Innovations in Microbial Energy Production and Next-Gen Fuels

Dr. A. Ganesh Kumar[1], Dr. G . Dharani[2] , Prof. R Balaji[3]

[1]*Scientist E, Marine Biotechnology Division, National Institute of Ocean Technology, Chennai - 600100. Email: ganeshkumar.niot@gov.in*

[2]*Scientist G, Marine Biotechnology Division, National Institute of Ocean Technology, Chennai - 600100. Email: dharani.niot@gov.in*

[3]*Director, National Institute of Ocean Technology, Chennai - 600100. Email: director.niot@gov.in*

Marine microorganisms including microalgae, oleaginous yeasts, and bacteria have emerged as key factors for the development of sustainable biofuels and renewable energy solutions. This presentation highlights technological innovations in marine microbial bioenergy with emphasis on third-generation biofuels, waste to energy systems and advanced biofuel molecules. Marine microalgae represent a promising source of third-generation biofuels based on their high photosynthetic efficiency, growth rates and ability to accumulate lipids. At National Institute of Ocean Technology (NIOT), large cultivation of *Chlorella* sp. using tubular and bubble-column photo-bioreactors and solar-powered raceway culture systems have achieved significant biomass and lipid accumulation. Biodiesel derived from algal lipids met ASTM fuel quality standards and successful field trials of B10 biodiesel blends demonstrated the techno-economic feasibility of algal biofuels. Marine oleaginous yeasts are a promising source of microbial oil since these microorganisms can accumulate up to 70% of their dry biomass as intracellular lipids. The marine oleaginous yeast *Meyerozyma guilliermondii* demonstrated 42% lipid accumulation when cultured on raw glycerol, highlighting the potential and sustainable feedstock for biodiesel production. Marine bacteria isolated from deep-sea sediments enable innovative waste to energy applications, including microbial fuel cells that convert the metabolic processes into electrical power. Marine fermentative microbes (green and sulphur bacteria) facilitate biological hydrogen production through bio-photolysis or dark fermentation. Additionally, marine derived bio-butanol emerges as a high-energy-density biofuel alternative to ethanol. By focusing on cutting-edge research third generation biofuels, waste to energy systems and advanced hydrogen and butanol production using marine derived technologies, sustainable pathways for next-generation energy production can be realized.

Recent advances in Multi-Omics approaches are being used to identify key regulatory networks controlling lipid accumulation, hydrogen generation and solvent production in marine microbes. These approaches accelerate strain improvement and process optimization for biofuel production. Synthetic biology studies have transformed marine bioenergy research by tailoring marine microbes through genome editing, promoter engineering and redesigning metabolic pathway. Together, advances in marine microbial biotechnology, synthetic and systems biology concepts are rapidly transforming marine microbes into next-generation platforms for sustainable energy production.

.

National Workshop on Ocean Energy and Water for a Sustainable Future: Potential and Challenges (OEWSF-2026)

BIO DATA



Dr. A. Ganesh Kumar Ph.D.
Scientist E
Marine Biotechnology
National Institute of Ocean Technology, Pallikaranai, Chennai - 600 100
Mob: 08870576212, E-mail: ganeshkumar.niot@nic.in

Patents Granted: 3 Nos.

1. **Patent No: 423452**. Apparatus for Deep-Sea Microbial Culture and Method Thereof. (Application No: 2726/CHE/2014; Date of Filing 03/06/2014; Granted date: 28/02/2023).
2. **Patent No: IN255419** and IPC Classification: B01J23/00. A novel catalyst useful for the removal of pathogen from wastewater.
3. **Patent No: IN253584** and IPC Classification: C02F1/00. A process for recovery of salt from salt laden water containing dissolved organics for reusable.

Patents Filed: 4 Nos.

1. Application No: **202041032482/** Date of Filing 29.07.2020. A Composition for Bioremediation of Oil Spills and a Process for Preparation thereof.
2. Application No: **202341038267/** Date of Filing 03.06.2023. Microbial based composition for the bioremediation of crude oil contamination and a process for preparation thereof". **NRDC/IPFC/VSKP/PA47/2022-23; European Patent**
3. Application No: **202041051155/** Date of Filing 24.11.2020. A Process of extraction of bioactives exhibiting excellent angiogenesis inhibitor activity from secondary metabolites of *Penicillium citrinum*.
4. Application No.: **202141003291**/Date of Filing 24.01.2021. A Process for high yield production of lipids from oleaginous yeasts.

Technologies Transferred through NRDC-Ministry of Sci &Tech. Govt. of India: 4 Nos.

MARESOL Technology: Marine oil spill bioremediation technology

1. Transferred to M/s. Eco Build Corp Pvt Ltd, Bengaluru on 17th September 2021 through NRDC.
2. Transferred to M/s. Oil Spill Combat Team, Thane on July 2022 through NRDC
3. Transferred to M/s. NatCap on November 2023 through NRDC

BIOREMESOL Technology: Biosurfactant for waste management & Environmental clean-up

4. Transferred to M/s. Eco Build Corp Pvt Ltd, Bengaluru on 5th July 2021 through NRDC

Publication details (h-index: 21; i-10 index: 42; citations: 2472)

Papers published in International Journals	:	38 publications
Papers published in National Journals	:	12 publications
Book chapters published	:	5 publications
Comparative transcriptome analysis deposited in NCBI	:	4 data sets
Whole Genome sequences deposited in NCBI	:	12 Genome sequences
International Research cruise participation	:	**IODP expedition 355 – JOIDES m RESOLUTION, United states Ocean drilling research shi**p, 31st March to 31st May 2015