uchoi, Nadella, R. K., Pankaj Kishore, Niladri S. Chatterjee, Femeena Hassan and George Ninan (eds.) (2023) Laboratory Manual on Bacteria of Public Health Significance. Central Institute of Fisheries Technology, Cochin, India. pp 63-66. http://krishi.icar.gov.in/jspui/handle/123456789/83289

Devananda Uchoi, Pankaj Kishore and Nadella, R. K (2023) Conventional Identification techniques. In: Devananda Uchoi, Nadella, R. K., Pankaj Kishore, Niladri S. Chatterjee, Femeena Hassan and George Ninan (eds.) (2023) Laboratory Manual on Bacteria of Public Health Significance. Central Institute of Fisheries Technology, Cochin, India. pp 25-28. http://krishi.icar.gov.in/jspui/handle/123456789/83283

Devananda Uchoi, Pankaj Kishore and Nadella, R. K. (2023) Most Probable Number (MPN) technique. In: Devananda Uchoi, Nadella, R. K., Pankaj Kishore, Niladri S. Chatterjee, Femeena Hassan and George Ninan (eds.) (2023) Laboratory Manual on Bacteria of Public Health Significance. Central Institute of Fisheries Technology, Cochin, India. pp 7-15. http://krishi.icar.gov.in/jspui/handle/123456789/83278

Devi Sanjeev, Murugadas, V. and Prasad, M. M. (2023) Environment as Sink for Antimicrobial Resistance and Genes. In: Prasad, M. M., Ravishankar, C. N., Murugadas, V., Rajesh Bhatia, Joykrushna Jena and Madhusudana Rao, B. (eds.) (2023) Handbook on Antimicrobial Resistance. *Springer Singapore.* Pp 1-18. https://doi.org/10.1007/978-981-16-9723-4_10-1 http://krishi.icar.gov.in/jspui/handle/123456789/83175

Elavarasan, K. (2023) Chitin and its Derivatives. In: Parvathy, U., Sathish Kumar, K., Mohan, C. O., Rejula, K., Nikita Gopal and Bindu, J. (eds.) (2023). Technological Interventions in Processing, Value addition and Packaging of Aquatic Resources. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 105-113. http://krishi.icar.gov.in/jspui/handle/123456789/83130

Elavarasan, K. (2023) Chitin and its derivatives. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe.

Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 148-155. http://krishi.icar.gov.in/jspui/handle/123456789/83052

Elavarasan, K. (2023) Importance of fish as food. In: Bindu, J., Mohan, C.O., Remya, S. and Sathish Kumar, K. (eds.) (2023) Advanced food packaging techniques and quality evaluation of packaging materials, ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 14-22. http://krishi.icar.gov.in/jspui/handle/123456789/82864

Elavarasan, K. (2023) Importance of fish in human nutrition. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 70-77. http://krishi.icar.gov.in/jspui/handle/123456789/83041

Elavarasan, K. (2023) Importance of Fish in Human Nutrition. In: Parvathy, U., Sathish Kumar, K., Mohan, C. O., Rejula, K., Nikita Gopal and Bindu, J. (eds.) (2023). Technological Interventions in Processing, Value addition and Packaging of Aquatic Resources. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 1-10. http://krishi.icar.gov.in/jspui/handle/123456789/83103

Elavarasan, K. (2023) Nutritional importance of fish. In: Jeyakumari, A., Elavarasan, K., Joshy, C.G. and Bindu, J. (eds.) (2023) Advances in Seafood Processing and waste utilization. ICAR-Central institute of Fisheries Technology, Kochi, India. pp 1-10. http://krishi.icar.gov.in/jspui/handle/123456789/82878

Elavarasan, K. (2023) Production of chitin and its derivatives. In: Jeyakumari, A., Elavarasan, K., Joshy, C.G. and Bindu, J. (eds.) (2023) Advances in Seafood Processing and waste utilization. ICAR-Central institute of Fisheries Technology, Kochi, India. pp 58-66. http://krishi.icar.gov.in/jspui/handle/123456789/82883

Elavarasan, K. (2023) Protein and protein derivatives from aquatic food processing waste. In: Devananda Uchoi, Pankaj Kishore, Nadella, R. K., Niladri S. Chatterjee, Priya, E. R., Laly S.J., Femeena Hassan, Minimol V.A., Paras Nath Jha, Remya, S., Jeyakumari A. and Shivendra Kumar (eds.) (2023) Treatise on Fisheries Harvest and Post-Harvest Technologies. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 123-136. http://krishi.icar.gov.in/jspui/handle/123456789/83226

Ezhil Nilavan, S. (2023) Water quality parameters in aquatic animal health. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 358-361. http://krishi.icar.gov.in/jspui/handle/123456789/83079

Ezhil Nilavan, S. and Toms C. Joseph (2023) Probiotics in aquatic animal health management. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 333-346. http://krishi.icar.gov.in/jspui/handle/123456789/82876

Ezhil Nilavan, S. and Prasad, M. M. (2023) Vibrio mimicus and Its Antimicrobial Resistance in Fish and Aquatic Environments. In: Prasad, M. M., Ravishankar, C. N., Murugadas, V., Rajesh Bhatia, Joykrushna Jena and Madhusudana Rao, B. (eds.) (2023) Handbook on Antimicrobial Resistance. Springer Singapore. pp 1-21. https://doi.org/10.1007/978-981-16-9723-4_19-1 http://krishi.icar.gov.in/jspui/handle/123456789/83187

Ezhil Nilavan, S., Muthulakshmi, T. and Minimol, V. A. (2023) Detection of pathogenic of Vibrios: Vibrio mimicus, Vibrio harveyi and Vibrio parahaemolyticus. In: Toms C. Joseph, Murugadas, V., Minimol, V. A., Ezhil Nilavan, S., Muthulakshmi, T. and Anupama, T. K. (eds.) (2023) Advanced Microbiological and Molecular Techniques for Improving the Competence of Students in Biological Sciences (under SCSP). ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 46-54. http://krishi.icar.gov.in/jspui/handle/123456789/83204

Ezhil Nilavan, S., Vineetha Das, Sreejith, V.N. (2023) Extraction of DNA and RNA. In: Toms C. Joseph, Murugadas, V., Minimol, V. A., Ezhil Nilavan, S., Muthulakshmi, T. and Anupama, T. K. (eds.) (2023) Advanced Microbiological and Molecular Techniques for Improving the Competence of Students in Biological Sciences (under SCSP). ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 74-79. http://krishi.icar.gov.in/jspui/handle/123456789/83209

Femeena Hassan (2023) Importance of hygiene and sanitation in fish handling. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 241-245. http://krishi.icar.gov.in/jspui/handle/123456789/83065

Femeena Hassan (2023) Overall Perception of Fish Safety and Quality. In: Priya, E. R., Devananda Uchoi, Nadella, R. K., Pankaj Kishore, Niladri S. Chatterjee, Laly, S. J., Femeena Hassan and George Ninan (eds.) (2023)

Seafood Quality Assurance. ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 1-9. http://krishi.icar.gov.in/jspui/handle/123456789/83412

Femeena Hassan (2023) Overview of HACCP in fish processing establishments. In: Priya, E. R., Laly, S. J., Devananda Uchoi., Nadella, R. K., Pankaj Kishore,Niladri Sekhar Chatterjee, Rejula, K.,Satyen Kumar Panda, Zynudheen, A. A., Femeena Hassan,A. K. Mohanty and George Ninan(eds.) (2023) ISO 22000/HACCP for fish processing establishments, Central Institute of Fisheries Technology, Cochin, India. pp 1-8. http://krishi.icar.gov.in/jspui/handle/123456789/78392

Femeena Hassan (2023) Overview: Safety and quality of fish. In: Devananda Uchoi, Pankaj Kishore, Nadella, R. K., Niladri S. Chatterjee, Priya, E. R., Laly S.J., Femeena Hassan, Minimol V.A., Paras Nath Jha, Remya, S., Jeyakumari A. and Shivendra Kumar (eds.) (2023) Treatise on Fisheries Harvest and Post-Harvest Technologies. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 253-261. http://krishi.icar.gov.in/jspui/handle/123456789/83240

Femeena Hassan (2023) Post-mortem Quality Changes in Fish. In: George Ninan, Zynudheen, A. A., Nikita Gopal, Femeena Hassan, Niladri S. Chatterjee, Laly, S. J., Martin Xavier, K. A., Pankaj Kishore, Nadella, R. K., Devananda Uchoi, Priya, E. R. and Chandrasekar, V. (eds.) (2023) Quality Assurance of Fish and Fishery products, Central Institute of Fisheries Technology, Cochin, India. pp 6-11. http://krishi.icar.gov.in/jspui/handle/123456789/83258

Femeena Hassan (2023) Preparation of HACCP plan. In: Priya, E. R., Laly, S. J., Devananda Uchoi., Nadella, R. K., Pankaj Kishore,Niladri Sekhar Chatterjee, Rejula, K.,Satyen Kumar Panda, Zynudheen, A. A., Femeena Hassan,A. K. Mohanty and George Ninan(eds.) (2023) ISO 22000/HACCP for fish processing establishments, Central Institute of Fisheries Technology, Cochin, India. pp 97-104. http://krishi.icar.gov.in/jspui/handle/123456789/78404

Femeena Hassan (2023) Quality Issues in Powdered Fishery Products and its Control Measures. In: George Ninan, Zynudheen, A. A., Nikita Gopal, Femeena Hassan, Niladri S. Chatterjee, Laly, S. J., Martin Xavier, K. A., Pankaj Kishore, Nadella, R. K., Devananda Uchoi, Priya, E. R. and Chandrasekar, V. (eds.) (2023) Quality Assurance of Fish and Fishery products, Central Institute of Fisheries Technology, Cochin, India. pp 133-137. http://krishi.icar.gov.in/jspui/handle/123456789/83273

Femeena Hassan (2023) Safety standards for fish and fishery products in India. In: Jeyakumari, A., Elavarasan, K., Joshy, C.G. and Bindu, J. (eds.) (2023) Advances in Seafood Processing and waste utilization. ICAR-Central institute of Fisheries Technology, Kochi, India. pp 121-137. http://krishi.icar.gov.in/jspui/handle/123456789/82899

Femeena Hassan (2023) Sanitation and hygiene in seafood processing. In: Priya, E. R., Devananda Uchoi, Nadella, R. K., Pankaj Kishore, Niladri S. Chatterjee, Laly, S. J., Femeena Hassan and George Ninan (eds.) (2023) Seafood Quality Assurance. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 69-74. http://krishi.icar.gov.in/jspui/handle/123456789/83421

Femeena Hassan, Devananda Uchoi, Pankaj Kishore and Nadella, R. K. (2023) Isolation and Identification of faecal coliforms. In: Devananda Uchoi, Nadella, R. K., Pankaj Kishore, Niladri S. Chatterjee, Femeena Hassan and George Ninan (eds.) (2023) Laboratory Manual on Bacteria of Public Health Significance. Central Institute of Fisheries Technology, Cochin, India. pp 16-19. http://krishi.icar.gov.in/jspui/handle/123456789/83279

Femeena Hassan, Pankaj Kishore, Nadella, R. K. and Devananda Uchoi (2023) Isolation and Identification of Escherichia coli. In: Devananda Uchoi, Nadella, R. K., Pankaj Kishore, Niladri S. Chatterjee, Femeena Hassan and George Ninan (eds.) (2023) Laboratory Manual on Bacteria of Public Health Significance. Central Institute of Fisheries Technology, Cochin, India. pp 37-42. http://krishi.icar.gov.in/jspui/handle/123456789/83285

Geethalakshmi, V. (2023) Application of quantitative statistics in fisheries research. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 455-461. http://krishi.icar.gov.in/jspui/handle/123456789/83100

George Ninan, Ravisankar, C. N., Ajeesh Kumar, K. K. Lijin Nambiar and Rasiya Muhammed, A. (2023) സംരംഭകത്വ വളർച്ചയിൽ വ്യവസായ ഇൻക്യൂബേറ്ററിന്റെ പങ്ക്. In: Manoj, P. Samuel, Murali, S., Alfiya, P. V., Aniesrani Delfiya, D. S., Menon, A. R. S. and Ragesh M. Raghavan (2023) Pre-processing and Drying of Fish (മത്സ്യ സംസ്കരണവും ഉണക്കലും) ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 43-48. (In Malayalam) http://krishi.icar.gov.in/jspui/handle/123456789/83322

Gokulan, C. R. and Zynudheen, A. A. (2023) മീൻ ചെതുമ്പൽ കളയുന്ന ഉപകരണങ്ങൾ. In: Manoj, P. Samuel, Murali, S., Alfiya, P. V., Aniesrani Delfiya, D. S., Menon, A. R. S. and Ragesh M. Raghavan (2023) Pre-processing and Drying of Fish (മത്സ്യ സംസ്കരണവും ഉണക്കലും) ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 28-31. (In Malayalam) http://krishi.icar.gov.in/jspui/handle/123456789/83335

Gopika, R., Muhamed Ashraf, P.and Anjana, C. S. (2023) Applications of Nano Carbon Analouges. In: Muhamed Ashraf, P., Manju Lekshmi, N., Sandhya, K. M., Gopika, R. and Anjana, C. S. (eds.) (2023) Nanotechnological Applications in Fisheries. ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 40-49. http://krishi.icar.gov.in/jspui/handle/123456789/83387

Gopika, R., Muhamed Ashraf, P.and Anjana, C. S. (2023) Nano Carbon Analouges Properties and Synthesis. In: Muhamed Ashraf, P., Manju Lekshmi, N., Sandhya, K. M., Gopika, R. and Anjana, C. S. (eds.) (2023) Nanotechnological Applications in Fisheries. ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 31-39. http://krishi.icar.gov.in/jspui/handle/123456789/83386

Greeshma, S. S., Devika Pillai and Toms C. Joseph (2023) Multidrug Resistance in Salmonella Serotypes Across the Globe: Alarming Rate of Spread. In: Prasad, M. M., Ravishankar, C. N., Murugadas, V., Rajesh Bhatia, Joykrushna Jena and Madhusudana Rao, B. (eds.) (2023) Handbook on Antimicrobial Resistance. *Springer, Singapore*. pp 1-17. https://doi.org/10.1007/978-981-16-9723-4_20-1 http://krishi.icar.gov.in/jspui/handle/123456789/83173

Gurjar, U. R., Takar, S., Amin, A. and Martin Xavier, K. A. (2023) Microplastic Contamination in Aquatic Organisms: An Ecotoxicological Perspective. In: Rather, M.A., Amin, A., Hajam, Y.A., Jamwal, A.and Ahmad, I. (eds.) Xenobiotics in Aquatic Animals. Springe Singapore. pp 353–367. https://doi.org/10.1007/978-981-99-1214-8_17. http://krishi.icar.gov.in/jspui/handle/123456789/83179

Harper, S., Kleiber, D., Appiah, S., Atkins, M., Bradford, K., Choudhury, A., Cohen, P.J., de la Puente, S., de la TorreCastro, M., Duffy-Tumasz, A., Fakoya, K., Fent, A., Fröcklin, S., Gopal, N., Gough, C., Gustavsson, M., Hapke, H.M., Hellebrandt, L., Ferrer, A.J., Johnson, J.L., Kusakabe, K., Lawless, S., Macho, G., Mangubhai, S., Manyungwa-Pasani, C., McDougall, C., Ojea, E., Oloko, A., Pedroza, C., Randrianjafimanana, T., Rasoloniriana, R., Robson, L., Romeo, C., Salgueiro-Otero, D., Snyder, H., Soejima, K. (2023) Towards gender inclusivity and equality in small-scale fisheries. In: FAO, Duke University & WorldFish. 2023. Illuminating Hidden Harvests: the contributions of small-scale fisheries to sustainable development. Rome, FAO; Durham, USA, Duke University; Penang, Malaysia, WorldFish. pp 127-144. https://doi.org/10.4060/cc4576en http://krishi.icar.gov.in/jspui/handle/123456789/83399

Jesmi Debbarma (2023) Methods for Sensory Evaluation of Fish. In: Viji, P., Madhusudana Rao, B., Jesmi Debbarma and Ahamed Basha, K. (eds.) (2023) Quality Assurance of Fish and Fish Products. ICAR-Central Institute of Fisheries Technology (ICAR-CIFT), pp 33-39. http://krishi.icar.gov.in/jspui/handle/123456789/83716

Jesmi Debbarma, Viji, P. and Madhusudana Rao, B. (2023) Battered and breaded fish products. In: Jesmi Debbarma, Viji, P. and Madhusudana Rao, B. (eds.) (2023) Entrepreneurship development of Apatani tribes through hygienic fish drying and value addition programme. ICAR-Central Institute of Fisheries Technology (ICAR-CIFT), pp 29-36. http://krishi.icar.gov.in/jspui/handle/123456789/83324

Jesmi Debbarma, Viji, P. and Madhusudana Rao, B. (2023) Fish pickle. In: Jesmi Debbarma, Viji, P. and Madhusudana Rao, B. (eds.) (2023) Entrepreneurship development of Apatani tribes through hygienic fish drying and value addition programme. ICAR-Central Institute of Fisheries Technology (ICAR-CIFT), pp 26-28. http://krishi.icar.gov.in/jspui/handle/123456789/83323

Jesmi Debbarma, Viji, P. and Madhusudana Rao, B. (2023) Freezing technology in shrimp processing. In: Janakiram, P., Madhusudana Rao, B., Reddy, A. K., Chidambar Nadiger, Manmadha Rao, B., Viji, P., Jesmi Debbarma, Ahamed Basha, K., Mohanty, S., Phani Prakash, K., Sunil Kumar, D. and Brahma Reddy (eds.) Course Manual on Shrimp Processing and Quality Assurance for Export. AU-Avanti Aquaculture Skill Development Centre, Visakhapatnam. pp 15-29. http://krishi.icar.gov.in/jspui/handle/123456789/83697

Jesmi Debbarma, Viji, P. and Madhusudana Rao, B. (2023) Hygienic handling of fish in the retail markets. In: Jesmi Debbarma, Viji, P. and Madhusudana Rao, B. (eds.) (2023) Entrepreneurship development of Apatani tribes through hygienic fish drying and value addition programme. ICAR-Central Institute of Fisheries Technology (ICAR-CIFT), pp 7-11. http://krishi.icar.gov.in/jspui/handle/123456789/83318

Jesmi Debbarma, Viji, P. and Madhusudana Rao, B. (2023) Hygienic drying of Fish. In: Jesmi Debbarma, Viji, P. and Madhusudana Rao, B. (eds.) (2023) Entrepreneurship development of Apatani tribes through hygienic fish drying and value addition programme. ICAR-Central Institute of Fisheries Technology (ICAR-CIFT), pp 20-25. http://krishi.icar.gov.in/jspui/handle/123456789/83316

Jesmi Debbarma, Viji, P. and Madhusudana Rao, B. (2023) Nutritional significance of seafood. In: Jesmi Debbarma, Viji, P. and Madhusudana Rao, B. (eds.) (2023) Entrepreneurship development of Apatani tribes through hygienic fish drying and value addition programme. ICAR-Central Institute of Fisheries Technology (ICAR-CIFT), pp 1-6. http://krishi.icar.gov.in/jspui/handle/123456789/83317

Jesmi Debbarma, Viji, P. and Madhusudana Rao, B. (2023) Ready to cook chilled fish. In: Jesmi Debbarma, Viji, P. and Madhusudana Rao, B. (eds.) (2023) Entrepreneurship development of Apatani tribes through hygienic fish drying and value addition programme. ICAR-Central Institute of Fisheries Technology (ICAR-CIFT), pp 12-19. http://krishi.icar.gov.in/jspui/handle/123456789/83320

Jesmi Debbarma, Viji, P. and Madhusudana Rao, B. (2023) Speciality fish products. In: Jesmi Debbarma, Viji, P. and Madhusudana Rao, B. (eds.) (2023) Entrepreneurship development of Apatani tribes through hygienic fish drying and value addition programme. ICAR-Central Institute of Fisheries Technology (ICAR-CIFT), pp 37-40. http://krishi.icar.gov.in/jspui/handle/123456789/83325

Jeyakumari, A. (2023) Cured and dried fish products. In: Devananda Uchoi, Pankaj Kishore, Nadella, R. K., Niladri S. Chatterjee, Priya, E. R., Laly S.J., Femeena Hassan, Minimol V.A., Paras Nath Jha, Remya, S., Jeyakumari A. and Shivendra Kumar (eds.) (2023) Treatise on Fisheries Harvest and Post-Harvest Technologies. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 104-113. http://krishi.icar.gov.in/jspui/handle/123456789/83224

Jeyakumari, A. (2023) Encapsulation of Fish Based Bioactive Compounds. In: Parvathy, U., Sathish Kumar, K., Mohan, C. O., Rejula, K., Nikita Gopal and Bindu, J. (eds.) (2023). Technological Interventions in Processing, Value addition and Packaging of Aquatic Resources. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 143-148. http://krishi.icar.gov.in/jspui/handle/123456789/83136

Jeyakumari, A. (2023) Fish silage: turning fish waste into healthy feed. In: Jeyakumari, A., Elavarasan, K., Joshy, C.G. and Bindu, J. (eds.) (2023) Advances in Seafood Processing and waste utilization. ICAR-Central institute of Fisheries Technology, Kochi, India. pp 103-115. http://krishi.icar.gov.in/jspui/handle/123456789/82897

Jeyakumari, A. (2023) High Value Secondary Products from Fish Processing Discards. In: Parvathy, U., Sathish Kumar, K., Mohan, C. O., Rejula, K., Nikita Gopal and Bindu, J. (eds.) (2023). Technological Interventions in Processing, Value addition and Packaging of Aquatic Resources. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 93-104. http://krishi.icar.gov.in/jspui/handle/123456789/83127

Jeyakumari, A. (2023) Microencapsulation techniques: principles and application. In: Jeyakumari, A., Elavarasan, K., Joshy, C.G. and Bindu, J. (eds.) (2023) Advances in Seafood Processing and waste utilization. ICAR-Central institute of Fisheries Technology, Kochi, India. pp 80-87. http://krishi.icar.gov.in/jspui/handle/123456789/82889

Jeyakumari, A. and Sreelakshmi, K.R. (2023) Hygienic handling of seafoods and low temperature preservation. In: Jeyakumari, A., Elavarasan, K., Joshy, C.G. and Bindu, J. (eds.) (2023) Advances in Seafood Processing and waste utilization. ICAR-Central institute of Fisheries Technology, Kochi, India. pp 11-25. http://krishi.icar.gov.in/jspui/handle/123456789/82879

Jeyakumari, A. and Zynudheen, A. A. (2023) Fish Processing Waste: A Valuable Raw Material for Meal, Silage, Foliar Spray and Animal Feed. In: Parvathy, U., Sathish Kumar, K., Mohan, C. O., Rejula, K., Nikita Gopal and Bindu, J. (eds.) (2023). Technological Interventions in Processing, Value addition and Packaging of Aquatic Resources. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 114-121. http://krishi.icar.gov.in/jspui/handle/123456789/83131

Jeyakumari, A., Binsi, P. K. and Elavarasan, K. (2023) Fish meal and fish oil: production, properties and standards. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 156-164. http://krishi.icar.gov.in/jspui/handle/123456789/83053

Jeyakumari, A., Renuka, V., and Parvathy, U. (2023) Micro- and Nanoemulsion Delivery of Nutritional Ingredients. In: Rajakumari, R. and Thomas, S. (eds.) Handbook of Nutraceuticals. Springer Nature. pp 1-19. https://doi.org/10.1007/978-3-030-69677-1_27-1 http://krishi.icar.gov.in/jspui/handle/123456789/83132

Joshy C. G. (2023) Role of statistics in research. In: Devananda Uchoi, Pankaj Kishore, Nadella, R. K., Niladri S. Chatterjee, Priya, E. R., Laly S.J., Femeena Hassan, Minimol V.A., Paras Nath Jha, Remya, S., Jeyakumari A. and Shivendra Kumar (eds.) (2023) Treatise on Fisheries Harvest and Post-Harvest Technologies. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 148-155. http://krishi.icar.gov.in/jspui/handle/123456789/83228

Joshy, C. G. (2023) Descriptive and basic exploratory statistics. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 185-192. http://krishi.icar.gov.in/jspui/handle/123456789/83057

Joshy, C. G. (2023) Development of value-added fish products and quality assessment of fish using web-based applications. In: Jeyakumari, A., Elavarasan, K., Joshy, C.G. and Bindu, J. (eds.)

(2023) Advances in Seafood Processing and waste utilization. ICAR-Central institute of Fisheries Technology, Kochi, India. pp 116-120. http://krishi.icar.gov.in/jspui/handle/123456789/82898

Joshy, C. G. (2023) Process and Product Development using Response Surface Methodology. In: Parvathy, U., Sathish Kumar, K., Mohan, C. O., Rejula, K., Nikita Gopal and Bindu, J. (eds.) (2023). Technological Interventions in Processing, Value addition and Packaging of Aquatic Resources. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 202-210. http://krishi.icar.gov.in/jspui/handle/123456789/83143

Kishore, P., Minimol, V. A., Kumar, A., Mohan, C. O., Devananda Uchoi, Niladri S. Chatterjee, & Panda, S. K. (2023). Impact of Climate Change on Emergence of Biotoxin in Fish and Shellfish. In Outlook of Climate Change and Fish Nutrition (pp. 179-194). Singapore: Springer Nature Singapore http://krishi.icar.gov.in/jspui/handle/123456789/78924

Laly, S. J. (2023) Chemical contaminants in fish and fishery products. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 262-267. http://krishi.icar.gov.in/jspui/handle/123456789/83068

Laly, S. J. (2023) Implementation of ISO 22000:2018 Food Safety Management System. In: George Ninan, Zynudheen, A. A., Nikita Gopal, Femeena Hassan, Niladri S. Chatterjee, Laly, S. J., Martin Xavier, K. A., Pankaj Kishore, Nadella, R. K., Devananda Uchoi, Priya, E. R. and Chandrasekar, V. (eds.) (2023) Quality Assurance of Fish and Fishery products, Central Institute of Fisheries Technology, Cochin, India. pp 110-120. http://krishi.icar.gov.in/jspui/handle/123456789/83259

Laly, S. J. (2023) Sensory Evaluation & Hygenic Handling of Fish. In: George Ninan, Zynudheen, A. A., Nikita Gopal, Femeena Hassan, Niladri S. Chatterjee, Laly, S. J., Martin Xavier, K. A., Pankaj Kishore, Nadella, R. K., Devananda Uchoi, Priya, E. R. and Chandrasekar, V. (eds.) (2023) Quality Assurance of Fish and Fishery products, Central Institute of Fisheries Technology, Cochin, India. pp 12-22. http://krishi.icar.gov.in/jspui/handle/123456789/83260

Laly, S. J. and Priya, E. R. (2023) Chemical Contaminants in Fish and Fishery Products. In: Priya, E. R., Devananda Uchoi, Nadella, R. K., Pankaj Kishore, Niladri S. Chatterjee, Laly, S. J., Femeena Hassan and George Ninan (eds.) (2023) Seafood Quality Assurance. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 18-23. http://krishi.icar.gov.in/jspui/handle/123456789/83242

Laly, S. J. and Priya, E. R. (2023) Chemical contaminants in fish and fishery products. In: Devananda Uchoi, Pankaj Kishore, Nadella, R. K., Niladri S. Chatterjee, Priya, E. R., Laly S.J., Femeena Hassan, Minimol V.A., Paras Nath Jha, Remya, S., Jeyakumari A. and Shivendra Kumar (eds.) (2023) Treatise on Fisheries Harvest and Post-Harvest Technologies. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 269-275. http://krishi.icar.gov.in/jspui/handle/123456789/83242

Laly, S. J. and Priya, E. R. (2023) Orientation to hazards - Chemical -I (Antibiotic residues, Additives & Heavy metals). In: Priya, E. R., Laly, S. J., Devananda Uchoi., Nadella, R. K., Pankaj Kishore, Niladri Sekhar Chatterjee, Rejula, K., Satyen Kumar Panda, Zynudheen, A. A., Femeena Hassan, A. K. Mohanty and George Ninan(eds.) (2023) ISO 22000/HACCP for fish processing establishments, Central Institute of Fisheries Technology, Cochin, India. pp 44-50. http://krishi.icar.gov.in/jspui/handle/123456789/78396

Lekshmi R. G. K., Tejpal C. S., Anas K. K., Niladri S. Chatterjee, Anandan R., Suseela Mathew, C. N. Ravishankar (2023) Squalene: bioactivity, extraction, encapsulation, and future perspectives. In book: Marine Antioxidants. Elsevier Publishers. DOI: 10.1016/B978-0-323-95086-2.00038-2 http://krishi.icar.gov.in/jspui/handle/123456789/83133

Lekshmi R. G. Kumar, Niladri S. Chatterjee and Suseela Mathew (2023) Green Technologies for Developing High-Value Novel Marine Nutraceuticals: Scope and Innovations. In: Ranendra, K. Majumder and Amjad, K. Balange (2023) Advances in Fish Processing Technologies. *Academic press,* pp 271-286. https://doi.org/10.1201/9781003300595 http://krishi.icar.gov.in/jspui/handle/123456789/83866

Lekshmi R. G. Kumar, Tejpal, C. S., Anas, K. K. and Anandan, R. (2023) Seaweed Based Nutraceuticals – Present Trends and Future Prospects. In: Aniesrani Delfiya, D. S., Murali, S. and Neethu, K. C. (eds.) (2023) Current trends in food processing technology. ICAR-Central Institute of Fisheries Technology, Kochi, India. pp 183-187. http://krishi.icar.gov.in/jspui/handle/123456789/83295

Lekshmi R. G. Kumar, Tejpal, C. S., Anas, K. K., Renuka, V. and Anandan, R. (2023) Fish biomolecules in fighting malnutrition. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 218-220. http://krishi.icar.gov.in/jspui/handle/123456789/83061

Lekshmi, R. G. Kumar, Anas, K. K.and Tejpal, C. S. (2023) Green technologies for isolation of

marine bioactive compounds. In: Parvathy, U., Sathish Kumar, K., Mohan, C. O., Rejula, K., Nikita Gopal and Bindu, J. (eds.) (2023). Technological Interventions in Processing, Value addition and Packaging of Aquatic Resources. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 149-154. http://krishi.icar.gov.in/jspui/handle/123456789/83137

Lekshmi, R. G. Kumar, Tejpal, C. S., Anas, K. K., Niladri S. Chatterjee, Anandan, R., Mathew, S. and Ravishankar, C. N. (2023) Squalene: bioactivity, extraction, encapsulation, and future perspectives. In: Se-Kwon Kim, Kyung-Hoon Shin and Jayachandran Venkatesan (eds.) Marine Antioxidants: Preparations, Syntheses, and Applications. *Academic Press*. pp. 409-419. https://doi.org/10.1016/B978-0-323-95086-2.00038-2 http://krishi.icar.gov.in/jspui/handle/123456789/83133

Lekshmi, R. G. Kumar, Tejpal, C. S., Anas, K. K., Niladri S. Chatterjee, Anandan, R., Mathew, S. and Ravishankar, C. N. (2023) Squalene: bioactivity, extraction, encapsulation, and future perspectives. In: Se-Kwon Kim, Kyung-Hoon Shin and Jayachandran Venkatesan (2023) Marine Antioxidants. *Academic Press. Elsevier Publishers*. pp 409-419. https://doi.org/10.1016/B978-0-323-95086-2.00038-2 http://krishi.icar.gov.in/jspui/handle/123456789/83133

Madhu, V. R. (2023) Bycatch issues in fishing gears. In: Sandhya, K. M. and Manju Lekshmi, N. (eds.) (2023) Advances in fishing gear materials. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 65-67. http://krishi.icar.gov.in/jspui/handle/123456789/83153

Madhusudana Rao, B. (2023) Infrastructure and amenities for quality assurance in shrimp processing plant. In: Janakiram, P., Madhusudana Rao, B., Reddy, A. K., Chidambar Nadiger, Manmadha Rao, B., Viji, P., Jesmi Debbarma, Ahamed Basha, K., Mohanty, S., Phani Prakash, K., Sunil Kumar, D. and Brahma Reddy (eds.) Course Manual on Shrimp Processing and Quality Assurance for Export. AU-Avanti Aquaculture Skill Development Centre, Visakhapatnam. pp 1-8. http://krishi.icar.gov.in/jspui/handle/123456789/83699

Madhusudana Rao, B. and Ahamed Basha, K. (2023) Antimicrobial Resistance (AMR) and its Detection Methods. In: Viji, P., Madhusudana Rao, B., Jesmi Debbarma and Ahamed Basha, K. (eds.) (2023) Quality Assurance of Fish and Fish Products. ICAR-Central Institute of Fisheries Technology (ICAR-CIFT), pp 48-52. http://krishi.icar.gov.in/jspui/handle/123456789/83718

Madhusudana Rao, B. and Ahamed Basha, K. (2023) Bacteria of Public Health Significance and Laboratory Methods for the Detection of Bacteria in Fish / Shrimp Meat. In: Viji, P., Madhusudana Rao, B., Jesmi Debbarma and Ahamed Basha, K. (eds.) (2023) Quality Assurance of Fish and Fish Products. ICAR-Central Institute of Fisheries Technology (ICAR-CIFT), pp 40-47. http://krishi.icar.gov.in/jspui/handle/123456789/83717

Madhusudana Rao, B. and Ahamed Basha, K. (2023) Laboratory methods for detection of food borne bacteria in shrimp. In: Janakiram, P., Madhusudana Rao, B., Reddy, A. K., Chidambar Nadiger, Manmadha Rao, B., Viji, P., Jesmi Debbarma, Ahamed Basha, K., Mohanty, S., Phani Prakash, K., Sunil Kumar, D. and Brahma Reddy (eds.) Course Manual on Shrimp Processing and Quality Assurance for Export. AU-Avanti Aquaculture Skill Development Centre, Visakhapatnam. pp 105-117. http://krishi.icar.gov.in/jspui/handle/123456789/83695

Madhusudana Rao, B. and Jesmi Debbarma (2023) Food safety for ensuring production of safe shrimp products. In: Janakiram, P., Madhusudana Rao, B., Reddy, A. K., Chidambar Nadiger, Manmadha Rao, B., Viji, P., Jesmi Debbarma, Ahamed Basha, K., Mohanty, S., Phani Prakash, K., Sunil Kumar, D. and Brahma Reddy (eds.) Course Manual on Shrimp Processing and Quality Assurance for Export. AU-Avanti Aquaculture Skill Development Centre, Visakhapatnam. pp 65-71. http://krishi.icar.gov.in/jspui/handle/123456789/83696

Madhusudana Rao, B. and Viji, P. (2023) Good harvesting practices for farmed shrimp. In: Janakiram, P., Madhusudana Rao, B., Reddy, A. K., Chidambar Nadiger, Manmadha Rao, B., Viji, P., Jesmi Debbarma, Ahamed Basha, K., Mohanty, S., Phani Prakash, K., Sunil Kumar, D. and Brahma Reddy (eds.) Course Manual on Shrimp Processing and Quality Assurance for Export. AU-Avanti Aquaculture Skill Development Centre, Visakhapatnam. pp 9-11. http://krishi.icar.gov.in/jspui/handle/123456789/83698

Madhusudana Rao, B. and Viji, P. (2023) Quality and Safety Standards/Requirements for Fish and Fish Products. In: Viji, P., Madhusudana Rao, B., Jesmi Debbarma and Ahamed Basha, K. (eds.) (2023) Quality Assurance of Fish and Fish Products. ICAR-Central Institute of Fisheries Technology (ICAR-CIFT), pp 62-68. http://krishi.icar.gov.in/jspui/handle/123456789/83720

Madhusudana Rao, B., Jesmi Debbarma and Ahamed Basha, K. (2023) Hazard Analysis Critical Control Point (HACCP) System: An Overview. In: Viji, P., Madhusudana Rao, B., Jesmi Debbarma and Ahamed Basha, K. (eds.) (2023) Quality Assurance of Fish and Fish Products. ICAR-Central Institute of Fisheries Technology (ICAR-CIFT), pp 53-61. http://krishi.icar.gov.in/jspui/handle/123456789/83719

Madhusudana Rao, B., Murugadas, V., Prasad, M. M. and Ravishankar, C. N. (2023) Status of AMR in Food Sector: Implications for Food Safety and Food Security with

Special Reference to Fisheries. In: Mothadaka, M.P., Vaiyapuri, M., Rao Badireddy, M., Nagarajrao Ravishankar, C., Bhatia, R., Jena, J. (eds.) Handbook on Antimicrobial Resistance. Springer, Singapore, pp 1-36. http://krishi.icar.gov.in/jspui/handle/123456789/78790

Manju Lekshmi, N. (2023) Fishing gear related micro plastics: impacts /assessment methods. In: Sandhya, K. M. and Manju Lekshmi, N. (eds.) (2023) Advances in fishing gear materials. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 68-72. http://krishi.icar.gov.in/jspui/handle/123456789/82885

Manju Lekshmi, N. (2023) Micro and nano plastics pollution in marine environment. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 63-69. http://krishi.icar.gov.in/jspui/handle/123456789/83040

Manju Lekshmi, N. and Arun, K. S. (2023) Concepts of Biofouling in the Marine Environment. In: Muhamed Ashraf, P., Manju Lekshmi, N., Sandhya, K. M., Gopika, R. and Anjana, C. S. (eds.) (2023) Nanotechnological Applications in Fisheries. ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 81-88. http://krishi.icar.gov.in/jspui/handle/123456789/83391

Manju Lekshmi, N. and Arun, K. S. (2023) Nanotechnological Interventions for the Prevention of Biofouling in Aquaculture Cages. In: Muhamed Ashraf, P., Manju Lekshmi, N., Sandhya, K. M., Gopika, R. and Anjana, C. S. (eds.) (2023) Nanotechnological Applications in Fisheries. ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 89-92. http://krishi.icar.gov.in/jspui/handle/123456789/83392

Manju Lekshmi, N. and Sreejith S. Kumar (2023) Micro and Nanoplastics Pollution in the Marine Environment. In: Muhamed Ashraf, P., Manju Lekshmi, N., Sandhya, K. M., Gopika, R. and Anjana, C. S. (eds.) (2023) Nanotechnological Applications in Fisheries. ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 93-99. http://krishi.icar.gov.in/jspui/handle/123456789/83393

Manju Lekshmi, N., Paras Nath Jha and Leela Edwin (2023) Environmental impacts of fishing. In: Devananda Uchoi, Pankaj Kishore, Nadella, R. K., Niladri S. Chatterjee, Priya, E. R., Laly S.J., Femeena Hassan, Minimol V.A., Paras Nath Jha, Remya, S., Jeyakumari A. and Shivendra Kumar (eds.) (2023) Treatise on Fisheries Harvest and Post-Harvest Technologies. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 195-200. http://krishi.icar.gov.in/jspui/handle/123456789/83234

Martin Xavier, K. A. (2023) Microplastics Issues in Seafood and its Control Measures. In: George Ninan, Zynudheen, A. A., Nikita Gopal, Femeena Hassan, Niladri S. Chatterjee, Laly, S. J., Martin Xavier, K. A., Pankaj Kishore, Nadella, R. K., Devananda Uchoi, Priya, E. R. and Chandrasekar, V. (eds.) (2023) Quality Assurance of Fish and Fishery products, Central Institute of Fisheries Technology, Cochin, India. pp 48-52. http://krishi.icar.gov.in/jspui/handle/123456789/83265

Martin Xavier, K. A. (2023) Quality issues in frozen fish and fishery products. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 466-472. http://krishi.icar.gov.in/jspui/handle/123456789/83102

Martin Xavier, K. A. (2023) Quality Issues in Live/Fresh/Chilled/Frozen Fish and Fish Products. In: George Ninan, Zynudheen, A. A., Nikita Gopal, Femeena Hassan, Niladri S. Chatterjee, Laly, S. J., Martin Xavier, K. A., Pankaj Kishore, Nadella, R. K., Devananda Uchoi, Priya, E. R. and Chandrasekar, V. (eds.) (2023) Quality Assurance of Fish and Fishery products, Central Institute of Fisheries Technology, Cochin, India. pp 23-28.

Minimol, V. A. (2023) Setting up of quantitative real time PCR. In: Toms C. Joseph, Murugadas, V., Minimol, V. A., Ezhil Nilavan, S., Muthulakshmi, T. and Anupama, T. K. (eds.) (2023) Advanced Microbiological and Molecular Techniques for Improving the Competence of Students in Biological Sciences (under SCSP). ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 107-111. http://krishi.icar.gov.in/jspui/handle/123456789/83214

Minimol, V. A. and Toms C. Joseph (2023) An overview of seafood borne bacterial pathogens. In: Devananda Uchoi, Pankaj Kishore, Nadella, R. K., Niladri S. Chatterjee, Priya, E. R., Laly S.J., Femeena Hassan, Minimol V.A., Paras Nath Jha, Remya, S., Jeyakumari A. and Shivendra Kumar (eds.) (2023) Treatise on Fisheries Harvest and Post-Harvest Technologies. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 187-194. http://krishi.icar.gov.in/jspui/handle/123456789/83233

Minimol, V. A. and Toms C. Joseph (2023) An overview of seafood borne bacterial pathogens. In: Toms C. Joseph, Murugadas, V., Minimol, V. A., Ezhil Nilavan, S., Muthulakshmi, T. and Anupama, T. K. (eds.) (2023) Advanced Microbiological and Molecular Techniques for Improving the Competence of Students in Biological Sciences (under SCSP). ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 1-9. http://krishi.icar.gov.in/jspui/handle/123456789/83197

Minimol, V. A. and Toms C. Joseph. (2023) Bacteria of public health significance. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 291-297. http://krishi.icar.gov.in/jspui/handle/123456789/83072

Minimol, V. A., Abhay Kumar and Prasad, M. M. (2023). Evolution and Milestones in the Development of AMR in Bacteria. In: Prasad, M. M., Ravishankar, C. N., Murugadas, V., Rajesh Bhatia, Joykrushna Jena and Madhusudana Rao, B. (eds.) (2023) Handbook on Antimicrobial Resistance. Springer Singapore. https://doi.org/10.1007/978-981-16-9723-4_2-1 http://krishi.icar.gov.in/jspui/handle/123456789/83181

Minimol, V. A., Pankaj Kishore and Prasad, M. M. (2023) Evolution and the Role of SXT-Related Integrative Conjugative Elements in Multidrug-Resistant Vibrio cholerae. In: Prasad, M. M., Ravishankar, C. N., Murugadas, V., Rajesh Bhatia, Joykrushna Jena and Madhusudana Rao, B. (eds.) (2023) Handbook on Antimicrobial Resistance. Springer Singapore. Pp 1-17. https://doi.org/10.1007/978-981-16-9723-4_22-1 http://krishi.icar.gov.in/jspui/handle/123456789/83185

Minimol, V. A., Sivaraman, G. K. and Toms C. Joseph (2023) Polymerase chain reaction and its types. In: Toms C. Joseph, Murugadas, V., Minimol, V. A., Ezhil Nilavan, S., Muthulakshmi, T. and Anupama, T. K. (eds.) (2023) Advanced Microbiological and Molecular Techniques for Improving the Competence of Students in Biological Sciences (under SCSP). ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 80-90. http://krishi.icar.gov.in/jspui/handle/123456789/83210

Minimol, V. A., Sivaraman, G. K. and Toms C. Joseph (2023) Principles of PCR and different types. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 309-316. http://krishi.icar.gov.in/jspui/handle/123456789/82887

Minimol, V. A., Sivaraman, G. K. and Toms C. Joseph (2023) Techniques in molecular detection of seafood borne pathogens. In: Devananda Uchoi, Pankaj Kishore, Nadella, R. K., Niladri S. Chatterjee, Priya, E. R., Laly S.J., Femeena Hassan, Minimol V.A., Paras Nath Jha, Remya, S., Jeyakumari A. and Shivendra Kumar (eds.) (2023) Treatise on Fisheries Harvest and Post-Harvest Technologies. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 358-366. http://krishi.icar.gov.in/jspui/handle/123456789/83250

Mohan, C. O. (2023) Active and intelligent packaging techniques for smart packaging application. In: Bindu, J., Mohan, C.O., Remya, S. and Sathish Kumar, K. (eds.) (2023) Advanced food packaging techniques and quality evaluation of packaging materials, ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 70-76. http://krishi.icar.gov.in/jspui/handle/123456789/82872

Mohan, C. O. (2023) Advanced food packaging techniques. In: Bindu, J., Mohan, C.O., Remya, S. and Sathish Kumar, K. (eds.) (2023) Advanced food packaging techniques and quality evaluation of packaging materials, ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 23-27. http://krishi.icar.gov.in/jspui/handle/123456789/82865

Mohan, C. O. (2023) Basics of thermal processing technology. In: Devananda Uchoi, Pankaj Kishore, Nadella, R. K., Niladri S. Chatterjee, Priya, E. R., Laly S.J., Femeena Hassan, Minimol V.A., Paras Nath Jha, Remya, S., Jeyakumari A. and Shivendra Kumar (eds.) (2023) Treatise on Fisheries Harvest and Post-Harvest Technologies. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 65-80. http://krishi.icar.gov.in/jspui/handle/123456789/83221

Mohan, C. O. (2023) Canning and retort pouch packaging. In: Bindu, J., Mohan, C.O., Remya, S. and Sathish Kumar, K. (eds.) (2023) Advanced food packaging techniques and quality evaluation of packaging materials, ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 95-107. http://krishi.icar.gov.in/jspui/handle/123456789/82875

Mohan, C. O. (2023) Quality Issues and its Control Measures in Thermal Processed Fishery Products. In: George Ninan, Zynudheen, A. A., Nikita Gopal, Femeena Hassan, Niladri S. Chatterjee, Laly, S. J., Martin Xavier, K. A., Pankaj Kishore, Nadella, R. K., Devananda Uchoi, Priya, E. R. and Chandrasekar, V. (eds.) (2023) Quality Assurance of Fish and Fishery products, Central Institute of Fisheries Technology, Cochin, India. pp 53-69. http://krishi.icar.gov.in/jspui/handle/123456789/83266

Mohan, C. O. (2023) Thermal Processing and RTE (Ready to Eat) Products. In: Parvathy, U., Sathish Kumar, K., Mohan, C. O., Rejula, K., Nikita Gopal and Bindu, J. (eds.) (2023). Technological Interventions in Processing, Value addition and Packaging of Aquatic Resources. ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 44-61. http://krishi.icar.gov.in/jspui/handle/123456789/83108

Mohan, C. O. and George Ninan (2023) Entrepreneurship development in fishery products. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.)

(2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 180-184. http://krishi.icar.gov.in/jspui/handle/123456789/83056

Mohan, C. O., Bindu, J. and Ravisankar, C. N. (2023) ഉണക്കമീൻ പാക്കേജിങ്ങ്. In: Manoj, P. Samuel, Murali, S., Alfiya, P. V., Aniesrani Delfiya, D. S., Menon, A. R. S. and Ragesh M. Raghavan (2023) Pre-processing and Drying of Fish (മത്സ്യ സംസ്കരണവും ഉണക്കലും) ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 24-27. (In Malayalam) http://krishi.icar.gov.in/jspui/handle/123456789/83334

Mohan, C. O., Remya, S. and Sreelakshmi, K. R. (2023) Thermally processed fishery products. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 125-131. http://krishi.icar.gov.in/jspui/handle/123456789/83049

Mohan, C. O., Remya, S., Sreelakshmi, K. R., Elavarasan, K. and Ravishankar, C. N. (2023) Emerging Fish Processing and Packaging Technologies: An Overview. In: Ranendra K. Majumder, Amjad K. Balange (eds.) Advances in Fish Processing Technologies. Apple Academic Press. pp 75-100. http://krishi.icar.gov.in/jspui/handle/123456789/83397

Mohan, C.O., Remya, S., Sreelakshmi, K. R. and Bindu, J. (2023) Thermal processing of food products. In: Jeyakumari, A., Elavarasan, K., Joshy, C.G. and Bindu, J. (eds.) (2023) Advances in Seafood Processing and waste utilization. ICAR-Central institute of Fisheries Technology, Kochi, India. pp 87-93. http://krishi.icar.gov.in/jspui/handle/123456789/82890

Mohanty, A. K., Sajesh, V. K., Sajeev, M. V., Chandrasekhar, V. and Rejula, K. (2023) Innovative extension approaches for technology dissemination in fisheries. In: Priya, E. R., Laly, S. J., Devananda Uchoi., Nadella, R. K., Pankaj Kishore, Niladri Sekhar Chatterjee, Rejula, K.,Satyen Kumar Panda, Zynudheen, A. A., Femeena Hassan,A. K. Mohanty and George Ninan(eds.) (2023) ISO 22000/HACCP for fish processing establishments, Central Institute of Fisheries Technology, Cochin, India. pp 157-167. http://krishi.icar.gov.in/jspui/handle/123456789/78410

Mohanty, A. K., Suresh, A. and Sajesh, V. K. (2023) Novel extension approaches for technology dissemination in fisheries. In: Devananda Uchoi, Pankaj Kishore, Nadella, R. K., Niladri S. Chatterjee, Priya, E. R., Laly S.J., Femeena Hassan, Minimol V.A., Paras Nath Jha, Remya, S., Jeyakumari A. and Shivendra Kumar (eds.) (2023) Treatise on Fisheries Harvest and Post-Harvest Technologies. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 367-388. http://krishi.icar.gov.in/jspui/handle/123456789/83251

Muhamed Ashraf, P. (2023) Basic concept of Nanotechnology. In: Muhamed Ashraf, P., Manju Lekshmi, N., Sandhya, K. M., Gopika, R. and Anjana, C. S. (eds.) (2023) Nanotechnological Applications in Fisheries. ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 4-10. http://krishi.icar.gov.in/jspui/handle/123456789/83383

Muhamed Ashraf, P. (2023) Nano technology and its applications in fisheries. In: Devananda Uchoi, Pankaj Kishore, Nadella, R. K., Niladri S. Chatterjee, Priya, E. R., Laly S.J., Femeena Hassan, Minimol V.A., Paras Nath Jha, Remya, S., Jeyakumari A. and Shivendra Kumar (eds.) (2023) Treatise on Fisheries Harvest and Post-Harvest Technologies. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 349-357. http://krishi.icar.gov.in/jspui/handle/123456789/83249

Muhamed Ashraf, P. (2023) Nanotechnology and its applications in fisheries. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 56-62. http://krishi.icar.gov.in/jspui/handle/123456789/83038

Muhamed Ashraf, P., Anjana, C. S. and Gopika, R. (2023) Characterization of Nanoparticles. In: Muhamed Ashraf, P., Manju Lekshmi, N., Sandhya, K. M., Gopika, R. and Anjana, C. S. (eds.) (2023) Nanotechnological Applications in Fisheries. ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 21-30. http://krishi.icar.gov.in/jspui/handle/123456789/83385

Muhamed Ashraf, P., Anjana, C. S. and Gopika, R. (2023) CIFT Initiatives Utilising Nanotechnology. In: Muhamed Ashraf, P., Manju Lekshmi, N., Sandhya, K. M., Gopika, R. and Anjana, C. S. (eds.) (2023) Nanotechnological Applications in Fisheries. ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 100-108. http://krishi.icar.gov.in/jspui/handle/123456789/83394

Muhamed Ashraf, P., Anjana, C. S. and Gopika, R. (2023) Synthesis of Nanoparticles. In: Muhamed Ashraf, P., Manju Lekshmi, N., Sandhya, K. M., Gopika, R. and Anjana, C. S. (eds.) (2023) Nanotechnological Applications in Fisheries. ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 11-20. http://krishi.icar.gov.in/jspui/handle/123456789/83384

Muhamed Ashraf, P., Arun, K. S. and Manju Lekshmi, N. (2023) Biofouling in fishing gears & vessels: assessment, impacts & prevention. In: Sandhya, K. M. and

Manju Lekshmi, N. (eds.) (2023) Advances in fishing gear materials. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 48-55. http://krishi.icar.gov.in/jspui/handle/123456789/83151

Muhamed Ashraf, P., Gopika, R. and Anjana, C. S. (2023) Application of Nanomaterials for Corrosion Research. In: Muhamed Ashraf, P., Manju Lekshmi, N., Sandhya, K. M., Gopika, R. and Anjana, C. S. (eds.) (2023) Nanotechnological Applications in Fisheries. ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 65-73. http://krishi.icar.gov.in/jspui/handle/123456789/83389

Muneeb Hamza, Sivaraman, G. K. and Prasad, M. M. (2023) Evolution, Characteristics, and Clonal Expansion of Livestock-Associated Methicillin-Resistant *Staphylococcus aureus* (LA-MRSA): Global Perspectives. In: Prasad, M. M., Ravishankar, C. N., Murugadas, V., Rajesh Bhatia, Joykrushna Jena and Madhusudana Rao, B. (eds.) (2023) Handbook on Antimicrobial Resistance. Springer Singapore. Pp 1-20. https://doi.org/10.1007/978-981-16-9723-4_23-1 http://krishi.icar.gov.in/jspui/handle/123456789/83176

Murali, S. (2023) Application dryers in fishery sector. In: Devananda Uchoi, Pankaj Kishore, Nadella, R. K., Niladri S. Chatterjee, Priya, E. R., Laly S.J., Femeena Hassan, Minimol V.A., Paras Nath Jha, Remya, S., Jeyakumari A. and Shivendra Kumar (eds.) (2023) Treatise on Fisheries Harvest and Post-Harvest Technologies. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 156-161. http://krishi.icar.gov.in/jspui/handle/123456789/83229

Murali, S. (2023) CIFT Machineries in Fish Processing. In: Parvathy, U., Sathish Kumar, K., Mohan, C. O., Rejula, K., Nikita Gopal and Bindu, J. (eds.) (2023). Technological Interventions in Processing, Value addition and Packaging of Aquatic Resources. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 192-201. http://krishi.icar.gov.in/jspui/handle/123456789/83142

Murali, S. (2023) CIFT's Engineering Solutions for Postharvest Fisheries Sector. In: Aniesrani Delfiya, D. S., Murali, S. and Neethu, K. C. (eds.) (2023) Current trends in food processing technology. ICAR-Central Institute of Fisheries Technology, Kochi, India. pp 50-62. http://krishi.icar.gov.in/jspui/handle/123456789/83302

Murali, S. (2023) Equipment and instruments for small-scale fish processing industries. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 226-233. http://krishi.icar.gov.in/jspui/handle/123456789/83063

Murali, S., Alfiya, P. V., Aniesrani Delfiya, D. S. and Manoj, P. Samuel (2023) മത്സ്യ മൂല്യ വർദ്ധന വിനായ് സി.ഐ.എഫ്.ടി. സോളാർ ഡ്രയറുകൾ.. In: Manoj, P. Samuel, Murali, S., Alfiya, P. V., Aniesrani Delfiya, D. S., Menon, A. R. S. and Ragesh M. Raghavan (2023) Pre-processing and Drying of Fish (മത്സ്യ സംസ്കരണവും ഉണക്കലും) ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 7-13. (In Malayalam) http://krishi.icar.gov.in/jspui/handle/123456789/83330

Murali, S., Siddique, V., Babu, K. C., Gopakaumar, G. and Manoj, P. Samuel (2023) ശീതീകരണ സംവിധാനത്തോടു കൂടിയ ആധുനിക മത്സ്യ വിപണന സംവിധാനം. In: Manoj, P. Samuel, Murali, S., Alfiya, P. V., Aniesrani Delfiya, D. S., Menon, A. R. S. and Ragesh M. Raghavan (2023) Pre-processing and Drying of Fish (മത്സ്യ സംസ്കരണവും ഉണ ക്കലും) ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 32-34. (In Malayalam) http://krishi.icar.gov.in/jspui/handle/123456789/83336

Murugadas, V. and Radhakrishnan, V. N. (2023) Introduction to molecular fingerprinting tools and bioinformatic analysis. In: Toms C. Joseph, Murugadas, V., Minimol, V. A., Ezhil Nilavan, S., Muthulakshmi, T. and Anupama, T. K. (eds.) (2023) Advanced Microbiological and Molecular Techniques for Improving the Competence of Students in Biological Sciences (under SCSP). ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 96-104. http://krishi.icar.gov.in/jspui/handle/123456789/83212

Murugadas, V., Ahamed Basha, K. and Madhusudana Rao, B. (2023) Molecular Mechanisms of Antimicrobial Resistance. In: Prasad, M. M., Ravishankar, C. N., Murugadas, V., Rajesh Bhatia, Joykrushna Jena and Madhusudana Rao, B. (eds.) (2023) Handbook on Antimicrobial Resistance. *Springer, Singapore.* pp 1-18. https://doi.org/10.1007/978-981-16-9723-4_28-1 http://krishi.icar.gov.in/jspui/handle/123456789/83396

Murugadas, V., Prasad, M. M., Madhusudana Rao, B., Ravishankar, C. N. and Joykrushna Jena (2023) Antimicrobial Resistance in Fisheries. In: Handbook on Antimicrobial Resistance: Current Status, Trends in Detection and Mitigation Measures (eds.) Mukteswar Prasad Mothadaka, Chandragiri Nagarajrao Ravishankar, Murugadas Vaiyapuri, Rajesh Bhatia, Joykrushna Jena, Madhusudhana Rao Badireddy. Springer. http://krishi.icar.gov.in/jspui/handle/123456789/78791

Murugadas, V., Rekha, M., Reshmi, K. and Prinetha, U. P. (2023) Overview of biochemical methods for the identification of bacteria. In: Toms C. Joseph, Murugadas, V., Minimol, V. A., Ezhil Nilavan, S., Muthulakshmi, T. and Anupama, T. K. (eds.) (2023) Advanced Microbiological and Molecular Techniques for Improving the

Competence of Students in Biological Sciences (under SCSP). ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 30-38. http://krishi.icar.gov.in/jspui/handle/123456789/83200

Murugadas, V., Sreejith, V. N. and Vineetha Das (2023) Introduction to 16s rDNA sequencing and analysis, and gel documentation. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 388-393. http://krishi.icar.gov.in/jspui/handle/123456789/83083

Murugadas, V., Sreejith, V. N., Vineetha Das and Toms C. Joseph (2023) Setting up of ERIC PCR and gel documentation and analysis. In: Toms C. Joseph, Murugadas, V., Minimol, V. A., Ezhil Nilavan, S., Muthulakshmi, T. and Anupama, T. K. (eds.) (2023) Advanced Microbiological and Molecular Techniques for Improving the Competence of Students in Biological Sciences (under SCSP). ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 105-106. http://krishi.icar.gov.in/jspui/handle/123456789/83213

Murugads, V. and Radhakrishnan Nair, V. (2023) Molecular fingerprinting of seafood borne pathogens and bioinformatic analysis. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 317-323. http://krishi.icar.gov.in/jspui/handle/123456789/83074

Muthulakshmi, T. (2023) Pathogenic Vibrios of public health and aquatic animal health. In: Devananda Uchoi, Pankaj Kishore, Nadella, R. K., Niladri S. Chatterjee, Priya, E. R., Laly S.J., Femeena Hassan, Minimol V.A., Paras Nath Jha, Remya, S., Jeyakumari A. and Shivendra Kumar (eds.) (2023) Treatise on Fisheries Harvest and Post-Harvest Technologies. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 201-205. http://krishi.icar.gov.in/jspui/handle/123456789/83235

Muthulakshmi, T. and Greeshma, S. S. (2023) Isolation of Salmonella from seafood. In: Toms C. Joseph, Murugadas, V., Minimol, V. A., Ezhil Nilavan, S., Muthulakshmi, T. and Anupama, T. K. (eds.) (2023) Advanced Microbiological and Molecular Techniques for Improving the Competence of Students in Biological Sciences (under SCSP). ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 39-45. http://krishi.icar.gov.in/jspui/handle/123456789/83203

Muthulakshmi, T. and Prasad, M. M. (2023) Vibrio vulnificus and Its Antimicrobial Resistance. In: Prasad, M. M., Ravishankar, C. N., Murugadas, V., Rajesh Bhatia, Joykrushna Jena and Madhusudana Rao, B. (eds.) (2023) Handbook on Antimicrobial Resistance. Springer Singapore. pp 1-18. https://doi.org/10.1007/978-981-16-9723-4_25-1 http://krishi.icar.gov.in/jspui/handle/123456789/83188

Muthulakshmi, T. and Rajaswaminathan, T. (2023) Pathogenic vibrios of public health and aquatic animal health. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 303-308. http://krishi.icar.gov.in/jspui/handle/123456789/83073

Muthulakshmi, T. and Vishnuvinayagam, S. (2023) Introduction to Sanger sequencing. In: Toms C. Joseph, Murugadas, V., Minimol, V. A., Ezhil Nilavan, S., Muthulakshmi, T. and Anupama, T. K. (eds.) (2023) Advanced Microbiological and Molecular Techniques for Improving the Competence of Students in Biological Sciences (under SCSP). ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 91-95. http://krishi.icar.gov.in/jspui/handle/123456789/83211

Nadella, R. K. (2023) Advanced Microbiological Detection Techniques. In: George Ninan, Zynudheen, A. A., Nikita Gopal, Femeena Hassan, Niladri S. Chatterjee, Laly, S. J., Martin Xavier, K. A., Pankaj Kishore, Nadella, R. K., Devananda Uchoi, Priya, E. R. and Chandrasekar, V. (eds.) (2023) Quality Assurance of Fish and Fishery products, Central Institute of Fisheries Technology, Cochin, India. pp 121-132. http://krishi.icar.gov.in/jspui/handle/123456789/83272

Nadella, R. K. (2023) Physical Hazards in Seafood. In: George Ninan, Zynudheen, A. A., Nikita Gopal, Femeena Hassan, Niladri S. Chatterjee, Laly, S. J., Martin Xavier, K. A., Pankaj Kishore, Nadella, R. K., Devananda Uchoi, Priya, E. R. and Chandrasekar, V. (eds.) (2023) Quality Assurance of Fish and Fishery products, Central Institute of Fisheries Technology, Cochin, India. pp 70-71. http://krishi.icar.gov.in/jspui/handle/123456789/83267

Nadella, R. K. and Devananda Uchoi (2023) Introduction to HACCP Concepts. In: Priya, E. R., Devananda Uchoi, Nadella, R. K., Pankaj Kishore, Niladri S. Chatterjee, Laly, S. J., Femeena Hassan and George Ninan (eds.) (2023) Seafood Quality Assurance. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 84-94. http://krishi.icar.gov.in/jspui/handle/123456789/83424

Nadella, R. K. and Panda, S. K. (2023) Fundamentals of bacteriology of fish. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K.,

Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 268-279. http://krishi.icar.gov.in/jspui/handle/123456789/83070

Nadella, R. K., Devananda Uchoi and Pankaj Kishore (2023) Isolation and Identification of Salmonella spp. In: Devananda Uchoi, Nadella, R. K., Pankaj Kishore, Niladri S. Chatterjee, Femeena Hassan and George Ninan (eds.) (2023) Laboratory Manual on Bacteria of Public Health Significance. Central Institute of Fisheries Technology, Cochin, India. pp 29-36. http://krishi.icar.gov.in/jspui/handle/123456789/83284

Nadella, R. K., Ezhil Nilavan, S., Mothadaka, M. P. (2023) Economic impact of Antimicrobial Resistance and projected future trends. In: Handbook on Antimicrobial Resistance: Current Status, Trends in Detection and Mitigation Measures "Section V: Mitigation measures across the sectors" Eds: Mukteswar Prasad Mothadaka, Chandragiri Nagarajrao Ravishankar, Murugadas Vaiyapuri, Rajesh Bhatia, Joykrushna Jena, Madhusudhana Rao Badireddy. Springer. http://krishi.icar.gov.in/jspui/handle/123456789/79456

Nadella, R. K., Pankaj Kishore and Devananda Uchoi (2023) Automated Microbial Detection Techniques in Food Microbiology. In: Devananda Uchoi, Nadella, R. K., Pankaj Kishore, Niladri S. Chatterjee, Femeena Hassan and George Ninan (eds.) (2023) Laboratory Manual on Bacteria of Public Health Significance. Central Institute of Fisheries Technology, Cochin, India. pp 81-93. http://krishi.icar.gov.in/jspui/handle/123456789/83291

Nadella, R. K., Pankaj Kishore and Devananda Uchoi (2023) Isolation and Identification of Bacillus sp. and Clostridium sp. In: Devananda Uchoi, Nadella, R. K., Pankaj Kishore, Niladri S. Chatterjee, Femeena Hassan and George Ninan (eds.) (2023) Laboratory Manual on Bacteria of Public Health Significance. Central Institute of Fisheries Technology, Cochin, India. pp 48-53. http://krishi.icar.gov.in/jspui/handle/123456789/83201

Nadella, R. K., Pankaj Kishore and Devananda Uchoi (2023) Isolation and Identification of Shigella spp. In: Devananda Uchoi, Nadella, R. K., Pankaj Kishore, Niladri S. Chatterjee, Femeena Hassan and George Ninan (eds.) (2023) Laboratory Manual on Bacteria of Public Health Significance. Central Institute of Fisheries Technology, Cochin, India. pp 59-62. http://krishi.icar.gov.in/jspui/handle/123456789/83288

Nadella, R. K., Pankaj Kishore, and Devananda Uchoi (2023) Fundamentals of Bacteriology. In: Priya, E. R., Devananda Uchoi, Nadella, R. K., Pankaj Kishore, Niladri S. Chatterjee, Laly, S. J., Femeena Hassan and George Ninan (eds.) (2023) Seafood Quality Assurance. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 27-33. http://krishi.icar.gov.in/jspui/handle/123456789/83417

Nadella, R. K., Pankaj Kishore, Devananda Uchoi and Panda, S. K. (2023) Advanced Microbiological techniques for human health significant pathogens. In: Devananda Uchoi, Pankaj Kishore, Nadella, R. K., Niladri S. Chatterjee, Priya, E. R., Laly S.J., Femeena Hassan, Minimol V.A., Paras Nath Jha, Remya, S., Jeyakumari A. and Shivendra Kumar (eds.) (2023) Treatise on Fisheries Harvest and Post-Harvest Technologies. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 319-332. http://krishi.icar.gov.in/jspui/handle/123456789/83247

Nadella, R. K., Minimol, V. A. and Muthulakshmi, T. (2023) Antibiotic Resistance of Arcobacter Species: An Emerging Pathogen. In: Prasad, M. M., Ravishankar, C. N., Murugadas, V., Rajesh Bhatia, Joykrushna Jena and Madhusudana Rao, B. (eds.) (2023) Handbook on Antimicrobial Resistance. *Springer Singapore*. pp 1-18. https://doi.org/10.1007/978-981-16-9723-4_18-1 http://krishi.icar.gov.in/jspui/handle/123456789/83174

Narendrakumar, L., Geetha Preena, P. and Rajaswaminathan, T. (2023) Antimicrobial Resistance in Ornamental Fisheries: Causes and Preventive Measures. In: Prasad, M. M., Ravishankar, C. N., Murugadas, V., Rajesh Bhatia, Joykrushna Jena and Madhusudana Rao, B. (eds.) (2023) Handbook on Antimicrobial Resistance. *Springer, Singapore*. pp 1-15. https://doi.org/10.1007/978-981-16-9723-4_9-1 http://krishi.icar.gov.in/jspui/handle/123456789/83395

Neethu, K. C. (2023) Design and Development of an Ozone-Based Food Processing System. In: Aniesrani Delfiya, D. S., Murali, S. and Neethu, K. C. (eds.) (2023) Current trends in food processing technology. ICAR-Central Institute of Fisheries Technology, Kochi, India. pp 188-195. http://krishi.icar.gov.in/jspui/handle/123456789/83296

Neethu, K. C. (2023) Energy and exergy analysis of solar-electrical hybrid dryer. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 234-240. http://krishi.icar.gov.in/jspui/handle/123456789/83064

Neethu, K. C., Murali, S., Aniesrani Delfiya, D. S. and George Ninan (2023) Novel Engineering Solutions for Postharvest fisheries sector. In: Devananda Uchoi, Pankaj Kishore, Nadella, R. K., Niladri S. Chatterjee, Priya, E. R., Laly S.J., Femeena Hassan,

Minimol V.A., Paras Nath Jha, Remya, S., Jeyakumari A. and Shivendra Kumar (eds.) (2023) Treatise on Fisheries Harvest and Post-Harvest Technologies. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 168-181. http://krishi.icar.gov.in/jspui/handle/123456789/83231

Nikita Gopal (2023) Introduction to Fisheries Economics. In: Devananda Uchoi, Pankaj Kishore, Nadella, R. K., Niladri S. Chatterjee, Priya, E. R., Laly S.J., Femeena Hassan, Minimol V.A., Paras Nath Jha, Remya, S., Jeyakumari A. and Shivendra Kumar (eds.) (2023) Treatise on Fisheries Harvest and Post-Harvest Technologies. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 222-229. http://krishi.icar.gov.in/jspui/handle/123456789/83237

Niladri S. Chatterjee (2023) Orientation to Chemical hazards and other contaminants in Fishery Products. In: George Ninan, Zynudheen, A. A., Nikita Gopal, Femeena Hassan, Niladri S. Chatterjee, Laly, S. J., Martin Xavier, K. A., Pankaj Kishore, Nadella, R. K., Devananda Uchoi, Priya, E. R. and Chandrasekar, V. (eds.) (2023) Quality Assurance of Fish and Fishery products, Central Institute of Fisheries Technology, Cochin, India. pp 72-77. http://krishi.icar.gov.in/jspui/handle/123456789/83268

Niladri S. Chatterjee (2023) Overview of chromatography and mass spectrometry. In: Priya, E. R., Devananda Uchoi, Nadella, R. K., Pankaj Kishore, Niladri S. Chatterjee, Laly, S. J., Femeena Hassan and George Ninan (eds.) (2023) Seafood Quality Assurance. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 95-100. http://krishi.icar.gov.in/jspui/handle/123456789/83425

Niladri S. Chatterjee (2023) Overview of chromatography and mass spectrometry. In: Devananda Uchoi, Pankaj Kishore, Nadella, R. K., Niladri S. Chatterjee, Priya, E. R., Laly S.J., Femeena Hassan, Minimol V.A., Paras Nath Jha, Remya, S., Jeyakumari A. and Shivendra Kumar (eds.) (2023) Treatise on Fisheries Harvest and Post-Harvest Technologies. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 313-318. http://krishi.icar.gov.in/jspui/handle/123456789/83246

Niladri S. Chatterjee and Suseela Mathew (2023) Seaweed and its Nutritional Significance. In: Parvathy, U., Sathish Kumar, K., Mohan, C. O., Rejula, K., Nikita Gopal and Bindu, J. (eds.) (2023). Technological Interventions in Processing, Value addition and Packaging of Aquatic Resources. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 133-142. http://krishi.icar.gov.in/jspui/handle/123456789/83135

Niladri S. Chatterjee, Devananda Uchoi, Pankaj Kishore, Ranjit Kumar Nadella and Panda, S. K. (2023) Orientation to hazards - Chemical -II (Contaminants & Pesticide). In: Priya, E. R., Laly, S. J., Devananda Uchoi., Nadella, R. K., Pankaj Kishore,Niladri Sekhar Chatterjee, Rejula, K.,Satyen Kumar Panda, Zynudheen, A. A., Femeena Hassan,A. K. Mohanty and George Ninan(eds.) (2023) ISO 22000/HACCP for fish processing establishments, Central Institute of Fisheries Technology, Cochin, India. pp 51-57. http://krishi.icar.gov.in/jspui/handle/123456789/78397

Niladri S. Chatterjee, Toms C. Joseph and Minimol, V. A. (2023) Spectral Fingerprinting of Pathogenic Bacteria by Fourier Transform Infrared Spectroscopy (FTIR) and Chemometric Models for Rapid Identification. In: Devananda Uchoi, Nadella, R. K., Pankaj Kishore, Niladri S. Chatterjee, Femeena Hassan and George Ninan (eds.) (2023) Laboratory Manual on Bacteria of Public Health Significance. Central Institute of Fisheries Technology, Cochin, India. pp 71-80. http://krishi.icar.gov.in/jspui/handle/123456789/83262

Niladri, S. Chatterjee and Pankaj Kishore (2023) National and International standards for fishery products. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 280-290. http://krishi.icar.gov.in/jspui/handle/123456789/83071

Nimit Kumar, Manickavasagam, S., Ponmani, M., Madhu, V. R. and Meenakumari, B. (2023) Phytoplankton, primary productivity, and Fishery: Case study from Northern Indian Ocean. In: S. C. Tripathy, A. Singh (eds.) Dynamics of Planktonic Primary Productivity in the Indian Ocean. *Springer Nature Switzerland AG*. pp 343-354. https://doi.org/10.1007/978-3-031-34467-1_14 http://krishi.icar.gov.in/jspui/handle/123456789/83865

Panda, S. K. (2023) Overview of food safety scenario and regulatory requirements in fish and fishery products. In: Priya, E. R., Laly, S. J., Devananda Uchoi., Nadella, R. K., Pankaj Kishore,Niladri Sekhar Chatterjee, Rejula, K.,Satyen Kumar Panda, Zynudheen, A. A., Femeena Hassan, A. K. Mohanty and George Ninan(eds.) (2023) ISO 22000/HACCP for fish processing establishments, Central Institute of Fisheries Technology, Cochin, India. pp 9-27. http://krishi.icar.gov.in/jspui/handle/123456789/78393

Panda, S. K., Pankaj Kishore, Devananda Uchoi, Kumar, A. (2023) Regulatory requirements for fish and fishery products. In: Devananda Uchoi, Pankaj Kishore, Nadella, R. K., Niladri S. Chatterjee, Priya, E. R., Laly S.J., Femeena Hassan, Minimol V.A., Paras Nath Jha, Remya, S., Jeyakumari A. and Shivendra Kumar (eds.) (2023) Treatise on Fisheries Harvest and Post-Harvest Technologies. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp

333-348. http://krishi.icar.gov.in/jspui/handle/123456789/83248

Panda, S. K. and Niladri S. Chatterjee (2023) Antibiotic Residues in Aquatic Foods and Their Methods of Detection. In: Prasad, M. M., Ravishankar, C. N., Murugadas, V., Rajesh Bhatia, Joykrushna Jena and Madhusudana Rao, B. (eds.) (2023) Handbook on Antimicrobial Resistance. Springer Singapore. Pp 1-20. https://doi.org/10.1007/978-981-16-9723-4_41-1 http://krishi.icar.gov.in/jspui/handle/123456789/83184

Pankaj Kishore (2023) Orientation to Biological hazards. In: George Ninan, Zynudheen, A. A., Nikita Gopal, Femeena Hassan, Niladri S. Chatterjee, Laly, S. J., Martin Xavier, K. A., Pankaj Kishore, Nadella, R. K., Devananda Uchoi, Priya, E. R. and Chandrasekar, V. (eds.) (2023) Quality Assurance of Fish and Fishery products, Central Institute of Fisheries Technology, Cochin, India. pp 78-90. http://krishi.icar.gov.in/jspui/handle/123456789/83269

Pankaj Kishore (2023) Traceability and Seafood Authenticity. In: George Ninan, Zynudheen, A. A., Nikita Gopal, Femeena Hassan, Niladri S. Chatterjee, Laly, S. J., Martin Xavier, K. A., Pankaj Kishore, Nadella, R. K., Devananda Uchoi, Priya, E. R. and Chandrasekar, V. (eds.) (2023) Quality Assurance of Fish and Fishery products, Central Institute of Fisheries Technology, Cochin, India. pp 157-165. http://krishi.icar.gov.in/jspui/handle/123456789/83276

Pankaj Kishore and Panda, S. K. (2023) Orientation to Hazards: Biological I. In: Priya, E. R., Laly, S. J., Devananda Uchoi., Nadella, R. K., Pankaj Kishore,Niladri Sekhar Chatterjee, Rejula, K.,Satyen Kumar Panda, Zynudheen, A. A., Femeena Hassan,A. K. Mohanty and George Ninan(eds.) (2023) ISO 22000/HACCP for fish processing establishments, Central Institute of Fisheries Technology, Cochin, India. pp 58-73. http://krishi.icar.gov.in/jspui/handle/123456789/78398

Pankaj Kishore, Devananda Uchoi and Nadella, R. K. (2023) Determination of Total Plate Count. In: Devananda Uchoi, Nadella, R. K., Pankaj Kishore, Niladri S. Chatterjee, Femeena Hassan and George Ninan (eds.) (2023) Laboratory Manual on Bacteria of Public Health Significance. Central Institute of Fisheries Technology, Cochin, India. pp 1-6. http://krishi.icar.gov.in/jspui/handle/123456789/83277

Pankaj Kishore, Nadella, R. K. and Devananda Uchoi (2023) Isolation and Identification of Listeria monocytogenes. In: Devananda Uchoi, Nadella, R. K., Pankaj Kishore, Niladri S. Chatterjee, Femeena Hassan and George Ninan (eds.) (2023) Laboratory Manual on Bacteria of Public Health Significance. Central Institute of Fisheries Technology, Cochin, India. pp 43-47. http://krishi.icar.gov.in/jspui/handle/123456789/83286

Pankaj Kishore, Nadella, R. K. and Devananda Uchoi (2023) Isolation and Identification of *Yersinia enterocolitica.* In: Devananda Uchoi, Nadella, R. K., Pankaj Kishore, Niladri S. Chatterjee, Femeena Hassan and George Ninan (eds.) (2023) Laboratory Manual on Bacteria of Public Health Significance. Central Institute of Fisheries Technology, Cochin, India. pp 54-58. http://krishi.icar.gov.in/jspui/handle/123456789/83287

Pankaj Kishore, Nadella, R. K., Devananda Uchoi and Femeena Hassan (2023) Incidences of Pathogens in Fish and Fishery Products. In: Priya, E. R., Devananda Uchoi, Nadella, R. K., Pankaj Kishore, Niladri S. Chatterjee, Laly, S. J., Femeena Hassan and George Ninan (eds.) (2023) Seafood Quality Assurance. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 34-49. http://krishi.icar.gov.in/jspui/handle/123456789/83418

Pankaj Kishore, Nadella, R. K., Devananda Uchoi and Femeena Hassan (2023) Biological hazards in fish and fishery products. In: Devananda Uchoi, Pankaj Kishore, Nadella, R. K., Niladri S. Chatterjee, Priya, E. R., Laly S.J., Femeena Hassan, Minimol V.A., Paras Nath Jha, Remya, S., Jeyakumari A. and Shivendra Kumar (eds.) (2023) Treatise on Fisheries Harvest and Post-Harvest Technologies. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 276-292. http://krishi.icar.gov.in/jspui/handle/123456789/83243

Pankaj Kishore, Nadella. R. K. and Devananda Uchoi (2023) Molecular detection Techniques for Identification of Bacterial Pathogens. In: Devananda Uchoi, Nadella, R. K., Pankaj Kishore, Niladri S. Chatterjee, Femeena Hassan and George Ninan (eds.) (2023) Laboratory Manual on Bacteria of Public Health Significance. Central Institute of Fisheries Technology, Cochin, India. pp 67-70. http://krishi.icar.gov.in/jspui/handle/123456789/83290

Pankaj Kishore, Panda, S. K. and Niladri S. Chatterjee (2023) Traceability system in FSMS. In: Priya, E. R., Laly, S. J., Devananda Uchoi., Nadella, R. K., Pankaj Kishore, Niladri Sekhar Chatterjee, Rejula, K.,Satyen Kumar Panda, Zynudheen, A. A., Femeena Hassan,A. K. Mohanty and George Ninan(eds.) (2023) ISO 22000/HACCP for fish processing establishments, Central Institute of Fisheries Technology, Cochin, India. pp 131-138. http://krishi.icar.gov.in/jspui/handle/123456789/78409

Pankaj Kishore, Ranjit Kumar Nadella, R. K. and Devananda Uchoi (2023) Isolation and identification of Vibrio spp. In: Devananda Uchoi, Nadella, R. K., Pankaj Kishore, Niladri S. Chatterjee, Femeena Hassan and George Ninan (eds.) (2023) Laboratory Manual on Bacteria of Public Health Significance. Central Institute of Fisheries Technology, Cochin, India. pp 20-

24. http://krishi.icar.gov.in/jspui/handle/123456789/83280

Pankaj Kishore, Vrinda Vishwanath and Nadella, R. K. (2023) Molecular techniques for detection of foodborne Pathogens. In: Priya, E. R., Devananda Uchoi, Nadella, R. K., Pankaj Kishore, Niladri S. Chatterjee, Laly, S. J., Femeena Hassan and George Ninan (eds.) (2023) Seafood Quality Assurance. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 50-59. http://krishi.icar.gov.in/jspui/handle/123456789/83419

Paras Nath Jha and Leela Edwin (2023) Energy optimization in fishing systems through material substitution. In: Sandhya, K. M. and Manju Lekshmi, N. (eds.) (2023) Advances in fishing gear materials. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 43-47. http://krishi.icar.gov.in/jspui/handle/123456789/83150

Paras Nath Jha and Leela Edwin (2023) Energy use and its optimization in Indian fisheries. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 38-44. http://krishi.icar.gov.in/jspui/handle/123456789/83036

Paras Nath Jha and Leela Edwin (2023) Fisheries associated Environmental burdens and Energy use. In: Devananda Uchoi, Pankaj Kishore, Nadella, R. K., Niladri S. Chatterjee, Priya, E. R., Laly S.J., Femeena Hassan, Minimol V.A., Paras Nath Jha, Remya, S., Jeyakumari A. and Shivendra Kumar (eds.) (2023) Treatise on Fisheries Harvest and Post-Harvest Technologies. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 32-39. http://krishi.icar.gov.in/jspui/handle/123456789/83218

Paras Nath Jha and Renjith, R. K. (2023) Design considerations for fabrication of bycatch reduction devices. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 23-26. http://krishi.icar.gov.in/jspui/handle/123456789/82910

Parvathy, U. (2023) Hygienic Handling of Fish and Fishery Products. In: Parvathy, U., Sathish Kumar, K., Mohan, C. O., Rejula, K., Nikita Gopal and Bindu, J. (eds.) (2023). Technological Interventions in Processing, Value addition and Packaging of Aquatic Resources. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 20-25. http://krishi.icar.gov.in/jspui/handle/123456789/83105

Parvathy, U. (2023) Hygienic handling, chilling and freezing of fish and shell fish. In: Devananda Uchoi, Pankaj Kishore, Nadella, R. K., Niladri S. Chatterjee, Priya, E. R., Laly S.J., Femeena Hassan, Minimol V.A., Paras Nath Jha, Remya, S., Jeyakumari A. and Shivendra Kumar (eds.) (2023) Treatise on Fisheries Harvest and Post-Harvest Technologies. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 90-103. http://krishi.icar.gov.in/jspui/handle/123456789/83223

Parvathy, U. (2023) Seafood Preservation and Value Addition. In: Priya, E. R., Devananda Uchoi, Nadella, R. K., Pankaj Kishore, Niladri S. Chatterjee, Laly, S. J., Femeena Hassan and George Ninan (eds.) (2023) Seafood Quality Assurance. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 105-110. http://krishi.icar.gov.in/jspui/handle/123456789/83426

Parvathy, U. (2023) Value added fishery products. In: Jeyakumari, A., Elavarasan, K., Joshy, C.G. and Bindu, J. (eds.) (2023) Advances in Seafood Processing and waste utilization. ICAR-Central institute of Fisheries Technology, Kochi, India. pp 26-34. http://krishi.icar.gov.in/jspui/handle/123456789/82880

Parvathy, U. (2023) Value Addition in Fishery Sector. In: Parvathy, U., Sathish Kumar, K., Mohan, C. O., Rejula, K., Nikita Gopal and Bindu, J. (eds.) (2023). Technological Interventions in Processing, Value addition and Packaging of Aquatic Resources. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 26-34. http://krishi.icar.gov.in/jspui/handle/123456789/83106

Parvathy, U. (2023) Value addition in seafood sector. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 91-95. http://krishi.icar.gov.in/jspui/handle/123456789/83045

Pe Jeyya Jeyanthi (2023) Entrepreneurship development through value addition of fish and fishery products. In: Santhakumar. R., Sujathkumar, N. V., Ahilan, B., Shahaji Phand and Sushrirekha Das (2023) Fishpreneurship Development [E-book]. TNJFU - Fisheries College and Research Institute, Thoothukudi & National Institute of Agricultural Extension Management, Hyderabad, India. pp 16-32. https://www.manage.gov.in/publications/eBooks/Fishpreneurship%20Development.pdf http://krishi.icar.gov.in/jspui/handle/123456789/83868

Pe. Jeyya Jeyanthi (2023) Economic Dimensions of Processing and Marketing of Fish. In: Aniesrani Delfiya, D. S., Murali, S. and Neethu, K. C. (eds.) (2023) Current trends in food processing technology. ICAR-Central Institute of Fisheries Technology, Kochi, India. pp 224-233. http://krishi.icar.gov.in/jspui/handle/123456789/83301

Pe. Jeyya Jeyanthi (2023) Post-harvest losses in the fish value chain: types, causes and method of assessment. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 444-450. http://krishi.icar.gov.in/jspui/handle/123456789/83091

Prajith, K. K. (2023) Marine mammal interaction in pelagic fishing gears and its mitigation. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 45-55. http://krishi.icar.gov.in/jspui/handle/123456789/83037

Prajith, K. K. (2023) Marine mammal interactions in fishing systems and their mitigation. In: Devananda Uchoi, Pankaj Kishore, Nadella, R. K., Niladri S. Chatterjee, Priya, E. R., Laly S.J., Femeena Hassan, Minimol V.A., Paras Nath Jha, Remya, S., Jeyakumari A. and Shivendra Kumar (eds.) (2023) Treatise on Fisheries Harvest and Post-Harvest Technologies. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 20-31. http://krishi.icar.gov.in/jspui/handle/123456789/83217

Prajith, K. K. (2023) Recent developments in trap fishing: design and materials. In: Sandhya, K. M. and Manju Lekshmi, N. (eds.) (2023) Advances in fishing gear materials. ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 28-33. http://krishi.icar.gov.in/jspui/handle/123456789/83148

Priya, E. R. (2023) Chemical Quality Indices and Freshness Indicators for Fish and Shellfish. In: George Ninan, Zynudheen, A. A., Nikita Gopal, Femeena Hassan, Niladri S. Chatterjee, Laly, S. J., Martin Xavier, K. A., Pankaj Kishore, Nadella, R. K., Devananda Uchoi, Priya, E. R. and Chandrasekar, V. (eds.) (2023) Quality Assurance of Fish and Fishery products, Central Institute of Fisheries Technology, Cochin, India. pp 29-34. http://krishi.icar.gov.in/jspui/handle/123456789/83263

Priya, E. R. (2023) Prerequisite programme requiremnt for seafood processing plant. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 246-250. http://krishi.icar.gov.in/jspui/handle/123456789/83066

Priya, E. R. (2023) Prerequisite Programs (GMP & SSOP) Implementation in Seafood Industry. In: George Ninan, Zynudheen, A. A., Nikita Gopal, Femeena Hassan, Niladri S. Chatterjee, Laly, S. J., Martin Xavier, K. A., Pankaj Kishore, Nadella, R. K., Devananda Uchoi, Priya, E. R. and Chandrasekar, V. (eds.) (2023) Quality Assurance of Fish and Fishery products, Central Institute of Fisheries Technology, Cochin, India. pp 91-95. http://krishi.icar.gov.in/jspui/handle/123456789/83270

Priya, E. R. (2023) Quality and Safety Issues in Seafoods. In: Aniesrani Delfiya, D. S., Murali, S. and Neethu, K. C. (eds.) (2023) Current trends in food processing technology. ICAR-Central Institute of Fisheries Technology, Kochi, India. pp 178-182. http://krishi.icar.gov.in/jspui/handle/123456789/83294

Priya, E. R. and Femeena Hassan (2023) Ensuring Safety and Quality of Packaged Food. In: Bindu, J., Mohan, C.O., Remya, S. and Sathish Kumar, K. (eds.) (2023) Advanced food packaging techniques and quality evaluation of packaging materials, ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 42-44. http://krishi.icar.gov.in/jspui/handle/123456789/82868

Priya, E. R. and Laly, S. J. (2023) Analysis of Pesticide Residue in Fish. In: Priya, E. R., Devananda Uchoi, Nadella, R. K., Pankaj Kishore, Niladri S. Chatterjee, Laly, S. J., Femeena Hassan and George Ninan (eds.) (2023) Seafood Quality Assurance. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 101-104. http://krishi.icar.gov.in/jspui/handle/123456789/83423

Priya, E. R. and Laly, S. J. (2023) Heavy Metal Residues in Fish and Fishery Products. In: Priya, E. R., Devananda Uchoi, Nadella, R. K., Pankaj Kishore, Niladri S. Chatterjee, Laly, S. J., Femeena Hassan and George Ninan (eds.) (2023) Seafood Quality Assurance. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 24-26. http://krishi.icar.gov.in/jspui/handle/123456789/83416

Priya, E. R. and Laly, S. J. (2023) Post-Mortem Changes and Mechanism of Fish Spoilage. In: Priya, E. R., Devananda Uchoi, Nadella, R. K., Pankaj Kishore, Niladri S. Chatterjee, Laly, S. J., Femeena Hassan and George Ninan (eds.) (2023) Seafood Quality Assurance. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 10-17. http://krishi.icar.gov.in/jspui/handle/123456789/83413

Priya, E. R. and Laly, S. J. (2023) Preliminary steps in HACCP implementation. In: Priya, E. R., Laly, S. J., Devananda Uchoi., Nadella, R. K., Pankaj Kishore, Niladri Sekhar Chatterjee, Rejula, K., Satyen Kumar Panda, Zynudheen, A. A., Femeena Hassan, A. K. Mohanty and George Ninan(eds.) (2023) ISO 22000/HACCP for fish processing establishments, Central Institute of Fisheries Technology, Cochin, India. pp 94-96. http://krishi.icar.gov.in/jspui/handle/123456789/79245

Priya, E. R. and Laly, S. J. (2023) PRPs and physical hazards in seafood. In: Priya, E. R., Laly, S. J., Devananda Uchoi., Nadella, R. K., Pankaj Kishore,Niladri Sekhar Chatterjee, Rejula, K.,Satyen Kumar Panda, Zynudheen, A. A., Femeena Hassan,A. K. Mohanty and George Ninan(eds.) (2023) ISO 22000/HACCP for fish processing establishments, Central Institute of Fisheries Technology, Cochin, India. pp 39-43. http://krishi.icar.gov.in/jspui/handle/123456789/79244

Priya, E. R. and Laly, S. J. (2023) PRPs for Fish Processing Establishments. In: Devananda Uchoi, Pankaj Kishore, Nadella, R. K., Niladri S. Chatterjee, Priya, E. R., Laly S.J., Femeena Hassan, Minimol V.A., Paras Nath Jha, Remya, S., Jeyakumari A. and Shivendra Kumar (eds.) (2023) Treatise on Fisheries Harvest and Post-Harvest Technologies. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 293-296. http://krishi.icar.gov.in/jspui/handle/123456789/83244

Priya, E. R. and Laly, S. J. (2023) Spoilage indices for fish and shellfish. In: Devananda Uchoi, Pankaj Kishore, Nadella, R. K., Niladri S. Chatterjee, Priya, E. R., Laly S.J., Femeena Hassan, Minimol V.A., Paras Nath Jha, Remya, S., Jeyakumari A. and Shivendra Kumar (eds.) (2023) Treatise on Fisheries Harvest and Post-Harvest Technologies. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 262-268. http://krishi.icar.gov.in/jspui/handle/123456789/83241

Priya, E. R., Laly, S. J. and Panda, S. K. (2023) ISO 22000Series of standards on PRPs. In: Priya, E. R., Laly, S. J., Devananda Uchoi., Nadella, R. K., Pankaj Kishore,Niladri Sekhar Chatterjee, Rejula, K.,Satyen Kumar Panda, Zynudheen, A. A., Femeena Hassan,A. K. Mohanty and George Ninan(eds.) (2023) ISO 22000/HACCP for fish processing establishments, Central Institute of Fisheries Technology, Cochin, India. pp 123-124. http://krishi.icar.gov.in/jspui/handle/123456789/78407

Priya, E. R., Laly, S. J. and Panda, S. K. (2023) Overview of ISO 22000:2018 FSMS. In: Priya, E. R., Laly, S. J., Devananda Uchoi., Nadella, R. K., Pankaj Kishore,Niladri Sekhar Chatterjee, Rejula, K.,Satyen Kumar Panda, Zynudheen, A. A., Femeena Hassan,A. K. Mohanty and George Ninan(eds.) (2023) ISO 22000/HACCP for fish processing establishments, Central Institute of Fisheries Technology, Cochin, India. pp 105-111. http://krishi.icar.gov.in/jspui/handle/123456789/78405

Priya, E. R., Laly, S. J. and Panda, S. K. (2023) Process of certification, accreditation, and benchmarking of FSMS standards. In: Priya, E. R., Laly, S. J., Devananda Uchoi., Nadella, R. K., Pankaj Kishore,Niladri Sekhar Chatterjee, Rejula, K.,Satyen Kumar Panda, Zynudheen, A. A., Femeena Hassan,A. K. Mohanty and George Ninan(eds.) (2023) ISO 22000/HACCP for fish processing establishments, Central Institute of Fisheries Technology, Cochin, India. pp 125-130. http://krishi.icar.gov.in/jspui/handle/123456789/78408

Radhakrishnan Nair, V. (2023) Introduction to bioinformatics, sequencing and bioinformatics analysis. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 373-387. http://krishi.icar.gov.in/jspui/handle/123456789/83082

Radhakrishnan Nair, V. (2023) Introduction to Bioinformatics. In: Devananda Uchoi, Pankaj Kishore, Nadella, R. K., Niladri S. Chatterjee, Priya, E. R., Laly S.J., Femeena Hassan, Minimol V.A., Paras Nath Jha, Remya, S., Jeyakumari A. and Shivendra Kumar (eds.) (2023) Treatise on Fisheries Harvest and Post-Harvest Technologies. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 206-221. http://krishi.icar.gov.in/jspui/handle/123456789/83236

Raj, N. S., Arivarasan, V. K., Hameed, A. S. S. and Swaminathan, T. R. (2023) Nanotechnologies in the Health Management of Aquatic Animal Diseases. In: Kirthi, A.V., Loganathan, K. and Karunasagar, I. (eds.) Nanotechnological Approaches to the Advancement of Innovations in Aquaculture. Nanotechnology in the Life Sciences. Springer, Cham. pp 157-181. https://doi.org/10.1007/978-3-031-15519-2_9 http://krishi.icar.gov.in/jspui/handle/123456789/83398

Raja Swaminathan, T. (2023) Basics in animal cell culture – principles and applications. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 324-332. http://krishi.icar.gov.in/jspui/handle/123456789/83077

Raja Swaminathan, T. (2023) Isolation of fish viruses and its confirmation in cell culture. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 367-372. http://krishi.icar.gov.in/jspui/handle/123456789/83081

Ranjit Kumar Nadella, Pankaj Kishore, Devananda Uchoi and Panda, S. K. (2023) Orientation to Hazards: Biological II. In: Priya, E. R., Laly, S. J., Devananda Uchoi., Nadella, R. K., Pankaj Kishore,Niladri Sekhar

Chatterjee, Rejula, K.,Satyen Kumar Panda, Zynudheen, A. A., Femeena Hassan,A. K. Mohanty and George Ninan(eds.) (2023) ISO 22000/HACCP for fish processing establishments, Central Institute of Fisheries Technology, Cochin, India. pp 74-84. http://krishi.icar.gov.in/jspui/handle/123456789/78399

Raveendran, K., Murugadas, V., and Madhusudana Rao, B. (2023). Molecular Tools for Characterizing AMR Pathogens. In: Mothadaka, M.P., Vaiyapuri, M., Rao Badireddy, M., Nagarajrao Ravishankar, C., Bhatia, R., Jena, J. (eds.) Handbook on Antimicrobial Resistance. Springer, Singapore, pp 1-25. https://doi.org/10.1007/978-981-16-9723-4_32- http://krishi.icar.gov.in/jspui/handle/123456789/78792

Ravishankar, C. N. and Mohan, C. O. (2023) Advancement in Fish Processing Technology: The Indian Scenario. In: Ranendra K. Majumder, Amjad K. Balange (eds.) Advances in Fish Processing Technologies. Apple Academic Press. http://krishi.icar.gov.in/jspui/handle/123456789/79790

Rejula, K. (2023) Training need assessment and problem analysis. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 441-443. http://krishi.icar.gov.in/jspui/handle/123456789/83090

Remesan, M. P. (2023) Recent advancements in fish harvest sector by ICAR-CIFT. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 1-11. http://krishi.icar.gov.in/jspui/handle/123456789/82900

Remesan, M. P. (2023) Resource and energy conservations measures in fishing gears. In: Sandhya, K. M. and Manju Lekshmi, N. (eds.) (2023) Advances in fishing gear materials. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 11-17. http://krishi.icar.gov.in/jspui/handle/123456789/83146

Remya, S. (2023) MAP, Active and Intelligent Packaging. In: Parvathy, U., Sathish Kumar, K., Mohan, C. O., Rejula, K., Nikita Gopal and Bindu, J. (eds.) (2023). Technological Interventions in Processing, Value addition and Packaging of Aquatic Resources. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 86-92. http://krishi.icar.gov.in/jspui/handle/123456789/83126

Remya, S. (2023) Nanomaterials in food packaging. In: Bindu, J., Mohan, C.O., Remya, S. and Sathish Kumar, K. (eds.) (2023) Advanced food packaging techniques and quality evaluation of packaging materials, ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 77-82. http://krishi.icar.gov.in/jspui/handle/123456789/82873

Remya, S. (2023) Non-thermal fish preservation techniques. In: Devananda Uchoi, Pankaj Kishore, Nadella, R. K., Niladri S. Chatterjee, Priya, E. R., Laly S.J., Femeena Hassan, Minimol V.A., Paras Nath Jha, Remya, S., Jeyakumari A. and Shivendra Kumar (eds.) (2023) Treatise on Fisheries Harvest and Post-Harvest Technologies. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 81-89. http://krishi.icar.gov.in/jspui/handle/123456789/83222

Remya, S. (2023) Non-thermal fish preservation techniques. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 132-136. http://krishi.icar.gov.in/jspui/handle/123456789/83050

Remya, S. (2023) Non-Thermal Processing Techniques. In: Parvathy, U., Sathish Kumar, K., Mohan, C. O., Rejula, K., Nikita Gopal and Bindu, J. (eds.) (2023). Technological Interventions in Processing, Value addition and Packaging of Aquatic Resources. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 62-67. http://krishi.icar.gov.in/jspui/handle/123456789/83124

Remya, S. (2023) Novel Food Packaging Techniques. In: Aniesrani Delfiya, D. S., Murali, S. and Neethu, K. C. (eds.) (2023) Current trends in food processing technology. ICAR-Central Institute of Fisheries Technology, Kochi, India. pp 164-177. http://krishi.icar.gov.in/jspui/handle/123456789/83293

Remya, S. (2023) Packaging and labelling requirements. In: Priya, E. R., Laly, S. J., Devananda Uchoi., Nadella, R. K., Pankaj Kishore,Niladri Sekhar Chatterjee, Rejula, K.,Satyen Kumar Panda, Zynudheen, A. A., Femeena Hassan,A. K. Mohanty and George Ninan(eds.) (2023) ISO 22000/HACCP for fish processing establishments, Central Institute of Fisheries Technology, Cochin, India. pp 85-93. http://krishi.icar.gov.in/jspui/handle/123456789/78402

Remya, S. (2023) Packaging of fish and fishery products. In: Jeyakumari, A., Elavarasan, K., Joshy, C.G. and Bindu, J. (eds.) (2023) Advances in Seafood Processing and waste utilization. ICAR-Central institute of Fisheries Technology, Kochi, India. pp 47-57. http://krishi.icar.gov.in/jspui/handle/123456789/82882

Remya, S. (2023) Plastic packaging material identification & property testing. In: Bindu, J., Mohan, C.O., Remya, S. and Sathish Kumar, K. (eds.) (2023) Advanced food packaging techniques and quality

evaluation of packaging materials, ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 45-54. http://krishi.icar.gov.in/jspui/handle/123456789/82869

Remya, S. (2023) Regulations on food packaging and labelling. In: Bindu, J., Mohan, C.O., Remya, S. and Sathish Kumar, K. (eds.) (2023) Advanced food packaging techniques and quality evaluation of packaging materials, ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 108-117. http://krishi.icar.gov.in/jspui/handle/123456789/82877

Remya, S. and Bindu, J. (2023) Non-thermal food preservation techniques. In: Bindu, J., Mohan, C.O., Remya, S. and Sathish Kumar, K. (eds.) (2023) Advanced food packaging techniques and quality evaluation of packaging materials, ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 28-33. http://krishi.icar.gov.in/jspui/handle/123456789/82866

Remya, S. and Bindu, J. (2023) Testing and quality evaluation of paper and plastic packaging materials. In: Bindu, J., Mohan, C.O., Remya, S. and Sathish Kumar, K. (eds.) (2023) Advanced food packaging techniques and quality evaluation of packaging materials, ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 55-69. http://krishi.icar.gov.in/jspui/handle/123456789/82870

Renjith, R. K. (2023) Indian deep-sea fishing: status and challenges. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 12-16. http://krishi.icar.gov.in/jspui/handle/123456789/82908

Renjith, R. K. (2023) Line fishing in India and advances in the materials. In: Sandhya, K. M. and Manju Lekshmi, N. (eds.) (2023) Advances in fishing gear materials. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 34-42. http://krishi.icar.gov.in/jspui/handle/123456789/83149

Renjith, R. K. (2023) Line Fishing in India: Status and Conservation Challenges. In: Devananda Uchoi, Pankaj Kishore, Nadella, R. K., Niladri S. Chatterjee, Priya, E. R., Laly S.J., Femeena Hassan, Minimol V. A., Paras Nath Jha, Remya, S., Jeyakumari A. and Shivendra Kumar (eds.) (2023) Treatise on Fisheries Harvest and Post-Harvest Technologies. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 40-49. http://krishi.icar.gov.in/jspui/handle/123456789/83219

Renuka, V. (2023) Effect of Seafood Processing and Preservation Methods on Nutritional Aspects of Marine Food. In: Aniesrani Delfiya, D. S., Murali, S. and Neethu, K. C. (eds.) (2023) Current trends in food processing technology. ICAR-Central Institute of Fisheries Technology, Kochi, India. pp 216-223. http://krishi.icar.gov.in/jspui/handle/123456789/83300

Renuka, V. (2023) Seaweeds chromatography-principles and application in nutrient profiling. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 211-217. http://krishi.icar.gov.in/jspui/handle/123456789/83060

Sajeev, M. V. (2023) Fish and seafood consumption and its determinants in India: an overview. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 413-418. http://krishi.icar.gov.in/jspui/handle/123456789/83087

Sajeev, M.V. (2023) Fish consumption in India: Patterns, determinants and consumer perspective. In: Devananda Uchoi, Pankaj Kishore, Nadella, R. K., Niladri S. Chatterjee, Priya, E. R., Laly S.J., Femeena Hassan, Minimol V.A., Paras Nath Jha, Remya, S., Jeyakumari A. and Shivendra Kumar (eds.) (2023) Treatise on Fisheries Harvest and Post-Harvest Technologies. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 246-252. http://krishi.icar.gov.in/jspui/handle/123456789/83239

Sajesh, V. K. (2023) Advanced extension techniques for harnessing potential of fisheries sector. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 419-427. http://krishi.icar.gov.in/jspui/handle/123456789/83088

Sandhya, K. M. (2023) Fishing gear materials & identification. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 17-22. http://krishi.icar.gov.in/jspui/handle/123456789/82909

Sandhya, K. M. (2023) Fishing Gear Materials: Properties and Degradation Pattern. In: Muhamed Ashraf, P., Manju Lekshmi, N., Sandhya, K. M., Gopika, R. and Anjana, C. S. (eds.) (2023) Nanotechnological Applications in Fisheries. ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 74-80. http://krishi.icar.gov.in/jspui/handle/123456789/83390

Sandhya, K. M. (2023) Gillnet fishing:

materials, impacts and mitigation measures. In: Sandhya, K. M. and Manju Lekshmi, N. (eds.) (2023) Advances in fishing gear materials. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 18-27. http://krishi.icar.gov.in/jspui/handle/123456789/83147

Sandhya, K. M. and Manju Lekshmi, N. (2023) Fishing gear materials: properties & identification. In: Devananda Uchoi, Pankaj Kishore, Nadella, R. K., Niladri S. Chatterjee, Priya, E. R., Laly S.J., Femeena Hassan, Minimol V.A., Paras Nath Jha, Remya, S., Jeyakumari A. and Shivendra Kumar (eds.) (2023) Treatise on Fisheries Harvest and Post-Harvest Technologies. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 11-19. http://krishi.icar.gov.in/jspui/handle/123456789/83216

Sandhya, K. M. and Saly, N. Thomas (2023) Fishing gear materials: classification, properties and advancements. In: Sandhya, K. M. and Manju Lekshmi, N. (eds.) (2023) Advances in fishing gear materials. ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 1-10. http://krishi.icar.gov.in/jspui/handle/123456789/83145

Sathish Kumar, K. (2023) Smoked fishery products. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 108-117. http://krishi.icar.gov.in/jspui/handle/123456789/83047

Sathish Kumar, K. (2023) Smoke-drying technology for fish preservation. In: Jeyakumari, A., Elavarasan, K., Joshy, C.G. and Bindu, J. (eds.) (2023) Advances in Seafood Processing and waste utilization. ICAR-Central institute of Fisheries Technology, Kochi, India. pp 35-46. http://krishi.icar.gov.in/jspui/handle/123456789/82881

Sathish Kumar, K. and Bindu, J. (2023) Development of biodegradable packaging materials from marine and agro-waste. In: Bindu, J., Mohan, C.O., Remya, S. and Sathish Kumar, K. (eds.) (2023) Advanced food packaging techniques and quality evaluation of packaging materials, ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 83-94. http://krishi.icar.gov.in/jspui/handle/123456789/82874

Sathish Kumar, K. and Parvathy, U. (2023) Traditional Methods of Fish Preservation. In: Parvathy, U., Sathish Kumar, K., Mohan, C. O., Rejula, K., Nikita Gopal and Bindu, J. (eds.) (2023). Technological Interventions in Processing, Value addition and Packaging of Aquatic Resources. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 35-43. http://krishi.icar.gov.in/jspui/handle/123456789/83107

Shaheer, P., Sreejith, V. N., Toms C. Joseph and Lalitha, K. V. (2023) Anti-virulence to Counter the AMR Conundrum: Principles and Strategies. In: Prasad, M. M., Ravishankar, C. N., Murugadas, V., Rajesh Bhatia, Joykrushna Jena and Madhusudana Rao, B. (eds.) (2023) Handbook on Antimicrobial Resistance. Springer Singapore. pp 1-18. https://doi.org/10.1007/978-981-16-9723-4_44-1 http://krishi.icar.gov.in/jspui/handle/123456789/83183

Sharma, S. K. (2023) Impact of Global Warming on Changing Pattern of Biodiversity and Fish Production in Inland Open Waters. In: Sinha, A., Kumar, S., Kumari, K. (eds.) Outlook of Climate Change and Fish Nutrition. *Springer, Singapore.* pp 49-61. https://doi.org/10.1007/978-981-19-5500-6_5 http://krishi.icar.gov.in/jspui/handle/123456789/83172

Shine Kumar (2023) Seafood Export and Trade Issues. In: George Ninan, Zynudheen, A. A., Nikita Gopal, Femeena Hassan, Niladri S. Chatterjee, Laly, S. J., Martin Xavier, K. A., Pankaj Kishore, Nadella, R. K., Devananda Uchoi, Priya, E. R. and Chandrasekar, V. (eds.) (2023) Quality Assurance of Fish and Fishery products, Central Institute of Fisheries Technology, Cochin, India. pp 149-156. http://krishi.icar.gov.in/jspui/handle/123456789/83275

Shine Kumar C. S. (2023) Seafood Export and Trade Issues. In: Parvathy, U., Sathish Kumar, K., Mohan, C. O., Rejula, K., Nikita Gopal and Bindu, J. (eds.) (2023). Technological Interventions in Processing, Value addition and Packaging of Aquatic Resources. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 178-185. http://krishi.icar.gov.in/jspui/handle/123456789/83140

Shyma, P. K. (2023) Electronics and Instrumentation in Fisheries Sector. In: Aniesrani Delfiya, D. S., Murali, S. and Neethu, K. C. (eds.) (2023) Current trends in food processing technology. ICAR-Central Institute of Fisheries Technology, Kochi, India. pp 205-215. http://krishi.icar.gov.in/jspui/handle/123456789/83299

Siddique, V. K. (2023) Introduction to Basic Refrigeration and Air Conditioning. In: Aniesrani Delfiya, D. S., Murali, S. and Neethu, K. C. (eds.) (2023) Current trends in food processing technology. ICAR-Central Institute of Fisheries Technology, Kochi, India. pp 196-199. http://krishi.icar.gov.in/jspui/handle/123456789/83297

Sivaraman, G. K. (2023) Antimicrobial resistance in foodborne pathogens. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 298-302. http://krishi.icar.gov.in/jspui/handle/123456789/82884

Sivaraman, G. K. (2023) Introduction to Antimicrobial Resistance. In: Toms C. Joseph, Murugadas, V.,

Minimol, V. A., Ezhil Nilavan, S., Muthulakshmi, T. and Anupama, T. K. (eds.) (2023) Advanced Microbiological and Molecular Techniques for Improving the Competence of Students in Biological Sciences (under SCSP). ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 59-63. http://krishi.icar.gov.in/jspui/handle/123456789/83206

Sivaraman, G. K. (2023) Introduction to automated microbial system. In: Toms C. Joseph, Murugadas, V., Minimol, V. A., Ezhil Nilavan, S., Muthulakshmi, T. and Anupama, T. K. (eds.) (2023) Advanced Microbiological and Molecular Techniques for Improving the Competence of Students in Biological Sciences (under SCSP). ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 55-58. http://krishi.icar.gov.in/jspui/handle/123456789/83205

Sivaraman, G. K. (2023) Laboratory techniques in microbiology. In: Toms C. Joseph, Murugadas, V., Minimol, V. A., Ezhil Nilavan, S., Muthulakshmi, T. and Anupama, T. K. (eds.) (2023) Advanced Microbiological and Molecular Techniques for Improving the Competence of Students in Biological Sciences (under SCSP). ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 10-22. http://krishi.icar.gov.in/jspui/handle/123456789/83198

Sivaraman, G. K. and Prinetha, U. (2023) Determination of AMR by phenotypic method – Disk Diffusion assay. In: Toms C. Joseph, Murugadas, V., Minimol, V. A., Ezhil Nilavan, S., Muthulakshmi, T. and Anupama, T. K. (eds.) (2023) Advanced Microbiological and Molecular Techniques for Improving the Competence of Students in Biological Sciences (under SCSP). ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 64-69. http://krishi.icar.gov.in/jspui/handle/123456789/83207

Sivaraman, G. K. and Resmi, K. (2023) Determination of AMR by phenotypic method – disk diffusion assay. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 394-398. http://krishi.icar.gov.in/jspui/handle/123456789/83084

Sivaraman, G. K., Visnuvinayagam, S. and Ardhra Vijayan (2023). Trends In Determination of Antimicrobial Resistance in Aquaculture and Fisheries. In: Handbook on Antimicrobial Resistance: Current Status, Trends in Detection and Mitigation Measures. *Springer Nature*. pp 661-682. https://doi.org/10.1007/978-981-19-9279-7_31 http://krishi.icar.gov.in/jspui/handle/123456789/83864

Sreelakshmi, K. R. (2023) Battered and breaded products. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 118-124. http://krishi.icar.gov.in/jspui/handle/123456789/83048

Sreelakshmi, K. R. (2023) Hygienic handling and low temperature preservation. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 78-90. http://krishi.icar.gov.in/jspui/handle/123456789/83043

Sreelekshmi, K. R., Rehana Raj, Parvathy, U. and Sarika, K. (2023) മൂല്യവർദ്ധനവിന് മീൻ ഉണക്കൽ. In: Manoj, P. Samuel, Murali, S., Alfiya, P. V., Aniesrani Delfiya, D. S., Menon, A. R. S. and Ragesh M. Raghavan (2023) Pre-processing and Drying of Fish (മത്സ്യ സംസ്കരണവും ഉണക്കലും) ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 14-18. (In Malayalam) http://krishi.icar.gov.in/jspui/handle/123456789/83331

Sreepriya Prakasan (2023) Battered and Breaded Fish Products. In: Devananda Uchoi, Pankaj Kishore, Nadella, R. K., Niladri S. Chatterjee, Priya, E. R., Laly S.J., Femeena Hassan, Minimol V.A., Paras Nath Jha, Remya, S., Jeyakumari A. and Shivendra Kumar (eds.) (2023) Treatise on Fisheries Harvest and Post-Harvest Technologies. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 114-122. http://krishi.icar.gov.in/jspui/handle/123456789/83225

Sreepriya Prakasan, Parvathy, U. and Sreelakshmi, K. R. (2023) Cured fishery products. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 96-107. http://krishi.icar.gov.in/jspui/handle/123456789/83046

Suresh, A. (2023) Livestock. In: Swaminathan, M., Surjith, V. and Ramachandran, V. K. (eds.) Economic Changes in the Lower Cauvery Delta. Agrarian Studies 7. Tulika Books, New Delhi. pp 144-162. http://krishi.icar.gov.in/jspui/handle/123456789/83362

Suresh, A., Vijay Kiran and Neethu Mol Jacob (2023) Input and service delivery system in fisheries. In: Devananda Uchoi, Pankaj Kishore, Nadella, R. K., Niladri S. Chatterjee, Priya, E. R., Laly S.J., Femeena Hassan, Minimol V.A., Paras Nath Jha, Remya, S., Jeyakumari A. and Shivendra Kumar (eds.) (2023) Treatise on Fisheries Harvest and Post-Harvest Technologies. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp

230-245. http://krishi.icar.gov.in/jspui/handle/123456789/83238

Suresh, A., Vijay Kiran and Neethu Mol Jacob (2023) Input and service delivery system in fisheries. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 428-440. http://krishi.icar.gov.in/jspui/handle/123456789/83089

Suseela Mathew (2023) An introduction to biochemical aspects of fish preservation. In: Devananda Uchoi, Pankaj Kishore, Nadella, R. K., Niladri S. Chatterjee, Priya, E. R., Laly S.J., Femeena Hassan, Minimol V.A., Paras Nath Jha, Remya, S., Jeyakumari A. and Shivendra Kumar (eds.) (2023) Treatise on Fisheries Harvest and Post-Harvest Technologies. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 182-186. http://krishi.icar.gov.in/jspui/handle/123456789/83232

Suseela Mathew (2023) Seaweeds – nutrition facts and health benefits. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 193-202. http://krishi.icar.gov.in/jspui/handle/123456789/83058

Toms C. Joseph (2023) Microbiological Considerations in Food Packaging: Effects of Different Atmospheres and Preservation Methods. In: Bindu, J., Mohan, C.O., Remya, S. and Sathish Kumar, K. (eds.) (2023) Advanced food packaging techniques and quality evaluation of packaging materials, ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 34-41. http://krishi.icar.gov.in/jspui/handle/123456789/82867

Toms C. Joseph, Remya, S. and Greeshma, S. S. (2023) Prebiotic and Probiotic-Based Strategies for the Control of Antimicrobial Resistance. In: Prasad, M. M., Ravishankar, C. N., Murugadas, V., Rajesh Bhatia, Joykrushna Jena and Madhusudana Rao, B. (eds.) (2023) Handbook on Antimicrobial Resistance. Springer Singapore. Pp 1-46. DOIhttps://doi.org/10.1007/978-981-16-9723-4_38-1 http://krishi.icar.gov.in/jspui/handle/123456789/83186

Viji, P. (2023) Quality Defects in Cured Fish Products. In: Viji, P., Madhusudana Rao, B., Jesmi Debbarma and Ahamed Basha, K. (eds.) (2023) Quality Assurance of Fish and Fish Products. ICAR-Central Institute of Fisheries Technology (ICAR-CIFT), pp 25-27. http://krishi.icar.gov.in/jspui/handle/123456789/83713

Viji, P. and Jesmi Debbarma (2023) Biochemical Quality Assessment of Seafood. In: Viji, P., Madhusudana Rao, B., Jesmi Debbarma and Ahamed Basha, K. (eds.) (2023) Quality Assurance of Fish and Fish Products. ICAR-Central Institute of Fisheries Technology (ICAR-CIFT), pp 28-32. http://krishi.icar.gov.in/jspui/handle/123456789/83715

Viji, P. and Jesmi Debbarma (2023) Spoilage mechanism and quality changes in seafood. In: Viji, P., Madhusudana Rao, B., Jesmi Debbarma and Ahamed Basha, K. (eds.) (2023) Quality Assurance of Fish and Fish Products. ICAR-Central Institute of Fisheries Technology (ICAR-CIFT), pp 1-8. http://krishi.icar.gov.in/jspui/handle/123456789/83710

Viji, P. and Madhusudana Rao, B. (2023) Good Hygienic Handling Practices for Ensuring the Seafood Quality. In: Viji, P., Madhusudana Rao, B., Jesmi Debbarma and Ahamed Basha, K. (eds.) (2023) Quality Assurance of Fish and Fish Products. ICAR-Central Institute of Fisheries Technology (ICAR-CIFT), pp 14-24. http://krishi.icar.gov.in/jspui/handle/123456789/83712

Viji, P., Jesmi Debbarma, Madhusudana Rao, B. and Ahamed Basha, K. (2023) Quality Issues in Shrimp Processing. Viji, P., Madhusudana Rao, B., Jesmi Debbarma and Ahamed Basha, K. (eds.) (2023) Quality Assurance of Fish and Fish Products. ICAR-Central Institute of Fisheries Technology (ICAR-CIFT), pp 9-13. http://krishi.icar.gov.in/jspui/handle/123456789/83711

Visnuvinayagam, S. (2023) Alternative to antibiotics in aquaculture practices. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 362-366. http://krishi.icar.gov.in/jspui/handle/123456789/83080

Visnuvinayagam, S. (2023) Introduction to nanotechnology and its application in fisheries and aquaculture sector. In: Toms C. Joseph, Murugadas, V., Minimol, V. A., Ezhil Nilavan, S., Muthulakshmi, T. and Anupama, T. K. (eds.) (2023) Advanced Microbiological and Molecular Techniques for Improving the Competence of Students in Biological Sciences (under SCSP). ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 70-73. http://krishi.icar.gov.in/jspui/handle/123456789/83208

Visnuvinayagam, S. (2023) Methods for the microbiological examination of seafood. In: Toms C. Joseph, Murugadas, V., Minimol, V. A., Ezhil Nilavan, S., Muthulakshmi, T. and Anupama, T. K. (eds.) (2023) Advanced Microbiological and Molecular Techniques for Improving the Competence of Students in Biological Sciences (under SCSP). ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 23-29. http://krishi.icar.gov.in/jspui/handle/123456789/83199

Visnuvinayagam, S. (2023) Microbial Safety of Fish and Fishery Products. In: Parvathy, U., Sathish Kumar, K., Mohan, C. O., Rejula, K., Nikita Gopal and Bindu, J. (eds.) (2023). Technological Interventions in Processing, Value addition and Packaging of Aquatic Resources. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 186-191. http://krishi.icar.gov.in/jspui/handle/123456789/83141

Visnuvinayagam, S., Anandan, R. and Dara, P. K. (2023) Nanoparticle Approach to Control AMR. In: Mothadaka, M.P., Vaiyapuri, M., Rao Badireddy, M., Nagarajrao Ravishankar, C., Bhatia, R., Jena, J. (eds.) Handbook on Antimicrobial Resistance. Springer, Singapore. pp 1-22. https://doi.org/10.1007/978-981-16-9723-4_42-1 http://krishi.icar.gov.in/jspui/handle/123456789/83867

Zynudheen, A. A. (2023) Overview of Quality Aspects in Fish: Traditional and Modern Approach. In: George Ninan, Zynudheen, A. A., Nikita Gopal, Femeena Hassan, Niladri S. Chatterjee, Laly, S. J., Martin Xavier, K. A., Pankaj Kishore, Nadella, R. K., Devananda Uchoi, Priya, E. R. and Chandrasekar, V. (eds.) (2023) Quality Assurance of Fish and Fishery products, Central Institute of Fisheries Technology, Cochin, India. pp 1-5. http://krishi.icar.gov.in/jspui/handle/123456789/83255

Zynudheen, A. A. (2023) Quality Control of Fishery Products. In: Parvathy, U., Sathish Kumar, K., Mohan, C. O., Rejula, K., Nikita Gopal and Bindu, J. (eds.) (2023). Technological Interventions in Processing, Value addition and Packaging of Aquatic Resources. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 155-165. http://krishi.icar.gov.in/jspui/handle/123456789/83139

Zynudheen, A. A. (2023) മത്സ്യ മാലിന്യ സംസ്കരണം. In: Manoj, P. Samuel, Murali, S., Alfiya, P. V., Aniesrani Delfiya, D. S., Menon, A. R. S. and Ragesh M. Raghavan (2023) Pre-processing and Drying of Fish (മത്സ്യ സംസ്കരണവും ഉണക്കലും) ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 35-42. (In Malayalam) http://krishi.icar.gov.in/jspui/handle/123456789/83337

Zynudheen, A. A., Priya, E. R. and Laly, S. J. (2023) Introduction to quality control in fish and fishery products. In: Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J., Nikita Gopal (eds.) (2023) In plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 462-465. http://krishi.icar.gov.in/jspui/handle/123456789/83101

## POPULAR ARTICLES

Akhila S. Viswan, Sreelakshmi, K. R., Mohan, C. O. and Bindu, J. (2023) Production of Polyhydroxyalkanoates using Marine Algae and their Biomedical Applications. *Food and scientific reports.* 4(8):13-19. http://krishi.icar.gov.in/jspui/handle/123456789/83123

Akshay, P., Gopika, R., Mohanty, A. K., Sajeev, M. V., Murali, S., Murugadas, V., Manoj P. Samuel, Ravishankar, C. N., George Ninan and Suseela Mathew (2023) Development and inclusion of dried fish powder to alleviate malnutrition among fish consuming women and children of Odisha, India. *FishTech Reporter*. pp 27-30. http://krishi.icar.gov.in/jspui/handle/123456789/83194

Anas, K. K., Lekshmi R. G. Kumar, Tejpal, C. S., Anandan, R., Sahu, N. P. and Suseela Mathew (2023) Probing the potential of myctophid silage in aqua-feed formulation. *FishTech Reporter*. 9(2): 24-26. http://krishi.icar.gov.in/jspui/handle/123456789/83069

Anuj Kumar, Devananda Uchoi, Panda, S. K., Pankaj Kishore, Athira, A. S. and Zynudheen, A. A. (2023) Liquid chromatography-based method for estimation of colour additives in fishery products. *FishTech Reporter*. 9(1): 35-37. http://krishi.icar.gov.in/jspui/handle/123456789/83168

Anupama, T. K., Lekshmi R. G. Kumar, Elavarasan, K. and Toms C. Joseph (2023) Bioprocessing of shrimp shell for extracting chitin using *Bacillus licheniformis* and *Lactobacillus fermentum*. *FishTech Reporter*. 9(2): 27-32. http://krishi.icar.gov.in/jspui/handle/123456789/83054

Asha K. K., Raviprasad Prabhu, Laly, S. J., Rehana Raj, Greeshma, S. S., Sharma, S. K. and Abhay Kumar (2023) Macronutrient and mineral profiling of *Tegillarca granosa* (blood clam) sourced from Vashi Creek, Navi Mumbai, Maharashtra, India. *FishTech Reporter*. 9(1): 20-23. http://krishi.icar.gov.in/jspui/handle/123456789/83155

Dhiju Das, P. H., Manju Lekshmi, N. and Leela Edwin (2023) Report on High Juvenile Incidence in Beach Seine Operations off Kovalam, Kerala. *FishTech Reporter*. 9(1): 8-10. http://krishi.icar.gov.in/jspui/handle/123456789/83162

Dona Jaiju, Aniesrani Delfiya, D. S., Devananda Uchoi and Niladri S. Chatterjee (2023) Effect of infrared (IR) drying and electrical oven drying on antioxidant potential of brown seaweed. *FishTech Reporter*. 9(2): 21-23. http://krishi.icar.gov.in/jspui/handle/123456789/83075

Elavarasan, K. (2023) Agricultural Applications of Fish Amino Acids. *AgriTech Today*. 1(3):70-73. http://krishi.icar.gov.in/jspui/handle/123456789/83401

Elavarasan, K., Mohan, C. O. and Ravishankar, C. N. (2023) Fish paste: A viable option for Indian Seafood export industries. *Aqua International*. 30(9): 38-39. http://krishi.icar.gov.in/jspui/handle/123456789/83400

Gopika, R., Joshy, C. G., Sajeev, M. V., Akshay, P., Mohanty, A. K. and Suseela Mathew (2023) Distribution analysis of per capita fish consumption among the tribes of Wayanad. *FishTech Reporter.* 9(1): 40-42. http://krishi.icar.gov.in/jspui/handle/123456789/83160

Greeshma, S. S., Rehana Raj, Triveni Adiga, Ravi Prasad, Niladri, S. Chatterjee and Asha, K. K. (2023) Biochar from seaweed: A sustainable tool for ensuring the microbial water quality from the seafood industry. *FishTech Reporter.* 9(1): 33-34. http://krishi.icar.gov.in/jspui/handle/123456789/83158

Jesmi Debbarma, Viji, P. and Madhusudana Rao, B. (2023) Enzyme Assisted Peeling of Shrimp: A promising pre-processing intervention to minimize drudgery and maximize productivity in shrimp processing units. *FishTech Reporter*. 9(2): 10-13. http://krishi.icar.gov.in/jspui/handle/123456789/83094

Jeyakumari, A., Elavarasan, K. and Renuka, V. (2023) Quality Characteristics of Microwave and Sundried Chitosan: A comparative study. *FishTech Reporter.* 9(1): 15-16. http://krishi.icar.gov.in/jspui/handle/123456789/83164

Joshy, C. G., Binsi, P. K., Elavarasan, K., Zynudheen, A. A. and Bindu, J. (2023) Data Summarization of Import and Export Trade of Fishmeal in India. *FishTech Reporter.* 9(1): 38-39. http://krishi.icar.gov.in/jspui/handle/123456789/83169

Joshy, C. G., Shyla, N. C. and George Ninan (2023) A customized database on import and export trade of fish oil and fish meal in India. *FishTech Reporter*. 9(2): 44-46. http://krishi.icar.gov.in/jspui/handle/123456789/83035

Laly, S. J. (2023) Food allergens and its management as per international and national requirements. *23rd Indian International Seafood Show Souvenir*. pp. 80-89. http://krishi.icar.gov.in/jspui/handle/123456789/83345

Laly, S. J., Husna, K. A., Panda, S. K. and Zynudheen, A. A. (2023) Heavy metal content in dry fish sold in domestic markets of Navi Mumbai, Maharashtra. *FishTech Reporter.* 9(1): 24-26. http://krishi.icar.gov.in/jspui/handle/123456789/83165

Minimol, V. A. and Pankaj Kishore (2023) Molecular insights into DNA gyrase subunit A of an environmental El Tor variant of *V. cholerae* O1. *FishTech Reporter*. 9(2): 33-35. http://krishi.icar.gov.in/jspui/handle/123456789/83044

Murugadas, V., Vasudevan, R. N., Basha, K. A., Madhusudana Rao, B., Toms C. Joseph and Visnuvinayagam, S. (2023) Cephalosporin resistance: A predominant antimicrobial resistance found in E. coli isolated from Vembanad and Sasthamkotta Lake, Kerala. *FishTech Reporter.* 9(1): 30-32. http://krishi.icar.gov.in/jspui/handle/123456789/83167

Neethu, K. C., Aniesrani Delfiya, D. S. and Murali, S. (2023) An efficient smoking kiln for fisherfolks. *AgriTech Today*. 1(3): 19-20. http://krishi.icar.gov.in/jspui/handle/123456789/83863

Neethu, K. C., Hima, M. M., Aniesrani Delfiya, D. S. and Murali, S. (2023) Comparative analysis of drying properties of sole fish (*Cynoglossus malabaricus*) dried using open sun, solar-LPG and infrared dryer. *FishTech Reporter*. 9(2): 36-39. http://krishi.icar.gov.in/jspui/handle/123456789/83042

Pavan Kumar, A., Manjusha, L., Gireesh babu, Pankaj Kishore, Chaudhari, A., and Ravishankar, C. N. (2023) Ensuring trust and sustainability: Unveiling the journey of seafood from ocean to plate through labelling. *MPEDA Newsletter,* 11(4):17-20. http://krishi.icar.gov.in/jspui/handle/123456789/83411

Pe. Jeyya Jeyanthi, Sajesh, V. K. and Nikita Gopal (2023) Spatial and temporal variation of women labour in fish vending in Kerala. *FishTech Reporter.* 9(1): 43-45. http://krishi.icar.gov.in/jspui/handle/123456789/83170

Prajith, K. K., Mohammed Jabir, K. K., Madhu, V. R. and Remesan, M. P. (2023) Mass landing of swimming crab (*Charybdis smithii*) along the coastal waters of the Southwest coast of India and potential for utilization. *FishTech Reporter.* 9(2): 3-6. http://krishi.icar.gov.in/jspui/handle/123456789/83098

Priya, E. R., Nelbin Joseph, Laly, S. J., Panda, S. K. and Zynudheen, A. A. (2023) Phosphorus Level in Wild-Caught Shrimps of Kerala Coast. *FishTech Reporter.* 9(1): 27-29. http://krishi.icar.gov.in/jspui/handle/123456789/83166

Rasheeda, M., Remya, S., Mohan, C. O. and Bindu, J. (2023) Let's print "something fishy" by exploring the possibilities of 3D food printing. *MPEDA Newsletter*. 11(2): 26-28. http://krishi.icar.gov.in/jspui/handle/123456789/83404

Rehana Raj, Greeshma, S. S. and Asha, K. K (2023) Ready to cook marinated blood clam. *FishTech Reporter.* 9(1): 17-19. http://krishi.icar.gov.in/jspui/handle/123456789/83157

Rejula, K., Ashaletha, S., Suresh, A., Nikita Gopal, and Mohanty, A. K. (2023) Women fish vendors in Kerala, India: an analytical study of access to inputs and services. *Gender, Technology and Development*. 27(3):13. https://doi.org/10.1080/09718524.2023.2260656 http://krishi.icar.gov.in/jspui/handle/123456789/83196

Remya, S., Mohan, C. O. and Zynudheen, A. A. (2023) Biogenic amine content in fish feed prepared from Tilapia fish waste. *FishTech Reporter.* 9(2): 7-9. http://krishi.icar.gov.in/jspui/handle/123456789/83095

Sajeev, M. V. and Joshy, C. G. (2023) Exploring the strategic landscape of online fish markets in Ernakulam, Kerala. *FishTech Reporter*. 9(2): 40-43. http://krishi.icar.gov.in/jspui/handle/123456789/83039

Sajeev, M.V., Joshi, C. G., Jesmi Debbarma and Abhay Kumar (2023) Drivers and barriers to online purchase of fish and seafood: A conceptual model. *FishTech Reporter*. 9(1): 46-48. http://krishi.icar.gov.in/jspui/handle/123456789/83159

Sajesh, V. K., Suresh, A., Rejula and Pe. Jeyya Jeyanthi (2023) Access to and adoption of fisheries information by agricultural households. *Indian Farmer*. 10(4):145-148. IndFarmVol10Issue04_01.pdf (indianfarmer.net) http://krishi.icar.gov.in/jspui/handle/123456789/83343

Sandhya, K. M. and Saly N. Thomas (2023) Abandoned, lost or otherwise discarded fishing gears (ALDFG): Hidden killers in the sea. *AgroScience Today*. 4 (5): 590-593. http://krishi.icar.gov.in/jspui/handle/123456789/83319

Sarika, K., Ashish Kumar Jha, Ejaz R. Parmar and Sreejith, S. (2023) Extraction and characterization of ϕ-Chitin and Chitosan from Squid Pen. *FishTech Reporter*. 9(2): 18-20. http://krishi.icar.gov.in/jspui/handle/123456789/83076

Sharma, S. K., Manju Lekshmi, N. and Asha, K. K. (2023) Biodegradable Fishing Nets: A Sustainable Solution for the Oceans. *FishTech Reporter.* 9(1): 3-7. http://krishi.icar.gov.in/jspui/handle/123456789/83156

Siya K. Johnson, Renuka, V., Elavarasan, K. and Anandan, R. (2023) Extraction of astaxanthin from crustacean waste using supercritical fluid extraction. *The food tech times*. 9:13-14. http://krishi.icar.gov.in/jspui/handle/123456789/83700

Sujitha, A. P. and Renuka, V. (2023) Application of chitooligosaccharides conjugates. *The food tech times*. 9:19-21. http://krishi.icar.gov.in/jspui/handle/123456789/83706

Thankam Theresa Paul, Abhirami Sajeevan, Albin Albert, C., Deepa Sudheesan, Sandhya, K. M. and Das, B. K. (2023) Carbon Emissions from Kerala Reservoirs: An Estimation Study. *Bio. Res. Today*. 5(7): 540-542. http://krishi.icar.gov.in/jspui/handle/123456789/83193

Viji, P., Deepika, K., Sireesha, S., Jesmi Debbarma and Madhusudana Rao, B. (2023) Effects of microwave power on the biochemical quality of dark and white muscle of tuna during microwave vacuum heating. *FishTech Reporter.* 9(2): 14-17. http://krishi.icar.gov.in/jspui/handle/123456789/83085

Viji, P., Sireesha, S., Jesmi Debbarma and Madhusudana Rao, B. (2023) Pre-processing protocol for the drying of peeled and undeveined (PUD) *Penaeus vannamei. FishTech Reporter.* 9(1): 11-14. http://krishi.icar.gov.in/jspui/handle/123456789/83163

Visnuvinayagam, S., Murugadas, V. and Ezhil Nilavan, S. (2023) Climate Change: A Cause for Emergence and Re-Emergence of Seafood Pathogen with Altered Pathogenicity. *SSRN*: pp 16. https://ssrn.com/abstract=4561658 http://krishi.icar.gov.in/jspui/handle/123456789/83403

Visnuvinayagam, S., Murugadas, V. and Ezhil Nilavan, S. (2023) The emergence of Methicillin-resistant Staphylococcus aureus in seafood samples and possible control measures. *SSRN.* pp 16. https://ssrn.com/abstract=4534604 http://krishi.icar.gov.in/jspui/handle/123456789/83402

## TRAINING MANUAL

Aniesrani Delfiya, D. S., Murali, S. and Neethu, K. C. (eds.) (2023) Current trends in food processing technology. ICAR-Central Institute of Fisheries Technology, Kochi, India. pp 233. http://krishi.icar.gov.in/jspui/handle/123456789/83303

Bindu, J., Mohan, C.O., Remya, S., and Sathish Kumar, K. (eds.) (2023) Advanced food packaging techniques and quality evaluation of packaging materials. ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 117. http://krishi.icar.gov.in/jspui/handle/123456789/82853

Devananda Uchoi, Nadella, R. K., Pankaj Kishore, Niladri S. Chatterjee, Femeena Hassan and George Ninan (eds.) (2023) Laboratory Manual on Bacteria of Public Health Significance. Central Institute of Fisheries Technology, Cochin, India. pp 101. http://krishi.icar.gov.in/jspui/handle/123456789/83256

Devananda Uchoi, Pankaj Kishore, Nadella, R. K., Niladri S. Chatterjee, Priya, E. R., Laly S.J., Femeena Hassan, Minimol V.A., Paras Nath Jha, Remya, S., Jeyakumari A. and Shivendra Kumar (eds.) (2023) Treatise on Fisheries Harvest and Post-Harvest Technologies. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 401. http://krishi.icar.gov.in/jspui/handle/123456789/83191

George Ninan, Zynudheen, A. A., Nikita Gopal, Femeena Hassan, Niladri S. Chatterjee, Laly, S. J., Martin Xavier, K. A., Pankaj Kishore, Nadella, R. K., Devananda Uchoi, Priya, E. R. and Chandrasekar, V. (eds.) (2023) Quality Assurance of Fish and Fishery products. Central Institute of Fisheries Technology, Cochin, India. pp 165. http://krishi.icar.gov.in/jspui/handle/123456789/83885

Jesmi Debbarma, Viji, P. and Madhusudana Rao, B. (2023) Entrepreneurship development of Apatani tribes through hygienic fish drying and value addition programme. ICAR-Central Institute of Fisheries Technology (ICAR-CIFT), pp 40. http://krishi.icar.gov.in/jspui/handle/123456789/83316

Jeyakumari, A., Elavarasan, K., Joshy, C.G and Bindu, J. (eds.) (2023) Advances in Seafood Processing and waste utilization. ICAR-Central institute of Fisheries Technology, Kochi, India. pp 137. http://krishi.icar.gov.in/jspui/handle/123456789/82859

Manoj, P. Samuel, Murali, S., Alfiya, P. V., Aniesrani Delfiya, D. S., Menon, A. R. S. and Ragesh M. Raghavan (2023) Pre-processing and Drying of Fish (മത്സ്യ സംസ്കരണവും ഉണക്കലും). ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 48. (In Malayalam). http://krishi.icar.gov.in/jspui/handle/123456789/83329

Muhamed Ashraf, P., Manju Lekshmi, N., Sandhya, K. M., Gopika, R. and Anjana, C. S. (eds) (2023) Nanotechnological Applications in Fisheries. ICAR-Central Institute of Fisheries Technology, Cochin, India. pp108. http://krishi.icar.gov.in/jspui/handle/123456789/83382

Parvathy, U. and Bindu, J. (eds.) (2023) Hygienic Handling, Processing and Value Addition of Fish and Fishery Products. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 28. http://krishi.icar.gov.in/jspui/handle/123456789/82860

Parvathy, U., Sathish Kumar, K., Mohan, C.O., Rejula, K., Nikita Gopal and Bindu, J. (eds.) (2023) Technological Interventions in Processing, Value addition and Packaging of Aquatic Resources. ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 210. http://krishi.icar.gov.in/jspui/handle/123456789/82858

Priya, E. R., Devananda Uchoi, Nadella, R. K., Pankaj Kishore, Niladri S. Chatterjee, Laly, S. J., Femeena Hassan and George Ninan (eds.) (2023) Seafood Quality Assurance. Central Institute of Fisheries Technology, Cochin, India. pp 140. http://krishi.icar.gov.in/jspui/handle/123456789/79416

Priya, E. R., Devananda Uchoi, Nadella, R. K., Pankaj Kishore, Niladri S. Chatterjee, Laly, S. J., Zynudheen, A. A., Femeena Hassan and George Ninan (eds.) (2023) Analysis of Formaldehyde, Antibiotics and Pesticides in Fish and Fish Products. ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 105. http://krishi.icar.gov.in/jspui/handle/123456789/83428

Priya, E. R., Laly, S. J., Devananda Uchoi., Ranjith Kumar Nadella, Pankaj Kishore, Niladri S. Chatterjee, Rejula, K., Panda, S. K., Zynudheen, A. A., Femeena Hassan, Mohanty, A. K. and George Ninan (eds.) (2023) ISO 22000/HACCP for fish processing establishments. Central Institute of Fisheries Technology, Cochin, India. pp 168. http://krishi.icar.gov.in/jspui/handle/123456789/78411

Remya, S., Bindu, J., Mohan, C. O., and Sathish Kumar, K. (eds.) (2023) Basics of food packaging and testing of packaging materials. ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 117. http://krishi.icar.gov.in/jspui/handle/123456789/82855

Sandhya K. M., Manju Lekshmi N. (eds.) (2023) Advances in fishing gear materials. ICAR-Central Institute of Fisheries Technology, Cochin, India. pp 72. http://krishi.icar.gov.in/jspui/handle/123456789/83144

Sreelakshmi, K. R., Binsi, P. K., Jeyakumari, A., Renjith, R. K., Ezhil Nilavan, Anas, K. K., Neethu, K. C., Rejula, K., Pe. Jeyya Jeyanthi, Pankaj Kishore, Bindu, J. and Nikita Gopal (eds.) (2023) Training manual on In-plant training under student ready program. Central Institute of Fisheries Technology, Cochin, India. pp 473. http://krishi.icar.gov.in/jspui/handle/123456789/82854

Sreepriya Prakasan, Sreelakshmi, K. R., Parvathy, U., Mohan, C. O., Remya, S., and Bindu, J. (eds.) (2023) Preparation of enrobed and marinated fish and shell fish products. Central institute of Fisheries Technology, Cochin, India. pp 85. http://krishi.icar.gov.in/jspui/handle/123456789/82856

Toms C. Joseph, Murugadas, V., Minimol, V. A., Ezhil Nilavan, S., Muthulakshmi, T. and Anupama, T. K. (eds.) (2023) Advanced Microbiological and Molecular Techniques for Improving the Competence of Students in Biological Sciences (under SCSP). ICAR- Central Institute of Fisheries Technology, Cochin, India. pp 111. http://krishi.icar.gov.in/jspui/handle/123456789/83189

Viji, P., Madhusudana Rao, B. and Jesmi Debbarma (eds.) (2023) Entrepreneurship development through Hygienic handling and Value addition of Fish. ICAR-Central Institute of Fisheries Technology (ICAR-CIFT), pp 31. http://krishi.icar.gov.in/jspui/handle/123456789/83650

Viji, P., Madhusudana Rao, B., Jesmi Debbarma and Basha, K. A. (eds.) (2023) Quality Assurance of Fish and Fish Products. ICAR-Central Institute of Fisheries Technology (ICAR-CIFT), pp 103. http://krishi.icar.gov.in/jspui/handle/123456789/83466

## BROCHURES

Aniesrani Delfiya, D. S., Murali, S. Neethu, K. C., Babu, K. S. and Gopakumar, G. (2023) Hot-air assisted continuous infrared dryer. ICAR- Central Institute of Fisheries Technology, Cochin, India. http://krishi.icar.gov.in/jspui/handle/123456789/83307

Aniesrani Delfiya, D. S., Murali, S. Neethu, K. C., Babu, K. S. and Gopakumar, G. (2023) Hot-air assisted continuous infrared dryer. ICAR- Central Institute of Fisheries

Technology, Cochin, India. (Hindi) http://krishi.icar.gov.in/jspui/handle/123456789/83308

Aniesrani Delfiya, D. S., Murali, S. Neethu, K. C., Babu, K. S. and Gopakumar, G. (2023) Hot-air assisted continuous infrared dryer. ICAR- Central Institute of Fisheries Technology, Cochin, India. (Malayalam) http://krishi.icar.gov.in/jspui/handle/123456789/83309

Elavarasan, K. (2023) Benefits of Fish as Food. ICAR- Central Institute of Fisheries Technology, Cochin, India. (Tamil) http://krishi.icar.gov.in/jspui/handle/123456789/83721

Greeshma, S. S, Rehana Raj and Asha, K. K. (2023) ISO methods for Identification of Bacterial pathogens in Seafood. ICAR-CIFT. http://krishi.icar.gov.in/jspui/handle/123456789/83691

Greeshma, S. S, Rehana Raj, Zynudheen, A. and Asha, K. K. (2023) Total Plate Count (TPC): ISO Method 4833. ICAR-CIFT. http://krishi.icar.gov.in/jspui/handle/123456789/83703

Greeshma, S. S, Rehana Raj, Zynudheen, A. and Asha, K. K. (2023) Enumeration of ϕ-glucuronidase positive Escherichia coli by colony count method: ISO 16649-2. ICAR-CIFT. http://krishi.icar.gov.in/jspui/handle/123456789/83692

Greeshma, S. S, Rehana Raj, Zynudheen, A. and Asha, K. K. (2023) Enumeration of coagulase positive Staphylococcus aureus using Baird-Parker medium: ISO 6888-1. ICAR-CIFT. http://krishi.icar.gov.in/jspui/handle/123456789/83693

Greeshma, S. S, Rehana Raj, Zynudheen, A. and Asha, K. K. (2023) Isolation and detection of Salmonella: ISO 6579. ICAR-CIFT. http://krishi.icar.gov.in/jspui/handle/123456789/83704

Greeshma, S. S, Rehana Raj, Zynudheen, A. and Asha, K. K. (2023) Isolation and detection of Vibrio sp. As per ISO 21872. ICAR-CIFT. http://krishi.icar.gov.in/jspui/handle/123456789/83694

Greeshma, S. S, Rehana Raj, Zynudheen, A. and Asha, K. K. (2023) Enumeration of Listeria monocytogens and other Listeria sp. as per ISO 11290. ICAR-CIFT. http://krishi.icar.gov.in/jspui/handle/123456789/83705

Greeshma, S. S, Rehana Raj, Zynudheen, A. and Asha, K. K. (2023) Enumeration of yeasts & moulds: ISO 21527 Colony count technique. ICAR-CIFT. http://krishi.icar.gov.in/jspui/handle/123456789/83701

Greeshma, S. S, Rehana Raj, Zynudheen, A. and Asha, K. K. (2023) Key tests to discriminate different bacterial spp. & strains. ICAR-CIFT. http://krishi.icar.gov.in/jspui/handle/123456789/83702

Joshy, C. G., Shyla, N. C., Rakhi, K. R. and George Ninan (2023) ICT APPLICATIONS @ ICAR-CIFT. http://krishi.icar.gov.in/jspui/handle/123456789/83192

Murali, S., Neethu, K. C. and Aniesrani Delfiya, D. S. (2023) CIFT's Engineering technologies - A glance. ICAR- Central Institute of Fisheries Technology, Cochin, India. http://krishi.icar.gov.in/jspui/handle/123456789/83304

Murali, S., Neethu, K. C. and Aniesrani Delfiya, D. S. (2023) CIFT's Engineering technologies - A glance. ICAR- Central Institute of Fisheries Technology, Cochin, India. (Hindi) http://krishi.icar.gov.in/jspui/handle/123456789/83305

Murali, S., Neethu, K. C. and Aniesrani Delfiya, D. S. (2023) CIFT's Engineering technologies - A glance. ICAR- Central Institute of Fisheries Technology, Cochin, India. (Malayalam) http://krishi.icar.gov.in/jspui/handle/123456789/83306

Murali, S., Neethu, K. C. and Aniesrani Delfiya, D. S. (2023) Green, Clean and affordable dryers for fish processing and value addition. ICAR- Central Institute of Fisheries Technology, Cochin, India. http://krishi.icar.gov.in/jspui/handle/123456789/83883

Murali, S., Neethu, K. C. and Aniesrani Delfiya, D. S. (2023) Green, Clean and affordable dryers for fish processing and value addition. ICAR- Central Institute of Fisheries Technology, Cochin, India. (Hindi). http://krishi.icar.gov.in/jspui/handle/123456789/83881

Murali, S., Neethu, K. C. and Aniesrani Delfiya, D. S. (2023) Green, Clean and affordable dryers for fish processing and value addition. ICAR- Central Institute of Fisheries Technology, Cochin, India. (Malayalam). http://krishi.icar.gov.in/jspui/handle/123456789/83882

Rehana Raj, Greeshma, S. S., Abhay Kumar, Sharma, S. K. and Asha, K. K. (2023) Ready to cook coated Nobashi. ICAR- Central Institute of Fisheries Technology, Cochin, India. http://krishi.icar.gov.in/jspui/handle/123456789/83344

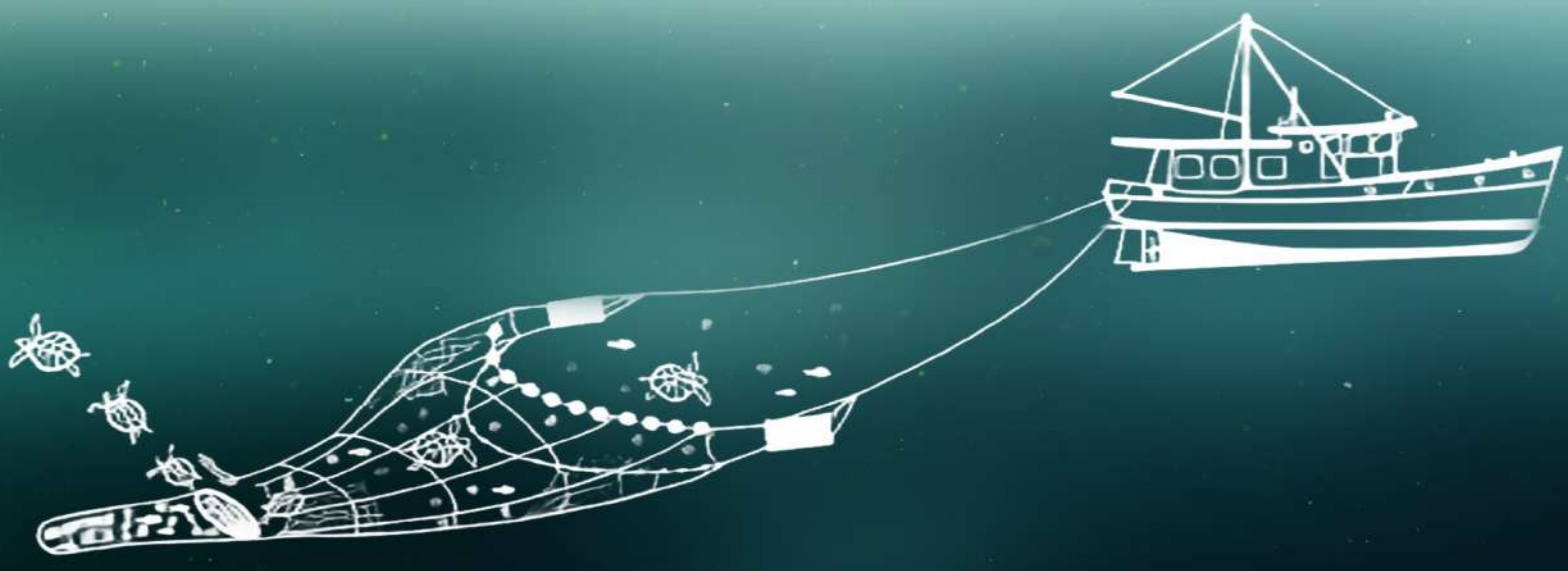
Sarika, K., Sreejith, S. and Ashish Kumar Jha (2023) Squid Pen: An untapped Marine resource. ICAR-CIFT. http://krishi.icar.gov.in/jspui/handle/123456789/83096

Sarika, K., Sreejith, S. and Ashish Kumar Jha (2023) Squid Pen: An untapped Marine resource. ICAR-CIFT. (Hindi) http://krishi.icar.gov.in/jspui/handle/123456789/83097

Sarika, K., Sreejith, S. and Ashish Kumar Jha (2023) Squid Pen: An untapped Marine resource. ICAR-CIFT. (Gujarati) http://krishi.icar.gov.in/jspui/handle/123456789/83346

Viji P., Jesmi Debbarma, Madhusudana Rao, B. (2023) Fish Pickle (Chepa Uragayi). ICAR-CIFT. (Telugu) http://krishi.icar.gov.in/jspui/handle/123456789/78800

Viji P., Jesmi Debbarma, Madhusudana Rao, B. (2023) Fish Wafers (Chepa odiyalu). ICAR-CIFT. (Telugu) http://krishi.icar.gov.in/jspui/handle/123456789/78801



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