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FAO Reference Centre

Annual report-2024

Title of FAO Reference Centre: FAO Reference Centre for Antimicrobial Resistance (AMR) & Aquaculture Biosecurity (AB)

Name of the institution: Nitte University

Country: India

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Activities related to Supporting raising awareness about AMR

1. Scientific Session on “Preventive Healthcare in Aquaculture – Significance and Strategies”



Dr. Iddya Karunasagar chaired a scientific session on “Preventive Healthcare in Aquaculture – Significance and Strategies” organized by the Kerala University of Fisheries and Ocean Sciences (KUFOS), Kochi, 12–14 January 2024. The session brought together eminent speakers from Indonesia, Germany, and India, fostering international knowledge exchange on disease prevention, biosecurity, and sustainable aquaculture practices. Key outcomes included strengthened global collaborations, identification of strategic approaches to reduce disease outbreaks through preventive healthcare measures, and enhanced awareness on improving productivity and sustainability in aquaculture systems. The deliberations contributed to promoting science-based health management practices for resilient and responsible aquaculture development.

2. International Conference on “Environmental Mutagenesis – Impact on Biodiversity and Human Health”



Dr. Iddya Karunasagar delivered an talk on “Antimicrobial Resistance in the Aquatic Environment” at the International Conference on “Environmental Mutagenesis – Impact on

Biodiversity and Human Health”, held at the Central University of Kerala, Kasaragod, 31 January 2024,. The presentation highlighted the growing impact of antimicrobial resistance (AMR) on aquatic ecosystems, biodiversity, and public health, emphasizing the need for integrated mitigation strategies. The event facilitated meaningful scientific exchange with experts from Malaysia, Singapore, the United Kingdom, and Germany, strengthening international academic collaboration.

3. National Technology Day 2024: Agri-Food Technology Exposition and Panel Discussion



The centre, in association with an ICAR–Directorate of Cashew Research, organized a National Technology Day Agri-Food Technology Exposition and Panel Discussion, on 11 May 2024. Dr. Dinakara Adiga, Director, ICAR-DCR, was the Chief Guest, and Prof. M.S. Moodithaya, Vice Chancellor, Nitte (DU), presided over the event. The program highlighted the importance of stakeholder collaboration, entrepreneurship, market potential of regional cash crops, and technology-driven development in strengthening the agri-food sector for participants from agri-food entrepreneurs, industry members, scientists, faculty, and students.

4. World Food Safety Day–2024 Outreach Programme



The center, in association with the Department of Public Health, KSHEMA, Nitte (DU), organized a World Food Safety Day outreach programme at St. Aloysius College Higher Primary School, Mangaluru On 7 June 2024. The event engaged around 370 students (Grades 5–7) and 25 teachers through educational sessions and an interactive quiz

competition. Speakers highlighted the significance of food safety and the global importance of World Food Safety Day in preventing and managing foodborne risks. The quiz, comprising multiple thematic rounds on food hygiene, nutrition, and food processing, encouraged active student participation and teamwork, with prizes awarded to the top teams. The programme effectively promoted awareness of safe and nutritious food practices among school students.

5. Interactive session related to World Food Day–2024 Theme: Right to Food for a Better Life and a Better Future.



The Center celebrated World Food Day–2024 on 16 October 2024 at NUCSER, based on the theme “Right to Food for a Better Life and a Better Future.” Dr. Vinod Kumar M.G., Radboud University Medical Centre, The Netherlands, was the Chief Guest. Dr. Iddya Karunasagar delivered a lecture on “One Health for Better Food, Better Life and Better Future,” highlighting global food security challenges, FAO initiatives, and the importance of adhering to international standards such as Codex, WOH, and SPS/TBT agreements. Dr. Indrani Karunasagar spoke on “Right to Quality Food and Water,” addressing food safety hazards and the need for strict regulatory compliance. The event, attended by around 120 faculty members and students, promoted awareness on food safety, nutrition, and sustainable food systems.

6. Highlighting Phage Research - convener of Phage session at VIROCON 2024



Dr Indrani Karunasagar, Vice President (Veterinary and Aquatic Virology) and executive committee member, Indian Virological Society convened a session on phage research at VIROCON-2024 held at Defense Research and Development Organization, Gwalior during 11-13, November 2024. She chaired the session and also delivered a keynote address on “Application of phages in food and water safety in One Health context”. The session included invited speakers from clinical, veterinary, aquatic and environmental sectors.

7. Keynote Lectures at Global Conference on Infection Prevention, Control and Antimicrobial Stewardship (G-SPARC 2024)



The Infection Control Academy of India (IFCAI), in association with Pragyaan Sustainable Health Outcomes Foundation (PRASHO), organized the Global Conference on Infection Prevention, Control and Antimicrobial Stewardship (G-SPARC 2024) at Hyderabad from 3–5 October 2024. Dr. Iddya Karunasagar and Dr. Indrani Karunasagar were invited as lead speakers and session moderators. Dr. Iddya Karunasagar delivered a lecture on “Antimicrobial Resistance, One Health and Assessment of Food Safety Risk,” while Dr. Indrani Karunasagar spoke on “Antimicrobial Resistance and One Health: Implications and Mitigation Strategies in Aquaculture.” The conference was attended by over 1000 scientists, professionals, and students from medical, veterinary, and environmental sectors, fostering interdisciplinary dialogue on AMR and One Health approaches.

8. One Health Webinar on “Foodborne Disease Surveillance”



Dr Iddya Karunasagar was guest speaker at the One Health Webinar organized jointly by the Indian Council of Medical Research (ICMR) and the Centers for Disease Control (CDC), USA on Foodborne Disease surveillance on 27 November 2024. Dr Carmen Savelli from World Health Organization and Dr Heather Carleton from CDC were the other speakers. Dr Iddya Karunasagar highlighted the resources available from FAO/WHO on foodborne disease surveillance including the use of whole genome sequences of pathogens.

Support towards developing capacity for surveillance of AMR, AMU and residues

1. Expert lecture on “Startup and funding ecosystem in Agri-food sector”



The Center, along with the Institution Innovation Council, organized an expert lecture on “Startup and Funding Ecosystem in the Agri-Food Sector” on 6 February 2024 at the University Auditorium, Paneer Campus. Mr Arvind Modi, Partner at Sathguru Catalysers, shared insights on grants, equity, debt, venture capital, angel investors, startup funding, and practical tips for founders on execution, cost management, and team building. The session concluded with a Q&A and vote of thanks by Dr Praveen Kumar Shetty.

2. 13th Indian Fisheries and Aquaculture Forum (IFAF)



Dr. Iddya Karunasagar served as Chair of the session “Frontiers in Fish Health Management” at the 13th Indian Fisheries and Aquaculture Forum (IFAF), held from 23–25 February 2024 at the Biswa Bangla Convention Center, Kolkata. He also participated as a Panelist in the “13th IFAF Student Interface Meet,” where he shared insights on technology development and startup opportunities in the aquaculture and fisheries sector. His deliberations emphasized the importance of skill development, innovation, and entrepreneurship promotion within Fisheries Universities. The engagement contributed to strengthening industry–academia collaboration and fostering a robust innovation ecosystem in fisheries and aquaculture.

3. Key Elements for the Success of the Food Industry: Regulatory, Technological, and Funding Ecosystem



The Centre in association with KCCI, organized a session on “Key Elements for the Success of the Food Industry Regulatory, Technological and Funding Ecosystem” on 28 February 2024.. The event brought together entrepreneurs, start-ups, students, investors, and industry

stakeholders. Dr. Sanu Jacob, Director, FSSAI, highlighted regulatory compliance, digital licensing systems, and food safety responsibilities under the Food Safety and Standards Act. Dr. K. Narayanan discussed technological advancement, mechanization, and venture capital opportunities in the food sector. The session concluded with a panel discussion moderated by Dr. Iddya Karunasagar, strengthening collaboration among regulators, academia, and industry to support a robust food industry ecosystem.

4. Invited Lecture at Symposium on “Food Safety and Health”



Dr. Iddya Karunasagar delivered an invited lecture at the Symposium on “Food Safety and Health,” organized by the Department of Food Technology, Royal Global University, Guwahati, Assam, on 16 September 2024. He addressed international food safety regulations and standards developed by the Codex Alimentarius Commission, the joint FAO/WHO standard-setting body, and explained the relevance of the WTO Sanitary and Phytosanitary (SPS) Agreement. He highlighted the scientific basis of standard development through risk assessments conducted by JEMRA and elaborated on the risk analysis framework encompassing risk assessment, risk management, and risk communication. The symposium also featured a lecture by Dr. Sabu Thomas on microbiome research and health, and was coordinated by Dr. Pranita Das, Head of the Department of Food Technology.

5. Regional Workshop on Antimicrobial Use and Antimicrobial Resistance in Aquaculture (Asia–Pacific)



Dr. Iddya Karunasagar was invited by WOAHP to deliver three lectures at the Regional Workshop on AMU/AMR in Aquaculture for the Asia–Pacific region, held from 30 October–1

November 2024 in Singapore and hosted by NParks. He spoke on antimicrobial stewardship, AMU/AMR in the shrimp industry, and alternatives to antibiotics in aquaculture. The workshop was attended by around 50 experts from Asia–Pacific countries and WOH offices, strengthening regional efforts to combat AMR in aquaculture.

6. International Workshop on “Utilising Microbiome and Genomic Resources to Mitigate Antimicrobial Resistance in Aquaculture in One Health Context”



FAO Reference Centre Nitte commemorated antibiotic awareness week by hosting an International hands-on workshop on "Utilising microbiome and genomic resources for understanding and mitigating antimicrobial resistance in aquaculture in One Health context," in accordance with the FAO Reference Centre's terms of reference on 18-22 Nov 2024. The workshop was organized in collaboration with the Indian Council of Agricultural Research, New Delhi, supported by UNESCO, Centre for Environment, Fisheries and Aquaculture Sciences, UK, National Fisheries Development Board (NFDB) and Marine Products Export Development Authority (MPEDA). Dr M.S. Moodithaya, the Vice Chancellor, Nitte DU presided the inaugural function. Dr J.K. Jena, Deputy Director General, ICAR was the Chief Guest and Dr Eduardo Leano, Director General of the Network of Aquaculture Centers in Asia Pacific (NACA) based in Thailand was the Guest of Honour. Other Guests of Honour included Dr. Karthikeyan, Director, MPEDA and Dr. Robin Paul, FAO India. FAO Headquarters in Rome was represented by Dr Melba Reantaso and FAO Reference Center in UK was represented by Dr Athina Papadopoulou and the US Reference Center was represented by Dr Hossam Abdelhamed from Mississippi State University, USA. The Workshop included resource persons from Italy, Norway, Philippines, and Sweden. Delegates from Bangladesh, Cambodia, Ethiopia, Nepal, Malaysia, Saudi Arabia, Sri Lanka, Tanzania, Thailand, Uzbekistan, Zambia and India attended this workshop.



After inauguration, Day-1 had lectures from FAO, WHO, ICAR, National One Health Institute, MPEDA, FAO Reference Centers in UK and US and country presentations to share experiences in mitigation of AMR. The Day-2 of the workshop included lectures from various resource persons on adopting standardized methods for antimicrobial susceptibility testing and wet lab experiments on antimicrobial susceptibility testing. Prof. Dr Iddya Karunasagar presented on issues in phenotypic testing for AMR, Dr Athina Papadopoulou, CEFAS gave a lecture on generating data for epidemiological cut-off points. The talk on phenotypic testing for AMR in aquaculture associated bacteria in the EU was delivered by Dr Manfrin Amedeo. Dr Luana Cortinavis, IZSve presented on quality control in AMR testing laboratory and instructions on practical phenotypic testing for AMR. Mechanisms of AMR in aquatic bacteria in the USA was dealt by Dr Hossam Abdelhamed, MSU. Dr Gaurav Rathore, ICAR-NBFGR presented on Indian network for fisheries and animal antibiotic resistance via virtual mode. Dr Gunnar Kahlmeter, EUCAST Development Laboratory explained about MIC distributions and ECOFFs and their correlation between "wild-type organisms" as determined with phenotypic and genotypic methods via online presentation. Laboratory sessions were mentored by Dr Luana Cortinavis, Dr Amadeo Manfrin, Dr Athina Papadopoulou, Dr Deekshit, Dr Biswajit Maiti, Dr Praveen Rai, Dr Juliet Mohanraj (Nitte DU).





The Day-3 of the workshop included lecture series related to sequencing and bioinformatics sessions with the aim of training participants of different countries about the implementation of standardized methods for detecting antimicrobial resistance and to promote prudent and responsible use of antimicrobials in One Health. Lecture on introduction to Next Generation Sequencing (NGS) and sequence analysis was handled by Dr Praveen Rai and Dr Prithvisagar KS, Nitte DU. Dr Deekshit, Nitte DU explained about the sample preparation required prior to sequencing. Ms Divya Shetty, Zelle Biotechnology Pvt Ltd gave an overview of Oxford Nanopore Sequencing Technology followed by demonstration of Oxford nanopore Library Preparation, sequencing, and sequence retrieval post run. The Day-4 and Day-5 of the workshops focused on Bioinformatics sessions which were handled by Dr Krishna Kumar B, Dr Prithvisagar KS, Dr Deekshit, Dr Praveen Rai Nitte DU, and Mr Ashwin, Biokart India Pvt Ltd. Hands on session included microbial whole genome sequence analysis, microbiome analysis including raw data QC, trimming & quality filter, assembly of the raw reads, annotations and AMR, virulence and mobile genetic element identification and analysis.



The participants also had a chance of visiting various research facilities available at NUCSER. The Mentimeter quiz sessions were conducted in between the sessions to assess the knowledge gain on topics covered in the workshop. The Workshop was a huge success with active participation of 48 faculties from 22 different Countries.



2. Externally funded research projects

A. Development and standardization of monoclonal antibody based immunochromatographic (lateral flow) technology for the rapid detection of enteric viruses (Norovirus and Hepatitis A) from aquatic food: Protecting food chain and public health. (PI: Dr Krishna Kumar B)

This project aims to develop and standardize sensitive monoclonal antibody-based lateral flow assays for rapid detection of Norovirus and Hepatitis A in food samples. The user friendly, field deployable technology facilitates early identification of viral contamination, supports routine food safety monitoring, reduces outbreak risks, and strengthens public health protection across the food supply chain.

B. CEFAS - Contract for services of whole genome sequencing of *Streptococcus agalactiae* serotypes in Indian aquatic systems, under the Ocean Country Partnership Programme (OCPP). (PI: Dr Akhila D S)

This project involves whole genome sequencing and molecular characterization of *Streptococcus agalactiae* serotypes from Indian aquatic systems under the Ocean

Country Partnership Programme (OCP). It aims to generate genomic data to understand strain diversity, virulence factors, antimicrobial resistance profiles, and transmission pathways. The findings will strengthen epidemiological surveillance, support evidence-based disease management strategies, and enhance aquatic animal health and biosecurity.

C. Investigating the role of Low calcium response H (LCRH) in secretion of *Vibrio parahaemolyticus* Type III Secretion System (T3SS) proteins (PI: Dr Krishna Kumar B)

Focusing on the molecular mechanisms of virulence, this study investigates the role of Low Calcium Response H (LCRH) in the secretion of Type III Secretion System (T3SS) proteins in *Vibrio parahaemolyticus*. It seeks to clarify how LCRH regulates T3SS expression and protein export, providing insights into pathogenicity and supporting the development of targeted control strategies.

D. Enhancing the lytic activity of *Bdellovibrio* by optimizing the media conditions (PI: Dr Divyashree M)

Targeting improved biological control strategies, this study seeks to enhance the lytic performance of *Bdellovibrio* by optimizing culture media and growth conditions. It examines the effects of nutrient composition, pH, temperature, and incubation parameters on predatory activity, with the aim of maximizing antibacterial efficacy and supporting sustainable alternatives to antibiotics in aquaculture and environmental systems.

3. Advisory support to Student Research Projects

A. *Streptococcus agalactiae* infections in tilapia: Isolation and characterization of *Streptococcus agalactiae* phages (International visiting student from Ghent University)

This study addresses *Streptococcus agalactiae* infections in tilapia through the isolation and comprehensive characterization of bacteriophages specific to the pathogen. It evaluates phage diversity, host specificity, lytic activity, stability, and therapeutic potential under laboratory conditions. The research aims to develop phage-based biocontrol strategies as sustainable alternatives to antibiotics, thereby reducing antimicrobial resistance risks and improving health management practices in aquaculture systems.

B. Cloning and sequencing of bacteriocin mersacidin from *Bacillus subtilis*

This study focuses on the cloning and sequencing of the bacteriocin mersacidin from *Bacillus subtilis*. It aims to characterize the genetic determinants responsible for its

production and assess its antimicrobial potential. The work supports the development of novel antimicrobial agents as alternatives to conventional antibiotics for controlling resistant bacterial pathogens.

C. Immune response evaluation of outer membrane protein-based vaccine against *Edwardsiella tarda* in zebrafish

This study evaluates the immune response elicited by an outer membrane protein-based vaccine against *Edwardsiella tarda* in zebrafish. It assesses humoral and cellular immune parameters, protective efficacy, and survival following challenges. The findings aim to support the development of effective vaccination strategies for controlling edwardsiellosis in aquaculture.

D. Detection of Salmonella from unprocessed foods and poultry farms using conventional Polymerase chain reaction

This study focuses on the detection of *Salmonella* in unprocessed food samples and poultry farm environments using conventional Polymerase Chain Reaction (PCR). It involves sample collection, bacterial isolation, DNA extraction, and amplification of specific target genes for accurate identification. The approach enhances sensitivity and specificity compared to traditional culture methods, enabling rapid confirmation of contamination. The findings contribute to improved surveillance, early outbreak detection, and strengthened biosecurity and food safety measures in the poultry production chain.

E. Assessing the Biodegradability of polymers by microbes in Marine mesocosm

This study evaluates the biodegradability of polymers by marine microbes using controlled mesocosm systems that simulate natural marine environments. It examines microbial colonization, biofilm formation, polymer degradation rates, and changes in physicochemical properties over time. The research aims to understand microbial-driven breakdown pathways and environmental factors influencing degradation, contributing to sustainable material design and mitigation of marine plastic pollution.

F. Cloning and sequencing of subtilisin bacteriocin from *Bacillus subtilis*

This study focuses on the cloning and sequencing of the subtilisin bacteriocin gene from *Bacillus subtilis*. It aims to identify and characterize the genetic elements involved in its biosynthesis, regulation, and antimicrobial activity. Molecular analysis will confirm gene integrity and sequence variations, while comparative studies will assess its potential against pathogenic bacteria. The findings support the development of novel, naturally derived antimicrobial agents as alternatives to conventional antibiotics.

G. Detection of *Salmonella typhi* from unprocessed foods and poultry samples using polymerase spiral reaction assay

This study focuses on the detection of *Salmonella typhi* in unprocessed food items and poultry samples using the Polymerase Spiral Reaction (PSR) assay. The method involves rapid DNA amplification under isothermal conditions, enabling sensitive and specific identification of the pathogen without sophisticated equipment. The approach aims to provide a quick, cost-effective diagnostic tool for routine surveillance, early contamination detection, and improved food safety management in poultry production systems.

H. Investigating the antioxidant activity of bioactive compounds from the selected Brown algae

This study investigates the antioxidant potential of bioactive compounds extracted from selected brown algae. It involves solvent extraction, phytochemical profiling, and evaluation of antioxidant activity using established in vitro assays such as DPPH, ABTS, and FRAP. The research aims to identify potent natural antioxidants, understand their functional properties, and explore their potential applications in nutraceutical, pharmaceutical, and food industries.

3. Supported internship trainings programs undertaken by post graduate students

1. Bacteriophage Based Biocontrol Agent For The Management Of *Aeromonas Hydrophila* Infections In Ornamental Fish

The training was undertaken at Aquatic Biosystems , Mangalore and Mangalore Biotech Laboratory, Mangalore. The training mainly focused on Four bacteriophages (P11, P21, P31, and P43) against *Aeromonas hydrophila* were isolated as potential alternatives to antibiotics in aquaculture. Training was also gained in host range analysis and lytic activity assessment. Exposure was obtained to MOI optimization, stability studies, and genomic and morphological characterization.

2. Metagenomics analysis using Bioinformatic tools

Hands-on training at Biokart India Pvt.Ltd. Bengaluru on the use of various Bioinformatic tools such as Galaxy Server , Illumina sequence Data , FASTQ , Kraken2 , BIOM-format , MEGAHIT for the Metagenomic Analysis.

Support strengthening governance related to AMR/AMU and aquaculture biosecurity

1. National Seminar on Seafood Safety and International Trade



Dr. Iddya Karunasagar delivered an invited talk on “Seafood Safety and International Trade A Regulatory Perspective” at the DBT-sponsored National Seminar on Seafood Safety On 04 January 2024 . The presentation provided comprehensive insights into regulatory frameworks, compliance requirements, and international standards governing seafood trade. The session enhanced awareness on food safety and quality assurance among stakeholders from ICAR institutes, universities, and the fish processing industry. It also strengthened linkages between research institutions and the seafood sector, contributing to improved export readiness and national capacity building in seafood safety management.

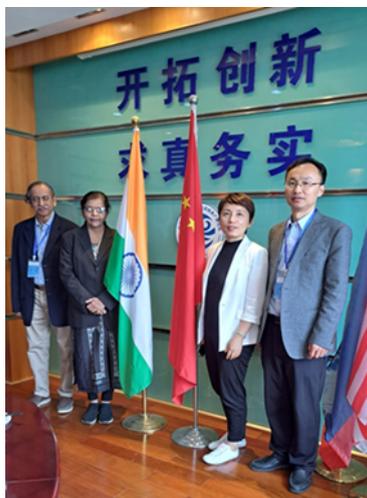
2. International Scientific Advisory Board Meeting on Food Safety Risk Assessment



Dr. Iddya Karunasagar was invited by the Government of the Kingdom of Saudi Arabia to serve as a Member of the International Scientific Advisory Board on Food Safety Risk Assessment. He attended the Advisory Board meeting held from 13–15 February in Riyadh, Saudi Arabia, where he provided expert inputs on food safety risk assessment processes undertaken by Joint FAO/WHO bodies and the application of scientific advice by the Codex Alimentarius Commission. On this occasion, he delivered two invited talks: (a) “Food Safety Considerations in Aquaculture Products” and (b) “Antimicrobial Resistance in Aquaculture.”

His participation strengthened international collaboration in food safety governance and contributed to evidence-based risk assessment and standard setting initiatives.

3. Global Reference Centre Meeting on Progressive Management Pathway for Aquaculture Biosecurity



Dr. Iddya Karunasagar and Dr. Indrani Karunasagar participated in the Global Reference Centre Meeting on the Progressive Management Pathway (PMP) for Aquaculture Biosecurity – Updates and Roll-out Monitoring, held at Qingdao, China From 13–15 May 2024. The meeting was jointly organized by FAO and the Chinese Academy of Fisheries Sciences and chaired by Dr. J.K. Jena, Deputy Director General, ICAR. The deliberations focused on strengthening aquaculture biosecurity frameworks, monitoring implementation strategies, and enhancing international collaboration for effective disease prevention and sustainable aquaculture development.

4. Strategy Development Workshop on Strengthening Seafood Import Control and Inspection Systems in Indonesia



Dr. Iddya Karunasagar was invited by the Trade Facilitation Office, Canada, to support the project “Enhancing Risk Management of Seafood Import Control and Inspection System of Indonesia” at a Strategy Development Workshop held from 5–7 August 2024. He provided expert inputs on international best practices in import control risk assessment and highlighted relevant guidelines from the World Organization for Animal Health (WOAH), Codex Alimentarius Commission, and Joint FAO/WHO standards. Based on earlier advisory inputs, the Ministry of Fisheries had introduced new regulations to strengthen risk management protocols. During the workshop, Indonesian quarantine officials shared lessons learned from the project, international study tours, and audit visits. Dr. Karunasagar further advised on strategic actions required to enhance and sustain improvements in Indonesia’s seafood import control system.

5. WHO Expert Group Consultation on Risk-Benefit Analysis of Food Substitutes



Dr. Iddya Karunasagar was nominated by the World Health Organisation (WHO) to be an expert committee member of Risk Benefit Assessment Group (RBAG) working on optimal intake of animal – source foods. The Expert committee meeting was held in Porto, Portugal during 11-15 November, 2024. The RBAG discussed microbiological and chemical hazards associated with various foods and considerations for the possibility of replacement of red meat with other healthier foods.

Promote good aquaculture practices and prudent use of antimicrobials

1. Expert Consultation on Risk Profiling of *Vibrio parahaemolyticus*



Dr. Indrani Karunasagar and Dr. Iddya Karunasagar participated in an FAO Zoom consultation meeting on 22 January 2024, contributing expert inputs toward the development of a risk profile for *Vibrio parahaemolyticus*. Their deliberations supported the formation and guidance of an international expert team for risk assessment and strengthened collaboration with FAO on global seafood safety and risk analysis initiatives. The engagement advanced evidence-based risk management strategies and reinforced international efforts to enhance seafood safety standards.

2. Presentation on AMU/AMR Surveillance



Dr. Iddya Karunasagar and Dr. Indrani Karunasagar presented the work on AMU/AMR surveillance and related activities undertaken by the FAO Reference Centre on AMR and Aquatic Biosecurity at Nitte University during the Meeting of FAO Reference Centres held at Qingdao, China from May 16–18 2024. The presentation highlighted surveillance initiatives, research progress, and collaborative efforts aimed at strengthening antimicrobial resistance monitoring and promoting responsible antimicrobial use in aquaculture at the global level.

3. Participation in WOAHA Global Expert Group Meeting on Antimicrobial Use Guidelines in Aquaculture



Dr. Indrani Karunasagar was nominated to the Global Expert Electronic Group for the development of guidelines on antimicrobial use in aquaculture in March 2023. She participated in the physical meeting of the expert group held at the World Organization for Animal Health (WOAH), Paris, from June 11–14 2024, where the draft guidelines were discussed in detail by international experts. Her contribution supported the development of science-based global guidelines to promote responsible antimicrobial use and mitigate antimicrobial resistance in aquaculture.

4. Fish-Vet + Dialogue II: One Health, Biosecurity, and Aquatic Organism Health



Dr. Iddya Karunasagar and Dr. Indrani Karunasagar were invited to participate in the FAO Expert Meeting on “Fish-Vet + Dialogue II: One Health and Biosecurity” and the International Conference on “Aquatic Organism Health – To Vaccinate or Not to Vaccinate,” held at FAO Headquarters, Rome, Italy, from June 18–20 2024. Dr. Iddya Karunasagar delivered a talk on “Foodborne AMR – Optimizing Genomic Resources for Mitigation of AMR,” while Dr. Indrani Karunasagar moderated Session 1 on One Health, AMR, zoonosis, fish safety, and fish welfare, and delivered a presentation on “Oral Nano-vaccines: Emerging Technology against *Aeromonas* Infection.” The meetings were attended by representatives of the Government of India, including Dr. J.K. Jena, Deputy Director General, ICAR, and technical officers from the Ministry of Fisheries. Their participation

strengthened international collaboration in aquatic animal health, biosecurity, and AMR mitigation under the One Health framework.

List of Publications

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List of Patents Published

1. Unique primers for the detection of Tilapia Lake Virus using reverse transcriptase polymerase spiral reaction(Indian Patent No.:202441001346)
2. Unique primer sequences for the detection of Shigella spp by loop mediated isothermal amplification (Indian Patent No.:202441001756)
3. Formulation of outer membrane protein nanovaccine medicated feed for oral vaccination in zebrafish(Indian Patent No.:202441027575)
4. Novel primers and guide RNA sequence for the detection of *Enterocytozoon hepatopenaei* (EHP) by Recombinance Polymerase amplification (RPA) -CRISPR-Cas12a based fluorescent assay(Indian Patent No.:202441097384)