AAR-2024

Advances in Algal Research

International Symposium on

Advances in Algal Research

17-18 December, 2024

PROCEEDINGS

Venue: Jawaharlal Nehru Technological University (JNTUH), Hyderabad

Indian Institute of Technology Guwahati

Jawaharlal Nehru Technological University Hyderabad

CSIR-India

सीएसआईआर CSIR भारत का नवाचार इंजन The Innovation Engine of India

भारत सरकार GOVERNMENT OF INDIA | विज्ञान और प्रौद्योगिकी मंत्रालय MINISTRY OF SCIENCE AND TECHNOLOGY

जैवप्रौद्योगिकी विभाग DEPARTMENT OF BIOTECHNOLOGY

About The Host Institute

Jawaharlal Nehru Technological University, Hyderabad, was established on 2nd October 1972 by the Legislature of the State of Andhra Pradesh as the first Technological University in the country. It has been in the forefront for the past 44 years in providing quality technological education of relevance in the State of Andhra Pradesh. After 36 years of existence, it was restructured into 4 different Universities by the Government vide Government Ordinance No.13, dated 18th August 2008 and Act of State Legislature No.30 dated September 2008 and this new University has been designated as Jawaharlal Nehru Technological University Hyderabad (JNTUH).

JNTUH is situated in a sprawling 89-acre campus at Kukatpally, Hyderabad. It has now 4 Constituent Engineering Colleges, one at Hyderabad, one at Kondagattu (Jagithyal), one at Manthani and one at Sultanpur (Medak dist.) and 15 other constituent units on Hyderabad campus. JNTUH offers B.Tech. programmes in 24 disciplines and B.Pharm at UG level; Integrated 5-year dual degree Masters programme; M.Tech. Programmes in 68 disciplines, M.Pharm. in 11 disciplines; M.Sc. in 10 disciplines; MCA, MBA and Double Degree Programmes at P.G. level; in addition to the offer of M.S., M.Phil., Ph.D. Research Programmes in various disciplines of Engineering, Technology, Science, Management and Humanities. JNTUH has 423 affiliated colleges spread over the Telangana State. JNTUH has more than 3.50 lakhs students on rolls. The University has Memoranda of University with many national and international organizations.

MESSAGE FROM THE CHAIRS

On behalf of the organizing committee, it is our pleasure to extend a warm welcome to all the delegates of the 2nd edition of the International Symposium on Advances in Algal Research (AAR 2024) taking place during 17-18 December, 2024 at Jawaharlal Nehru Technological University Hyderabad. AAR 2024 is being jointly hosted by IIT Guwahati and Jawaharlal Nehru Technological University Hyderabad.

AAR 2024 offers researchers from all over the world the opportunity to meet with colleagues, exchange research ideas and share new knowledge related to algal research. This symposium features a strong technical program that includes 10 technical sessions covering various aspects of algal research such as algal cultivation and harvesting techniques, omics/modeling & bioinformatics, advanced algal biorefinery, carbon dioxide sequestration, wastewater/heterotrophic cultivation, wastewater/heterotrophic cultivation and high value products from algal biorefinery.

We have around close to 100 presentations from invited and contributary speakers. We are convinced that this unique gathering of experts will guarantee rich, useful, and effective deliberations. The first edition of AAR Symposium was held at IIT Guwahati, Assam. Guwahati is also known as the City of Temples and the Gateway to North-East India. We wish that this symposium be held annually at various places under the banner of Algal Research Society of India.

Finally, we would like to take this opportunity to thank all members of the organizing committee, the technical program committee, invited speakers, contributary speakers, reviewers and the volunteers for their dedication and contribution to the symposium; without their tireless work, the symposium would not be a success.

Prof. Kaustubha Mohanty

Chair, AAR-2024

Dr. S Venkata Mohan

Chair, AAR-2024

MESSAGE FROM THE CONVENOR

It is our immense pleasure to extend warm welcome to all delegates of the **"2nd International Symposium on Advances in Algal Research"** hosted by Centre for Environment, JNTUH, Hyderabad; CSIR-IICT, Hyderabad and IIT, Guwahati from 16-17th December, 2024. Scope of the symposium is wide including algal based circular economy, innovation and bioengineering in algal research and applicability of macro and microalgae-based value-added products towards green economy, is having absolute relevancy in today's scenario. AAR-2024 will open up the opportunity to researchers, scientists, academician coming from all over the country and world to explore new areas of advance algal research and provide an excellent platform to exchange ideas on algal biorefinery, circular economy, carbon neutrality and sustainability.

Hyderabad, Telangana being a pharmaceutical hub and also known as "City of Pearls" situated in southern India is one of the most developed cities in India. It is a foremost city in culture in India with a lot of places of tourist attraction. In Centre for Environment, JNTUH we have more than one-decade research activities in diversified area of environment and energy including mass cultivation of microalgae in industrial/domestic effluent and extraction of value-based products. This symposium is planned to conduct at different cities of India each year under the banner of Algal Research Society of India.

I would like to extend my sincere thanks to the organizing committee, volunteers, technical program committee, invited speakers and all participants from India and abroad for their support and full-hearted involvement in the event and wish the program a great success.

Prof. V. Himabindu

Convenor, AAR-2024

ORGANIZING COMMITTEE

PROF. KAUSTUBHA MOHANTY
IIT Guwahati

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Saptaswa Biswas	V. Rakesh	B. Ragavarshini
	S. Dileep Babu	

PROGRAMME SCHEDULE

Venue: Golden Jubilee Conference Hall, J-HUB, JNTUH

DAY 1: 17th December 2024			
08:00-09:00	**Registration**		
09:00-09:30	**Inaugural Session**		
09:30-11:50	**IL Session I** Chairs: Pavan Jutur, Sabeela Beevi		
09:30-09:50	IL001	Anushree Malik, IIT Delhi	Algal Bacterial Coordination: ABC Driving environmental remediation and resource recovery
09:50-10:10	IL002	Dheeban Chakravarthi Kannan, The Energy and Resources Institute, Mumbai	Algal Production and Processing at a Marine Algal Facility for Integrated Biofuel Development
10:10-10:30	IL003	Gunjan Prakash, ICT Mumbai	Myoglobin expressing *Chlamydomonas reinharditii* and its functional characterization for alternative meat applications
10:30-10:50	IL004	Kalyan Gayen, NIT Agartala	Bioprocessing of microalgae-based multiple products using biorefinery approach
10:50-11:10	**Tea Break**		
11:10-11:30	IL005	Kit Wayne Chew, Nanyang Technological University, Singapore	Microalgae with artificial intelligence: A perspective on biotechnology for bioproducts
11:30-11:50	IL006	Krishna Mohan Poluri, IIT Roorkee	Mechanistic Insights into Microalgae based Biorefinery Framework using Integrated Omics Approaches
11:50-13:10	**Short Oral Presentations I** Chairs: Krishna Mohan Poluri, Nilotpala Pradhan		
11:50-12:00	SOP 001	Aiswarya Robert Antony, Central University of Kerala	Palette of colours from a novel, non-model green alga: Stress based modulation of carotenoid production in Graesiella emersonii

12:00-12:10	SOP 002	Alok Kumar, Indian Institute of Technology Delhi	Impact of Stress and Carbon Sequestration on Polyhydroxybutyrate (PHB) Production in Synechococcus elongatus
12:10-12:20	SOP 003	Anu Bharti, Central University of Jammu	Optimizing algal biofilm efficiency with HRTs for wastewater remediation: An experimental solution
12:20-12:30	SOP 004	Arathi Sreenikethanam, Central University of Tamil Nadu, Thiruvarur (India)	Salt stress induced metabolite accumulation and Extracellular Polymeric Substances (EPS) secretions in microalgae: A potential mechanism for cell survival
12:30-12:40	SOP 005	B. Vanavil, Kalasalingam Academy of Research and Education	Comparative Evaluation of Pyrolysis and Hydrothermal Liquefaction for Bio-Oil Production from Seaweed Wastes
12:40-12:50	SOP 006	Banavath Suresh, CSIR-Indian Institute of Chemical Technology, Hyderabad	Iron Stress-Induced Mixotrophic Cultivation of Coelastrella sp. SVMIICT5 for Enhanced Lipid Accumulation
12:50-13:00	SOP 007	Bharmjeet Singh, International Centre for Genetic Engineering and Biotechnology – New Delhi	Metabolic Adaptations of Chlorella saccharophila to Elevated CO_2: Implications for Carbon Capture
13:00-13:10	SOP 008	Bhavik Kantilal Bhagiya, CSIR-Central Salt and Marine Chemicals Research Institute, Bhavnagar,	Explant priming with combination of bio-effectors improves adventitious lateral shoot development in marine red alga Gracilaria dura (C. Agardh)
13:10-14:00	**Lunch Break & Networking; Venue: JN Auditorium Lounge**		
14:00-17:00	**IL Session II** Chairs: Gunjan Prakash, Soumya Sasmal		

14:00-14:20	IL007	Pavan Jutur, DBT-ICGEB	Beyond Carbon Capture: Trehalose Transforms Algae into Biofactories
14:20-14:40	IL008	Mona Sharma, Central University of Haryana	Exploration of Sohna Hot Spring (Shiv Kund), India: Revealing the Potential of Thermophilic Cyanobacteria for Industrial Applications
14:40-15:00	IL009	Paramasivan Balasubramanian, NIT Rourkela	Unlocking Sustainable Farming Innovations with Microalgal Solutions
15:00-15:20	IL010	Amritpreet Kaur Minhas, The Energy and Resources Institute, Delhi	Potential role of freshwater algae as a natural stimulator for improving the yield of wheat
15:20-15:40	IL011	Sanjeev Mishra, SSS NIBE, Kapurthala	Integration of algal biorefinery in the compressed biogas project
15:40-16:00	IL012	Pau Loke Show, University of Nottingham Malaysia, Malaysia	Innovation and Research Trend in Algal Technology
16:00-16:20	**Tea Break**		
16:20-16:40	IL013	Rajasri Yadavalli, Chaitanya Bharathi Institute of Technology	Seaweed-Based Bioplastics: A Sustainable Alternative for Packaging Applications – Opportunities and Challenges
16:40-17:00	IL014	Sabeela Beevi, Rajagiri College of Social Sciences	Sustainable microalgae biomass production in food industrial wastewater: A circular bioeconomy approach
17:00-18:20	**Short Oral Presentations II** Chairs: Dheeban Chakravarthi Kannan, Sanjeev Kumar Prajapati		
17:00-17:10	SOP 009	Chandrima Roy, JNTU, Hyderabad	Kinetic modeling and experimental investigation on Lipid and Polyhydroxybutyrate production in Chlorella and Co-culture cultivated in dairy wastewater

17:10-17:20	SOP 010	Francis Vincent, Homi Bhabha National Institute, Anushakti Nagar, Mumbai	Algal-bacterial granules for remediation of wastewater containing emerging contaminants
17:20-17:30	SOP 011	Gayatri Parida, CSIR-IMMT, Bhubaneswar	Studying effect of heat shock to algae with purpose to overcome afternoon short duration high temperature summer during outdoor cultivation
17:30-17:40	SOP 012	Jayshri Khadilkar, ICT Mumbai	Seaweed biostimulant supplementation for and improved growth high light tolerance of Nannochloropsis oculata under Indian tropical light cultivation
17:40-17:50	SOP 013	Kanhu Charan Panda, CSIR-Institute of Minerals & Materials Technology, Bhubaneswar	Effect of culture conditions especially culture volume on CO_2 Sequestration and Biomass Production by Microalgae.
17:50-18:00	SOP 014	Nikhil Kadalag, ICT Mumbai	Designing Phaeodactylum tricornutum as a host chassis for sustainable aviation fuel biosynthesis
18:00-18:10	SOP 015	Pallavi Vadla, Birla Institute of Technology and Science-Pilani, Hyderabad	Developing Algae-Bacteria Co-culture in Sequencing Batch Reactor for Enhanced Bioremediation and Energy Recovery
18:10-18:20	SOP 016	Pooja Singh, IIT Guwahati	Dairy wastewater treatment and production of polyhydroxybutyrate from Monoraphidium sp. KMC4 and Scenedesmus microalgae and their consortium
18:20-19:20	**Poster Session & Evaluation**		
19:20-20:00	**Cultural Evening (Performance by JNTUH students)**		
20:00-Onwards	**Dinner, Venue: JN Auditorium Lounge**		

DAY 2: 18th December 2024			
09:00-11:20	**IL Session III** Chairs: Anushree Malik, Mona Sharma		
09:00-09:20	IL015	Ajay Kumar Dalai, University of Saskatchewan, Canada	Hydrothermal liquefaction of microalgae in methanol-water system for bio-crude production and its upgrading to transportation fuel
09:20-09:40	IL016	Ramkrishna Sen, IIT Kharagpur	A tale of a light-inspired journey for the design and development of a flue-gas CO_2 based microalgal biorefinery
09:40-10:00	IL017	Sanjeev Kumar Prajapati, IIT Roorkee	Advancing Microalgae-Mediated Pathogen Removal for Wastewater Treatment: Optimization, Mechanisms, and Real-World applications
10:00-10:20	IL018	Anjani Chintagunta, Vignan's Foundation for Science Technology & Research, Guntur	Auxin Production by Cyanobacteria: Unlocking the Growth Potential of Paddy Seeds with *Aliinostoc* sp.
10:20-10:40	IL019	Sang-Hyoun Kim, Yonsei University, South Korea	Biohydrogen production from waste and renewable biomass
10:40-11:00	IL020	Soumya Sasmal, Visva Bharati	Sustainable Production of 5-Hydroxymethylfurfural from Microalgal Biomass: Optimization, Catalysis, and Therapeutic Potential
11:00-11:20	IL021	Lê Linh Thy, University of Medicine and Pharmacy, Ho Chi Minh City, Vietnam	Nutrients and organic removal through a moving bed membrane photobioreactor
11:20-11:40	**Tea Break**		
11:40:13:00	**Short Oral Presentations III** Chairs: Ramkrishna Sen, Kalyan Gayen		
11:40-11:50	SOP 017	Poonam Kumari, CSIR-Indian Institute of Chemical Technology, Hyderabad	Pigment Profiling in Coelestrella sp. Under Light and Salinity Stress Conditions and Evaluation of their Antioxidant Potential

11:50-12:00	SOP 018	Rashmi Gondi, Central University of Tamil Nadu	Effect of microwave-mediated bacterial disintegration of Chlorella sorokiniana (green microalgae) to enhance biofuel yield
12:00-12:10	SOP 019	Sumit S. Phakatkar, CSIR-National Institute of Oceanography	Assessment of Macroalgal Hydrocolloids to Enhance Shelf Life of Tomato (Lycopersicum esculentum)
12:10-12:20	SOP 020	Shiny Evangeline, Karunya Institute of Technology and Sciences	Insights on factors impacting Microalgal Biofilm towards circular economy
12:20-12:30	SOP 021	Shovon Mandal, The Energy and Resources Institute, New Delhi	Innovative approaches in microalgae cultivation and understanding algal health for successful large-scale production
12:30-12:40	SOP 022	Subhasmita Panigrahi, CSIR-Institute of Minerals & Materials Technology, BBSR	Metal Recovery from Bio-leach Liquor Using Extracellular Polymeric Substances from Synechocystis sp.: A Green Biotechnological Method
12:40-12:50	SOP 023	Subhisha Raj, Central University of Tamil Nadu, Thiruvarur (India)	Utilizing Microalgae for Phosphate Recycling: A study on their Metabolic Shifts and Gene Expression Patterns for Biofertilizer Production
12:50-13:00	SOP 024	Sudha Sahay, Loyola Centre for Research & Development, Xavier Research Foundation, Ahmadabad	Cultivation of Micractinium reisseri in wastewater for the enhancement of biofuel efficacy, wastewater treatment and value-added production: ongoing achievements
13:00-14:00	**Lunch Break & Networking, Venue: JN Auditorium Lounge**		
	IL Session IV Chairs: Ajay K. Dalai, Paramasivan Balasubramanian		
14:00-14:20	IL022	Nilotpala Pradhan, CSIR-IMMT Bhubaneswar	Use of industrial waste like slag and waste CO_2 for generation of high value algal biomass
14:20-14:40	IL023	Amit Kumar Bajhaiya, Central University of Tamil Nadu	Transcriptional engineering of *Chlamydomonas reinhardtii* for the production of carbon storage metabolites

14:40-15:00	IL024	Manohar Cathrine Sumathi, CSIR-National Institute of Oceanography	Bioactive potential of macroalgal oligosaccharides produced using enzymes from macroalgae-associated bacteria
15:00-15:20	IL025	Shailesh Patidar, Central University of Rajasthan	Implications of Quorum Sensing Mechanisms in Synthetic Ecology Inspired Models of Algae-bacteria and Prospective Lipid Amelioration
15:20-15:40	IL026	N.S. Sampath Kumar, Vignan's Foundation for Science Technology & Research, Guntur	Transforming challenges into solutions: the prebiotic benefits of chlorella sp. For shrimp health
15:40-16:00	IL027	Manupati Hemalatha, KL University	Microalgae biorefinery towards a circular economy: A path for harnessing multiple products for Sustainable development
16:00-16:20	IL028	Vaibhav V. Goud, IIT Guwahati	Optimization of growth conditions for lipid-rich novel strains Scenedesmus sp. and Limnothrix sp. for biodiesel feedstock
16:20-16:40	**Tea Break**		
16:40- 17:50	**Short Oral Presentations IV** Chairs: Sanjeev Mishra, Shailesh Patidar		
16:40-16:50	SOP 025	Brigita Jain, Xavier Research Foundation, Gujarat	Extraction and characterization of high-value by-products from Micractinium reisseri: an implication for sustainability and circular economy
16:50-17:00	SOP 026	Supratim Ghosh, Birla Institute of Technology and Science-Pilani, Hyderabad	Seaweed Biorefineries: Towards a sustainable and resource efficient future
17:00-17:10	SOP 027	Swati Pramod Pawar, CSIR-National Institute for Interdisciplinary Science and Technology Thiruvananthapuram	Unveiling Organic Selenium Synthesis Mechanism of Nannochloropsis oceanica CASA CC201: Insights from Ultrastructure and Cell Wall Composition

17:10-17:20	SOP 028	Tarun Pant, IIT Roorkee	Exploring the Impact of Glycerol and Yeast Extract on the Biochemical and Antioxidant Profile of Chlorella pyrenoidosa
17:20-17:30	SOP 029	Vaishnavi Newaskar, CHARUSAT University	Assessing Diatom Distribution in Cambay Basin, Western Arabian Sea: Impacts of Oil Spillage and Chemical Variables
17:30-17:40	SOP 030	Vivek Kumar Nair, Indian Institute of Technology Delhi	Effect of Night-time Aeration on Microalgal Bacterial Granular Sludge (MBGS) on the Stability and Treatment Performance For Tertiary Treatment of Textile wastewater
17:40-17:50	SOP 031	Zainab Syed, University of Rajasthan, Jaipur, Rajasthan	Low-Cost Algal Biomass Cultivation in Saline-Reject Water for Useful Pigments and Biopolymer Production
17:50-18:00	SOP 032	Dig Vijay Singh, SSS NIBE	Utilizing residual microalgae biomass under biorefinery framework for extraction of valuable biocompounds and bioenergy production
18:00-18:30	**Valedictory**		

Poster Session		
PP 001	Abhishek Sahu, Indian Institute of Technology Delhi	Optimization of Growth Media for Enhanced Biomass and PHB Production in Synechocystis pevaleikii
PP 002	Adya Pandey, BIT Mesra	Investigating the UV-protective potential of mycosporine-like amino acids and scytonemin from lyngbya.
PP 003	Athulya Babu, Sahrdaya College of Engineering and Technology, Kodakara, Kerala	Microalgae - Derived Phycocyanin: Sustainable Solution and it's Multifaceted Applications
PP 004	Bhavani Mishra, Odisha University of Agriculture & Technology, Bhubaneswar	Algae for Sustainable Agriculture and Food Security
PP 005	Digvijay Singh Yadav, CSIR- Central Salt and Marine Chemicals Research Institute, Bhavnagar	Analysis of Three-Decade Change in Global Seaweed Statistics Revealed Its Emergence as a Major Aquaculture Commodity
PP 006	Diptymayee Padhi, Amity Institute of Biotechnology AIB), Uttar Pradesh	Enhanced DIC for CO_2 biofixation and lipid production in Chlorella sp. BRE5 through combined NaOH and strategic carbon dioxide supply
PP 007	G.Prameela, Odisha University of Agriculture and University, Bhubaneshwar	Role of Algae for Sustainable Agriculture and Food Security
PP 008	Hardi Patel, CHARUSAT University	Impact of Microplastics on Chlorophyll Production in Microalgae: Assessing Ecological Disruption
PP 009	Kajol Goria, Central University of Jammu	Implementation of Waste almond shells to harvest two different Chlorella sp.
PP 010	Maddipatla Naga Sai Karthik, Birla Institute of Technology and Science-Pilani, Hyderabad	Valorization of anaerobic digestate for enhanced biomass production in Chlorella sorokiniana: a circular economy approach
PP 011	Mamta Bhandari, IIT Roorkee	A Green and Efficient Pretreatment Strategy for Unlocking Algal Potential
PP 012	Neha Saini, Guru Jambeshwar University	Microbial Community Assessment of Sohna hot spring (Shiv Kund), India

	Of Science and Technology, Hisar, Haryana	through culture-independent and culture-dependent study: A special attention on thermophilic cyanobacteria for potential benefits
PP 013	Nisha Das, Amity Institute of Biotechnology (AIB), Uttar Pradesh	Implementing semi-continuous cultivation strategy for enhanced biomass and lipid production performance of indigenous microalga Chlorella sorokiniana
PP 014	P. Gwen Grace, CSIR-CSMCRI-Marine Algal Research Station, Mandapam campus	Seaweed as a source of therapeutic activity and functional foods
PP 015	R. Sathish, CSIR-Institute of Minerals & Materials Technology, Bhubaneswar	Harnessing Microalgae for CO_2 Mitigation and Biomass Valorization
PP 016	Rachapudi Venkata Sreeharsha, C.S.J.M. University, Kanpur (Uttar Pradesh)	Boosted Lipid Production and their Oxygenated Derivatives from Novel Microalgae through Molecular Techniques
PP 017	Ragul M, Karunya Institute of Technology and Sciences	Exploring Biohydrogen production using microalgae towards sustainable green technologies
PP 018	Rajdeep Kovath, Pragathi Basavarajb, RV College of Engineering, Bangalore	Algae: Sustainable Alternative to Traditional Food, Medicine, and Agricultural Practices
PP 019	Rajeev Kumar Bhaskar, Central University of Tamil Nadu, Thiruvarur	Synergistic Impact of Potassium Persulfate on the Efficiency of Microwave mediated Cell Lysis of Macroalgal Biomass for Bioenergy Generation
PP 020	Razia Sultana.K, JAIN University	Microalgae: A Sustainable Solution for Producing Biobased Products
PP 021	Santosh Bhukal, Guru Jambheshwar University of Science and Technology, Hisar	Algal-Mediated Synthesis of Multifunctional Nanocomposite for Sustainable Approach Towards Environmental Remediation
PP 022	Shatakshi Kashyap, Amity Institute of Biotechnology (AIB), Uttar Pradesh	Influence of agricultural fertilizer and glycerol under different trophic modes of Chlorella sp. BRE4 cultivation for wastewater treatment and biomass production

PP 023	Shraddha Abhyankar, ICT Mumbai	Cultivation of Chromochloris spp. for value added products under different mode of cultivation
PP 024	Shreya Gupta, Dr B R Ambedkar National Institute of Technology, Jalandhar	Advanced microalgae cultivation using algal turf scrubber technology for biohydrogen production: A Review
PP 025	Suparna Sen, National Institute of Technology Agartala	Physicochemical and biological characterization of extracellular polysaccharide from isolated microalgae
PP 026	Supriya Pandey, Manipal Institute of Technology, MAHE, Manipal, Karnataka	Biodiesel Production from freshwater microalgae Chlorococcum sp.
PP 027	Sushma Lavudya, JNTU, Hyderabad	Synergistic Microalgal-Bacterial Treatment Approach for Secondary treatment of Legacy Landfill Leachate
PP 028	Swetha R, Sri Venkateswara College of Engineering	Exploration of dermo cosmetic effects of polyunsaturated fatty acids (PUFA) derived from marine macroalgae for anti-aging applications
PP 029	Vaishali Chaudhary, Motilal Nehru National Institute of Technology Allahabad	Synergistic Effect of ZnO Nanoparticles and Light Conditions on Microalgae Growth, Lipid Accumulation, and Carotenoid Biosynthesis for Potential Industries
PP 030	Vinaykumar Patil, ICT Mumbai	Biorefinery approach for evaluating microalgal extracts as biostimulant
PP 031	Vinuba N, Karunya Institute of Technology and Sciences	Microalgae derived astaxanthin in therapeutics and functional foods
PP 032	Vishwender Pratap Singh, University School of Chemical Technology, Guru Gobind Singh- New Delhi	Multivariable optimization of cultivation parameters for enhanced lipid production in Scenedesmus obliquus and Chlorella pyrenoidosa fermentation using Box-Behnken design
PP 033	Suchetna Kushwah, IIT Guwahati	Sustainable Valorization of Green Macroalgae Biomass: Conventional Pyrolysis and Hydrothermal Carbonization Approaches

Abstracts of Invited Speakers

IL001

Algal Bacterial Coordination: ABC Driving Environmental Remediation And Resource Recovery

Anushree Malik

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Indian Institute of Technology Delhi

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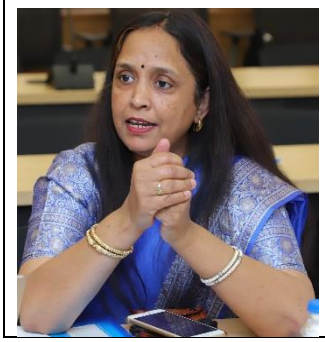

AM, a Professor at CRDT, IIT Delhi has led several carbon negative-integrated algal biorefinery projects, product formulation and technology development for on-site municipal and industrial effluent's treatment coupled with renewable energy generation. Supervised 29 PhDs, earned 6 patents, >200 high impact publications with 13,830 citations, h-i: 59, i-10-162. She holds a PhD from IITD followed by JSPS and a recent Fulbright-Kalam Visiting Professorship at Princeton University. Weaved international collaborations with Netherland, Sri-lanka, Brazil, France, besides industrial collaborations. Received DST-Lockheed Martin IIGP Award (2015), BRSI Fellow Award (2019), Prof. K.L. Chopra Applied Research Award (2023) and 75 women in STEAM.

ABSTRACT

Complex algal-bacterial interactions drive the functionality and performance of algal wastewater systems[1]. Algal-fungal interactions also exist in natural environment, but these are quite different from what could be engineered to increase the process efficiency[2]. I shall present the learnings acquired in the past few years on how these interactions can be engineered for specific advantages in nutrient recovery from waste streams followed by bioenergy production or even biorefinery routes. However, it is often difficult to control the nature and extent of these interactions, which prompts us to explore the fundamentals governing such interactions. We have identified some specific molecules promoting algal-fungal interactions[3]. Nevertheless, a more detailed investigation is required to establish how these molecules would facilitate interaction among spatially separated partners. Unfortunately, we often lack the platforms facilitating such investigations which limits our wings.

So, the key question that bothered me was how do we precisely design and execute investigations to spatially track the fate of algal-bacterial populations during the course of interaction? During my recent Fulbright-Kalam fellowship tenure, we could design and execute an experimental platform leveraging the tools Princeton has developed, to investigate cyanobacterial-bacterial interactions in transparent, crowed hydrogel matrices[4]. This platform enables by-product exchange, mirroring the interactions and spatial organization found in natural systems. The results reveal the emergence of complex dynamical spatio-temporal interactions between bacteria and cyanobacteria, vital to govern the fate of the interaction i.e. bacterial or cynaobacterial dominance.

[1]Dalvi et al., Algal Res., 55, 102228 (2021). [2]Bhattacharya et al., Algal res., 21, 42-51 (2017). [3]Bhattacharya et al., Biotechnol. & Biofuels, 12, 1-17 (2019). [4]Martínez-Calvo et al., PNAS, 119, e2208019119 (2022)

Keywords: algal; bacterial; fugal; interactions; wastewater treatment

IL002

Algal Production And Processing At A Marine Algal Facility For Integrated Biofuel Development

Dheeban Chakravarthi Kannan

The Energy and Resources Insitute (TERI), Navi Mumbai, India

(E-mail: dheeban_k@yahoo.com)

Dr Dheeban Chakravarthi is engaged in pilot-scale algal biofuel R&D. His focus areas are outdoor algal production, growth system design, algal harvest, lipid extraction and techno-economic analysis. He studied B Tech Chemical Engineering in Anna University, Chennai and obtained his PhD from The Pennsylvania State University. He is presently engaged in demonstration of marine algal production from a 100,000 L algal growth system and subsequent processing for development of transport fuels and value addition co-products, as part of the DBT-TERI Center of Excellence on Integrated Production of Advanced Biofuels and Biocommodities. He has publications on algal growth system, lipid extraction, algal nutrient uptake, engineering aspects of algal biofuels, biodiesel production and phase equilibrium thermodynamics.

ABSTRACT

A marine algal production and processing facility was set up in Navi Mumbai, India for integrated production of algal biofuels and biocommodities that included a sunlight distribution-based 100,000 L/220 m^2 algal growth system (open), a harvest mechanism based on self-aggregating feature of select algae and a 100 L wet algal lipid extraction unit that can process wet algal paste at normal temperature and pressure. Algal growth in the growth system was characterized by significant contamination challenges posed by the highly biodiverse backwater location until a high salinity-tolerant alga was adopted which resulted in a sustained productivity of 15.1 g/m^2/day. Algal strains adopted at normal sea water salinity (35 g/L) before this strain deteriorated frequently resulting in low active period of growth. The high salinity-tolerant strain facilitated highly effective harvest as well owing to its excellent self-aggregation feature. The wet algal lipid extraction unit (based on a method that yielded full lipid recovery at lab-scale) has resulted in an extraction efficiency of 90.1% ± 19.2% overall. A variety of coproducts were developed for value-addition from the cultivated algae by other partners. Technoeconomic analysis showed the following order and degree of influence: scale >> coproduct value-addition > algal productivity >> lipid content > lipid extraction efficiency.

Keywords: algal biofuels; pilot facility; outdoor cultivation; lipid extraction; biorefinery

IL003

Myoglobin Expressing Chlamydomonas Reinharditii And Its Functional Characterization For Alternative Meat Applications

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Dr Gunjan Prakash is a PhD from Indian Institute of Technology, Delhi and a faculty at Institute of Chemical Technology (ICT), Mumbai. She has fifteen years of experience in Algal Biotechnology as well as Industrial Biotechnology. Her lab focusses on Genetic and Metabolic Engineering of microalgae for value-added bio-products as well as bioprocess development. She is exploring both nuclear and chloroplast engineering of microalgal species for biofuels, abiotic stress resistance, enhanced photosynthetic efficiency as well as high-value biochemicals including peptides, carotenoids, heme proteins etc. for applications in nutraceutical, cosmeceutical, and pharmaceutical. She has published several research articles in international peer-reviewed journals.

ABSTRACT

A paradigm shift in the need to produce food sustainably with reduce land and water footprint has enforced humankind to explore alternative modes for food production especially protein. Alternative meat or faux meat that uses plant based material are thus gaining immense attention. Microalgae have found there application in food industry for a long time. There is a vast potential of microalgae to integrate with alternative meat as a source of protein. Additionally microalgae can be genetically modified to impart specific taste or flavour in alternative meat products. The success of microalgae addition in these food products also depends heavily on their functional properties which are essential for various food formulations. The present talk discusses the generation of transplastomic strain of Chlamydomonas reinharditii expressing myoglobin, a heme protein known to impart meaty taste and flavour in food products. Further the functional characterization of C. reinharditii for different food properties will be discussed which establishes its suitability for alternative meat applications.

Keywords: Alternative meat, C. reinharditii, Functional characterization, Myoglobin.

IL004

Bioprocessing Of Microalgae-Based Multiple Products Using Biorefinery Approach

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Dr. Kalyan Gayen is working as an academician in the department of Chemical Engineering, NIT Agartala. He has completed his PhD from IIT Bombay, M. Tech from IIT Kharagpur and B. Tech from University of Calcutta. He also worked as post-doctoral fellow in University of California, Santa Barbara, USA. His broad research interests are: i) Microalgae and cyanobacteria-based biofuels and bioproducts, ii) Conversion of biological wastes into biofuels and value-added products, iii) Nanomaterials, Nanobiotechnology and Advance material engineering, iv) Metabolic network analysis for biological systems, v) Systems biology & fermentation technology. He has successfully executed number of research projects from reputed funding agencies like DST, SERB, DBT and DRDO. As a research output, he has contributed more than fifty research articles in reputed journals, three books, fourteen book chapters along with several national and international conferences.

ABSTRACT

Now-a-days, it is well understood that microalgae-based biofuels as single product is economically infeasible. Therefore, the focus has been shifted towards the multiple products from microalgae using biorefinery approach. Further, process optimization is essential to achieve high cell density microalgal biomass by manipulating chemical and physicochemical parameters. In this work, optimization of nutrient concentrations for the cultivation of isolated Chlorella thermophila was performed by manipulating nine nutrients with the objectives of maximization of growth, carbohydrate, protein, and chlorophyll contents. Experiments were designed and effects of the parameters were studied using Taguchi orthogonal array (TOA). Experimental results of TOA were used for modeling artificial neural networks (ANN) followed by the optimization using genetic algorithm (GA) to find global optimal solutions. Results showed a substantial enhancement of growth and enhancement of carbohydrates, proteins, and chlorophylls. Further, optimum light intensity was found to be 128 mmol m□2 s□1 after conducting experiments in optimized chemical and physicochemical conditions, contributing to the enhancement of productivity of 46% for biomass and 106% for chlorophyll. Urea was found to be the most effective nitrogen source with an increase of 70% and 160% biomass and chlorophyll productivity, respectively. Moreover, sucrose as a carbon source contributed to an increase of 97% and 264% biomass and chlorophyll productivity.

Keywords: Artificial neural network; Chlorella thermophila; design of experiment; genetic algorithm; optimization; Taguchi orthogonal array

IL005

Microalgae With Artificial Intelligence: A Perspective On Biotechnology For Bioproducts

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Dr Kit Wayne Chew is an Assistant Professor at the School of Chemistry, Chemical Engineering and Biotechnology, Nanyang Technological University, Singapore. His research and technological development interests are in sustainable bioprocess engineering for food and pharmaceutical products, focusing on the utilization of algae biotechnology to develop cost-effective and environmentally friendly methods for the synthesis of functional ingredients. He received the Highly Cited Researcher award 2023, MIT Technology Review 2023 Innovators under 35, Green Talents Award 2022 and was listed as the Top 2% World Top Scientists in The Stanford List since 2021.

ABSTRACT

Identification of microalgae species is of great significance due to the discovery of various new species and to detect the occurrence of harmful algae blooms, which can affect both the aquatic habitat and human health. Microalgae are the future green biomass and alternatives due to their promising composition of bioactive compounds that can be utilized in many industrial applications. The potential of incorporating artificial intelligence into the processing of microalgae can give a “domino effect” in further providing optimization leverages to the supply chain, in the operations including cultivation, processing, system design, process integration, and products generation. Currently, microalgae species identification are conducted through DNA analysis and various microscopy techniques which poses several limitations such as costly validation, requiring skilled taxonomists, prolonged analysis, and low accuracy. To overcome these challenges, the potential and innovation of digital microscopy with the incorporation of both hardware and software that could produce a reliable recognition, detection, enumeration, and real-time acquisition of microalgae species, has been developed. From this perspective, the linkage between microalgae genetic information and optimized bioproducts using Artificial Intelligence can be closed further. The acceleration of artificial intelligence research, using large and complex data from microalgae research can be properly analyzed by combining the cutting-edge of both fields. These adaptation of automation in bioprocessing will then create the pathway for a digitalized future for microalgae bioproducts manufacturing and application.

Keywords: Chlorella; extraction; green biomass; machine learning; optimization

IL006

Mechanistic Insights Into Microalgae Based Biorefinery Framework Using Integrated Omics Approaches

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ABSTRACT

Microalgae are diverse group of microorganisms portraying a promising solution to mediate a paradigm shift to green energy, while conserving the carbon footprint. Accounting to the environmental benefits from green energy, direct implication of these green cells for remediation of wastewater with hazardous pollutants cannot be omitted. Thus, establishing a firm chain linking the benefits of environment and economy, our research group is working on the aspect of harnessing the potential of green microalgal cells for heavy metal remediation, bioremediation of nanoplastics and desalination to regenerate clean water, and to produce bioenergy, precisely biodiesel and EPS under the biorefinery approach. The work conducted in the lab is focused to dissect the intrinsic nexus of molecular pathways in microalgal cells by linking the high throughput information across different platforms such as transcriptomics, proteomics, NMR based metabolomics/lipidomics, and biochemical characterizations. While acquiring the in-depth knowledge of algal stress physiology, the vision of the group is to optimize the downstream processing of the renewable energy compounds /value-added products to establish a cost-effective, green, and sustainable environment/economy.

Keywords: Heavy metals; Nanoplastics; Microalgae; Biorefinery; Biofuels; Bioremediation; Environment-energy paradigm

IL007

Beyond Carbon Capture: Trehalose Transforms Algae into Biofactories

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Dr. Pannaga Pavan Jutur is a Group Leader at the International Centre for Genetic Engineering and Biotechnology (ICGEB), New Delhi. His research focuses on algal biology, specifically omics and metabolic engineering. He uses an integrative multi-omics approach and genome-scale metabolic models (GEMs) to develop strategies for converting light and carbon sources into biomass, biofuels, and biorenewables. Dr. Jutur has published around 70 research papers and is an active member of professional societies.

ABSTRACT

This study investigates the co-culture of Chlorella saccharophila and Exiguobacterium sp. for enhanced lutein production. The co-culture, particularly under nitrate-depleted conditions with 3% CO_2 supplementation, exhibited the highest lutein productivity (238.3 $\mu g \cdot L^{-1} d^{-1}$), a 1.33-fold and 3.54-fold increase compared to co-culture nitrate depletion and mono-culture, respectively. Additionally, the co-culture showed elevated chlorophyll-a levels, indicating a positive influence of both bacteria and CO_2 on algal photosynthesis. Metabolomics analysis revealed a significant decrease in bacterial trehalose and an increase in algal sucrose, suggesting beneficial metabolic interactions. These findings highlight the potential of co-culture strategies for inducing new metabolite pathways and increasing the yield of valuable compounds, contributing to a circular bioeconomy through CO_2 valorization.

Keywords: Chlorella saccharophila; Exiguobacterium sp.; Sucrose; Symbiosis; Trehalose

IL008

Exploration Of Sohna Hot Spring (Shiv Kund), India: Revealing The Potential Of Thermophilic Cyanobacteria For Industrial Applications

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Dr. Mona Sharma Head and Associate Professor at Department of Environmental Studies, Central University of Haryana, Mahendergarh, India. She is a PhD from Guru Jambheshwar University of Science & Technology, Hisar, a gold medalist in Industrial Waste Management and distinction holder in Environmental Sciences. Her key research interests include Phycoprospecting algae for biofuel, wastewater remediation and high-value products. Her research work has been published in many International Journals with high impact factor. She has also authored and edited many books and several chapters in Springer, CRC Press, Elsevier on Algae and its applications. She has delivered talks as Invited speaker, Keynote speaker and Session Chair in many conferences. She was awarded 'Environmentalist of the Year 2023', 'Women Researcher Award 2022', Best Invited Lecture Award-2021 by Sidang Pembekal Management, Selangor, Malaysia, 'Honorary Fellowship of Indian Academy of Environmental Sciences (FIAES)-2019', 'Esteemed Speaker Award 2024' 'Best Paper Presentation 2024 by Universitas Janabadra, Yogyakarta, Indonesia.

ABSTRACT

This study explores the unique ecosystem of the Sohna Hot Spring, also known as Shiv Kund, in India, focusing on its thermophilic cyanobacterial populations. Given the increasing interest in sustainable industrial practices, the thermophilic cyanobacteria present in this geothermal environment may hold valuable biochemical compounds for various applications.

Through systematic sampling and analysis, we aim to identify and characterize these microorganisms, assessing their potential for sustainable solutions to health, food and the environmental concerns. Thermophilic cynobacteria thrive in hot springs with extreme environmental circumstances such as high temperatures (>50°C), light, pH, and nutritional composition. However, thermophilic cyanobacteria are scarcely investigated for their industrial potential.

In the present study, thermophilic cyanobacteria were isolated from Sohna hot spring and identified with morphological and molecular approaches. Further, the strains were examined for biochemical profiling, nutraceuticals and bioremediation potentials. The highest biomass production and biomass

productivity per day obtained was 1041.6 mg/L and 42.33±1.52 **($p<0.01$) in 0.1875 g/L (N/8) and 1.5 g/L (N) sodium nitrate concentration, respectively. Further, by optimizing the isolation and cultivation of thermophilic algal strains, we identified and characterized several metabolites with antioxidant, antimicrobial, and anti-inflammatory properties. Using optimized extraction techniques, we have successfully isolated these compounds and evaluated their potent antioxidant, antimicrobial, and anti-inflammatory properties. To study the bioremediation potential, three different kinds of nano-adsorbents (algae-based zinc oxide and graphene oxide nanocomposite (ZnO/GO), and thermophilic algae-based titanium oxide and cetyl trimethyl ammonium bromide nanocomposite (TO@CTAB) have been synthesized form the isolated strains. The results indicate that TO@CTAB demonstrates superior decolorization efficiency and a more substantial reduction compared to ZnO/GO, making it a versatile adsorbent for remediation applications.

Keywords: Hot spring; Nanoparticles; Nutraceuticals; Pigment; Thermophilic cianobacteria

IL009

Unlocking Sustainable Farming Innovations with Microalgal Solutions

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Dr. Balasubramanian Paramasivan is serving as an Associate Professor in the Department of Biotechnology & Medical Engineering at National Institute of Technology Rourkela, India since April 2014. His research interests encompass bioenergy, environmental engineering and management, rural technologies, and sustainable development. He actively engages in conferences and research collaborations, working towards addressing environmental challenges and promoting sustainable solutions.

ABSTRACT

Conventional agricultural practices often involve intensive resource consumption, leading to soil depletion, water shortages, and increased greenhouse gas emissions. To address these issues, sustainable agriculture has become vital to meet the growing global food demand while preserving natural resources. It focuses on maintaining long-term soil health, reducing environmental impacts, and ensuring food security for future generations. In this context, microalgae and their derivatives have emerged as promising biostimulants that can enhance plant growth, increase productivity, and promote sustainability in agricultural systems.

Microalgae can be integrated into agricultural practices in various ways. For instance, the use of live microalgal cultures in hydroponic systems has shown potential by promoting nutrient recycling, increasing dissolved oxygen, and improving root metabolism, thereby supporting plant health and nutrient absorption. Additionally, microalgal cellular extracts, when applied as seed primers or foliar sprays, have demonstrated benefits such as accelerated seed germination, increased biomass, and enhanced chlorophyll content, providing a natural growth enhancement. Furthermore, polysaccharides derived from the microalgae have also proven to be effective biostimulants, improving growth rates and biomass yield when added to the nutrient solution in hydroponic systems.

These approaches collectively illustrate the diverse potential of microalgae in agriculture, from whole cell use to derivatives, opening pathways for enhancing crop productivity and sustainable resource management. Further exploration of these approaches will be vital for enhancing the effectiveness and broader adoption of microalgal derivatives across diverse agricultural systems, contributing to a more resource-efficient, resilient, and sustainable agricultural future.

Keywords: Biostimulants; Crop Productivity Enhancement; Hydroponic System; Sustainable Farming.

IL010

Potential Role Of Freshwater Algae As A Natural Stimulator For Improving The Yield Of Wheat

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Dr. Amritpreet Kaur Minhas has been passionately involved in microalgal research for over 6 years after her Ph.D in the area of microalgal biodiversity studies, research in the field of Bioprospecting and Biorefining of algal metabolites for food and agriculture applications. Her current research include upscale of microalgal culture for its potential as carotenoids which can add value to the overall biorefinery concept. Further the biomass is explored for extraction of compounds specifically the biostimulants and bioactives for fertilizer application. She guided one PhD student on immobilization of enzyme for concentration of omega- fatty acids. She is also actively involved in DBT funded project on developing a nanoprobe for extraction of bioactive molecules from microalgae. She has been passionate about using algal extract as biostimulants to increase the photosynthetic efficiency in crops. She is the editorial board member of journal of microbiology and biotechnology. She has published 15 research article having 688 citations.

ABSTRACT

There are large number of biostimulants drawn from plants both terrestrial and from Ocean. Macroalgae is also one of them including seaweeds. On the contrary microalgae is mostly used for food supplements and Nutraceuticals application. Microalgae extract is a biostimulant especially formulated to improve the plant and soil health. When applied at the development stage of plants, algae extract accelerates vegetative plant growth, thus improving the crop yield. TERI has a unique state of the art facility for large-scale microalgae cultivation and germplasm collection with a wide diversity of strains from natural habitats for a variety of agricultural applications. The biostimulants produced in TERI are made with a number of consortia of indigenous algal species depending on the individual needs providing essential nutrients for crop development. TERI's biostimulants provide all-in-one liquid concentrate extracted from consortia of microalgal species. It contains macronutrients which deliver all the necessary macronutrients with high amount of nitrogen, phosphorus, potassium (NPK) which greatly boost plant growth and micronutrients including iron, molybdenum, calcium, and magnesium, high carbon and proline content, which demonstrated it higher efficiency in plant growth and crop yield in wheat after foliar application. The extracts also contain proteins, amino acids, polyunsaturated fatty acids (PUFAs), pigments, and minerals which is used as nutrient source for various crop applications and protect plant against abiotic stress. The objective of this study was to evaluate the effect of algae extract as foliar spray on wheat yield. Field trials were conducted in randomized blocks with 3 replications per treatment. Recommended dose of fertilizer were used as absolute controls. Each treatment were evaluated and harvested at end of season. Results showed a significant effect on the yield contributing characters, such as overall yield, no.of tiller, Soil and plant development (SPAD), and thousand grain weight.

***Keywords*:** Microalgae; Wheat; Yield; Biostimulants; Foliar

IL011

Integration of algal biorefinery in the compressed biogas project

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He has also gained international exposure by participating in the Indo-German training programme at TU Berlin, Germany, and presented his research findings at the "Algal Research" conference, USA.

ABSTRACT

Ever-escalating global energy demand and global warming due to the burning of fossil fuels encourage the necessity for exploring and implementing alternate clean, green, and sustainable energy resources. Production of biogas and compressed biogas (CBG) have proven their sustainability through their commercial production in the recent past. However, carbon dioxide and digestate effluent are among the key challenges that need to be addressed. In this context, algal-mediated bioremediation of anaerobic digestate effluent and CO2 sequestration were found to be one of the promising processes. This organic waste is rich in nutrients such as nitrogen, phosphorous, organic carbon, and micronutrients that support superior algal biomass production. Simultaneously, the CO2 produced from the biogas plant helps algal culture pH and delivers superior biomass yield. The biomass obtained from this process can be further valorized for biofuel, nutraceuticals, and other high-value products such as biochar, biofertilizer, etc.

***Keywords*:** Algae; Biogas; Biorefinery; Bioremediation; Carbon sequestration;

IL012

Innovation and Research Trend in Algal Technology

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ABSTRACT

In recent year, Liquid Biphasic System (LBS) has become a proven tool used in separation and purification technology for circular bioeconomy in microalgae biorefinery. The application of Internet of Things (IoT) in LBSs in clarification, partitioning and partial purification of biomolecules and bioproducts had showed the rapid development. This method is able to give high recovery yield and high purity in a single step. The LBS shows characteristics of high selectivity and is easily to scale up. Therefore, LBS offers an attractive alternative that meets the requirements of the high demand in industry processes and it is also beneficial in terms of economic and environmental protection. This presentation aims to share on the recent literature works in the development of different type of LBSs and their applications in novel separations and purifications of biomaterials. Hopefully this presentation will able to build solid research collaborations among industry players and researchers.

Keywords: Algal; Circular Bioeconomy; Liquid Biphasic System; Internet of Things; Microalgae; Biorefinery

IL013

Seaweed-Based Bioplastics: A Sustainable Alternative for Packaging Applications – Opportunities and Challenges

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Dr. Rajasri Yadavalli, Associate Professor and Head of the Department of Biotechnology at CBIT, Hyderabad, has over 20 years of teaching and research experience. A Ph.D. graduate in Biotechnology from JNTUH, she is a recipient of the prestigious Young Engineer Award (2013-14) in Chemical Engineering from the Institute of Engineers, India.

With 31 publications, an H-index of 12, and 890 citations, Dr. Rajasri's research focuses on algal biofuels, bioplastics, and sustainable packaging. She published three patents, including innovations in microbial pigments and biodegradable seaweed-based films. Her work on sustainable biopackaging earned first prizes at the Women Hackathon 2.0 (2024) and the 9th International Food Convention (2023) organised by CFTRI,Mysuru.

As Project Coordinator of CBIT's Atal Community Innovation Center, funded with Rs. 2.25 crores, Dr. Rajasri promotes entrepreneurship and innovation. She has also led a DBT-funded project on algal biodiesel production worth Rs. 33.82 lakhs and completed a consultancy project on carbon capture devices using algae.

ABSTRACT

Seaweed-based bioplastics are emerging as a possible alternative to traditional petroleum-based plastics in packaging applications. These bioplastics, made from marine algae, provide a sustainable and biodegradable answer to the environmental problems caused by plastic pollution. Seaweed-based bioplastics are generally made up of polysaccharides such as alginate, carrageenan, and agar, which are derived from different seaweed species. These biopolymers have outstanding film-forming capabilities when combined with various plasticizers and compatibilizers, making them ideal for creating flexible and long-lasting packaging materials. Research has revealed that seaweed based bioplastics can inadiition efficiently preserve food from rotting and contamination, while also providing potential benefits in terms of gas barrier characteristics and mechanical strength. However, challenges remain in improving the characteristics of these bioplastics to fulfil the specific needs of various packaging applications. These issues include increasing the mechanical strength, water resistance, and thermal stability of seaweed-based bioplastics, as well as lowering production costs. Additional research and development are required to overcome these issues and improve the overall performance of seaweed-based bioplastics. Some potential tactics include combining seaweed-based polymers with other biodegradable materials, changing the chemical structure of seaweed-derived polymers, and inventing novel processing methods. Furthermore, increasing the output of seaweed biomass and perfecting extraction procedures are critical for making seaweed-based bioplastics profitable. By overcoming these challenges and advancing the technology, seaweed-based bioplastics have the potential to revolutionize the packaging industry and contribute to a more sustainable future.

***Keywords*:** Seaweeds, Bioplastics, Alginate, Carrageenan, Agar, Plasticizers, Compatibilizers.

IL014

Sustainable Microalgae Biomass Production In Food Industrial Wastewater: A Circular Bioeconomy Approach

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ABSTRACT

Microalgae are potent photosynthetic cell factories with plethora of biomolecules suitable as feedstock for feed, food, pharmaceuticals, nutraceuticals, and biofuels. The application of microalgal biomass in industry is challenging due to the cost associated with biomass production and its harvesting. Food industry wastewater attracts mass production of microalgae because of its low toxicity and ability to reduce freshwater load. Due to the high cost of traditional wastewater treatment and management processes, it is crucial to implement low-cost wastewater treatment methods that can generate revenue from various products. Microalgae are recognized as biocatalysts for the pollutants bioremediation. Microalgae-based wastewater bioremediation presents a viable alternative for recovering resources from wastewater, thereby providing low-cost biomass feedstock for industry. Here, we are highlighting the potential of microalgal growth and biomass production, along with various biomolecule characterizations in food industrial wastewater like dairy processing wastewater (DPWW). The cultivation of Neochloris sp. SK57 in DPWW yielded a maximum biomass of 1.6gL^{-1}. The chlorophyll, carotenoids, proteins, polysaccharides, and lipids are 29, 16.9 mg g^{-1}DW, 42.2%, 29.4%, and 26.8% DCW, respectively. Neochloris sp. removed 92% COD, 93% nitrogen, and 63% phosphate, respectively. The fatty acid profile of this microalga demonstrated its potential application as antimicrobials, biofuels, food additives, and nutraceuticals. The protein content from microalgae demonstrates its potential as a feedstock for vegan and animal protein sources in the food and feed industry. Data highlighted that integrating mass production of algal biomass in dairy processing wastewater (DPWW), is a sustainable approach for multi-bioproduct conversions within a circular bioeconomy framework.

***Keywords*:** Bioeconomy, Bioremediation, Dairy processing water, Food industrial wastewater, microalgae

IL015

Hydrothermal liquefaction of microalgae in methanol-water system for bio-crude production and its upgrading to transportation fuel

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ABSTRACT

Renewable energy obtained from biomass, which is sustainable and environmentally friendly, favors reduction of global warming and thus is highly desirable. Compared to pyrolysis of biomass, hydrothermal liquefaction (HTL) process requires lower temperature, and possesses high energy efficiency. Microalgae is considered as one of the most suitable and alternatives feedstock for biodiesel

production, due to its advantages such as fast growth rate, high oil content, high photosynthetic efficiency and lack of arable soil requirements. Hydrothermal liquefaction (HTL) of microalgae for production of biofuel under milder condition may confirm its feasibility as sustainable biofuel source. In this research, methanol was introduced along with water as a reactive organic polar solvent into the hydrothermal liquefaction process because lipid content in microalgae is more soluble in methanol and favors liquefaction process. Also, methanol can react with acidic compounds by transesterification reaction and produce biodiesel. In this study, the effects of temperature and reaction time on HTL of microalgae was investigated with 20% biomass loading at temperature of 222-322°C, and reaction time of 10-60 min at constant pressure of 11.5 MPa in an autoclave using response surface methodology. The optimum yield of bio-oil (57.8 wt %) was obtained with 75wt % of methanol in water at 272 °C and reaction time of 35 min. Bio-oils obtained from different reaction conditions were extensively characterized for their quality by CHNS, NMR spectroscopy and simulated distillation (Sim-Dist) techniques to ascertain their respective elemental compositions, functional groups, as well as, boiling point distributions.

Keywords**:** Microalgae; hydrothermal liquefaction; bio-crude; hydrodeoxygenation; clean fuel

IL016

A Tale Of A Light-Inspired Journey For The Design And Development Of A Flue-Gas CO_2 Based Microalgal Biorefinery

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Dr. Ramkrishna Sen is a Professor, Department of Bioscience & Biotechnology, IIT Kharagpur. He served as Manager (R&D-Biotech), Cadila Pharma Ltd., Ahmedabad and Fulbright Visiting Professor at the Columbia University, USA. He is engaged in R&D activities in Energy-Environment-Water-Healthcare nexus, with a focus on Bio-Process-&-Product Development in Microbial-&-Microalgal Biorefinery Models. So far, 30 students completed Ph.D under his guidance/joint-guidance. He has ~180 journal publications (Citations ≈14000; H-index = 59), 14 patents and 7 books to his credit. Prof. Sen's name featured in the World Ranking of Top 2% Scientists. He has been bestowed with several national and international honours.

ABSTRACT

Algal research has come of an age through innovations at the process and gene scales, and has advanced to the status of potential industrial significance as a biorefinery platform to meaningfully address some of the contemporary challenges of energy, environment, water, waste and society. Both micro- and macro-algae have been drawing attention for their new generation applications in food, pharma, energy, environment, water and healthcare sectors, thereby contributing to some of the seventeen sustainable development goals (SDGs) of the United Nations. Apart from their use for wastewater remediation and protein/functional food/nutraceutical applications, algae, particularly microalgae, have recently been developed as potentially useful feedstock for biofuels and value-added products like biopolymers, biopigments, PUFA, antioxidants etc. with concomitant CO_2 capture from polluted air/flue-gas from point sources, thereby achieving environmental sustainability and economic viability. Since 2009-2010, we have been engaged in R&D activities involving some promising microalgae as renewable sources of biofuels and have been able to develop processes / technologies / products at a pilot scale at TRL 4-6. Thus far, we have crossed a few milestones in our pursuit to derive some potentially sustainable and feasible solutions to the energy, environment, water and healthcare challenges in algal biorefinery model.

Keywords: Algal biorefinery; Algal biofuels & value-added products; Recent advancement; Semi-pilot scale cultivation; CO_2 capture; Waste valorization

IL017

Bioactive Metabolites From Chlorella Pyrenoidosa Exhibit Potent Antibacterial Activity Against Escherichia Coli: Implications For Microalgae-Mediated Pathogen Removal

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ABSTRACT

Microalgae-mediated pathogen removal (MAPR) from wastewater is an emerging domain. Chlorella pyrenoidosa-mediated Escherichia coli removal from wastewater has been recently demonstrated. During MAPR, microalgae have been speculated to accumulate antibacterial metabolites as a response mechanism to the bacterial presence. Hence, their analysis in the C. pyrenoidosa-based E. coli removal system is crucial for a comprehensive understanding of MAPR. Solvent-assisted extraction was employed for the extraction of intracellular C. pyrenoidosa metabolites. Substantial antibacterial activity was demonstrated against E. coli by acetone and methanol extract, with a minimum inhibitory concentration of 0.4 $mg.mL^{-1}$ and 2.5 $mg.mL^{-1}$, respectively. FTIR analysis revealed a higher abundance of specific functional groups corresponding to sulfate, esters, carbohydrates, alkanes/alkenes, and alcohols/phenols. Further, GC-MS profiling facilitated the identification of the bioactive metabolites, revealing a total of 39 compounds with potent antibacterial activity. The key bioactive compounds were fatty acid derivatives, alkanes and alkenes, phenolic compounds, derivatives of phthalate, caffeic acid, catechol, coumarin and pyrrole, alcohols and terpenoids. A bicyclic alkene, cis-Bicyclo[4.2.0]octa-3,7-diene, was the most abundant metabolite. Amide derivatives of myristic acid (C14:0), oleic acid (C18:1), and 3-octenoic acid were detected, along with the abundance of myristynoic acid. Overall, the findings provide valuable insights into the metabolite profile of C. pyrenoidosa for plausible applications in improving MAPR systems.

Keywords: algae; extract; fatty acids; intracellular; solvent

IL018

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Auxin Production by Cyanobacteria: Unlocking The Growth Potential Of Paddy Seeds With Aliinostoc Sp.

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Dr. Anjani Devi Chintagunta is Associate Dean of R&D and Associate Professor of Biotechnology at Vignan's Foundation. Holding a Ph.D. from IIT Kharagpur (2018), her research spans 2G bioethanol, cyanobacterial biofertilizers, and sustainable waste management. She has published 31 papers and 8 book chapters with an h-index of 17 and over 1,094 citations. Dr. Anjani has secured two major research grants from DST and ANRF and holds two patents. Focused on zero-waste management, she is currently studying cyanobacteria for agricultural and industrial applications. Presently, she is acting as reviewer for 10 prestigious journals. She is guided 3 Ph.D. students and actively contributes to conferences, workshops, and webinar globally.

ABSTRACT

Cyanobacteria, essential photosynthetic microorganisms in topsoil, play vital roles in preventing soil erosion, carbon and nitrogen fixation, and influencing soil hydrology. They produce numerous bioactive compounds, including lipopeptides, fatty acids, toxins, carotenoids, vitamins, and plant growth regulators. To evaluate their potential as plant growth promoters, soil samples from native paddy fields were collected, and cyanobacterial strains were isolated. Identification was performed using a polyphasic approach, encompassing 16S rRNA gene sequencing, phylogenetic analysis, and morphological and ecological assessments.

Microscopic examination revealed heterocytes and continuous akinetes, while transmission electron microscopy confirmed well-organized photosynthetic structures and nutrient storage mechanisms. Phylogenetic analysis authenticated the isolate as Aliinostoc sp., capable of synthesizing an auxin-like compound under varying tryptophan concentrations. This compound, identified as indole-3-acetic acid (IAA) through thin layer chromatography (TLC) and Fourier-transform infrared spectroscopy (FT-IR), was quantified at 126.26 ± 1.42 µg/mL using high-performance liquid chromatography (HPLC). Further, the paddy seeds were treated with the cyanobacterial extract containing IAA to evaluate the plant growth-promoting ability. In vitro experiments demonstrated that paddy seeds treated with the extracts achieved a germination rate of 95.55%, with significant root elongation (10.55 cm) and maximum shoot growth (7.24 cm) on 12th day. Additionally, enhancements in chlorophyll content (3.17 mg/g), fresh weight (0.63 g), dry weight (0.07 g), and total nitrogen content (0.70%) were recorded. These findings underscore the auxin-producing capacity of Aliinostoc sp. and its efficacy in promoting seed germination, root development, and overall plant growth for sustainable paddy cultivation.

Key words: Aliinostoc sp. Auxin, Cyanobacteria, IAA, Polyphasic approach, phylogenetic analysis, 16S rRNA gene sequencing

IL019

Biohydrogen production from red algal hydrolysate using dynamic membrane bioreactor

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ABSTRACT

Renewable H_2 via dark fermentation can produce from various complex organic waste such as algal biomass, food waste, agriculture waste, and it can be considered as clean, sustainable, and low carbon fuel. To achieve the high continuous H_2 productivity from organic waste, operation methods for growth and maintenance of H_2 producing bacteria in continuous system is necessary. Dynamic membrane bioreactor (DMBR) is highly permeable layer of biofilm formed on top of a support material, which would be maintained the H2 producing bacteria abundantly in a continuous system. Furthermore, successful high-rate H2 production was reported by optimizing the conditions such as shear velocity, substrate concentration, HRT, which system showed achievement of high H2 productivity and stability compare with other systems. This study aimed to achieve continuous high-rate H2 productivity from algal biomass using DMBR. A lab-scale DMBR was continuously fed with diluted as 20 g/L hexose of algal biomass for 109 days. Metabolic flux and microbiome were conducted to estimate the fluxes of carbohydrates to H2 and soluble by-products in dark fermentation.

Keywords: Dynamic membrane bioreactor; Dark fermentation; Algal biomass

IL020

Sustainable Production Of 5-Hydroxymethylfurfural From Microalgal Biomass: Optimization, Catalysis, And Therapeutic Potential

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Soumya Sasmal is presently employed as an Assistant Professor in the Department of Biotechnology at Visva Bharati, West Bengal, India. He has a master's in biotechnology and a PhD in chemical engineering. He has over three years of industrial research experience as a scientist and more than ten years of teaching and research experience at Netaji Subhas University of Technology New Delhi and the Centre of Innovative and Applied Bioprocessing in Mohali. His primary research interests include the advancement of bioreactors for biofuel production from lignocellulosic biomasses and microbial fermentation.

ABSTRACT

A sustainable approach for producing value-added compounds from algal biomass, specifically the furan molecule 5-hydroxymethylfurfural (HMF), is the primary focus of this work. This pathway will be developed by catalytic conversion. With the diminishing fossil resources, utilising microalgae as an alternative to petrochemical sources is a solution to the growing demand for essential chemicals. With the help of this research, the conditions for producing Chlorella sorokiniana in a unique electromagnetic photobioreactor (E-PBR) have been optimised, resulting in an increase of 12% in the biomass output and a 15% increase in the carbohydrate content within the E-PBR. In the conversion process, metal chlorides, most notably aluminium chloride (AlCl2), are utilised, producing up to 65.78% HMF in a DMSO reaction system. To produce HMF effectively, several reaction parameters, such as temperature and catalyst concentration, were enhanced. Additionally, the therapeutic potential of HMF and its derivatives was examined by computational studies, which revealed substantial interactions with targets related to targets related to anti-quorum sensing, Alzheimer's disease, and antibacterial activity. As a biofuel precursor and a platform for bioactive chemicals, the generation of hydrogen methyl ferrite (HMF) from microalgae is a double-edged sword, as these data demonstrate. This strategy promotes a sustainable, renewable chemical industry alternative by demonstrating algal biomass's versatility for high-value applications.

Keywords: Algal biomass, Bioactive compounds, Catalytic conversion, Electromagnetic photobioreactor, Microalgae-derived 5-HMF

IL021

Nutrients And Organic Removal Through A Moving Bed Membrane Photobioreactor

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I am interested in environmental engineering processes for water and waste treatment/remediation, environmental materials, energy and resources recovery.

ABSTRACT

Recently, the microalgae-based wastewater treatment process has been considered efficient for nitrogen removal and environmentally friendly. This study used a moving bed-membrane photobioreactor (MB-MPBR) to treat the anaerobic effluent. A 4 L photobioreactor with novel suspended sponges for maximizing the bacteria-microalgae biomass coupled with an external membrane module to keep the permeate reaching the discharged limit standards of Viet Nam. MB-MPBR system was operated under the light transparent of about 3000 lux, a light: dark cycle of 12h:12h, and a mixed activated sludge-microalgae ratio of 3:1, with a suspended biomass retention time of 7 days. The microalgae seed source for this study was Chlorella sp. The total biomass of 20 % and 10 % sponge (v/v) were 1825±187 mgMLSS/L and 2240±119 mgMLSS/L, where biomass productivity was 103.91±19 mgMLSS/L.d and 90.79±13 mgMLSS/L.d. Besides, the COD removal efficiency of about 98±1.6% for both carrier ratios. The ammonium removal efficiency of approximately 95%, and 81%, and TP removal efficiency of 32±6.3%, and 83±6.3%, respectively, at an organic loading rate of 0.2 kg COD/m3.day and nitrogen loading rate of 0.065 kg TN/m3.day. SEM images indicated that microalgae and bacteria attached on both the surface and deep inside of the carriers. These results showed that MB-MPBR could be an effective algal biomass production method that can be applied to create valuable products from microalgae.

Keywords: biomass production; membrane; microalgae; photobioreactor; sponges

IL022

Use Of Industrial Waste Like Slag And Waste CO_2 For Generation Of High Value Algal Biomass

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Dr Nilotpala Pradhan received her PhD in Biochemistry from Nagpur University. She has research experience of 22 yrs. She is working as Senior Principal Scientist at CSIR-Institute of Minerals and Materials Technology, Bhubaneswar. Her research area includes mineral bio processing and algal CO2 sequestration. She is recipient of prestigious "National Geosciences Award-2012" awarded by Ministry of Mines. Her name features in listed Top 2 % scientists in world by Scopus. To her credit above 5500 citations with h-index of 36 and i10-index of 66 as per Google Scholar website. Nine students have already completed their PhD while 8others are continuing.

ABSTRACT

Power plants, iron and steel industries use coal /coking coal/coke, generating huge amount of flue gas and blamed as major green-house gas (CO_2) emitters. They need ecofriendly, low cost technology to reduce their CO_2 gas emission. Such applications may help industry in getting green / carbon credits.

Microalgae when grown in large quantity near the point source of CO_2 in presence of water, sunlight and few commercial fertilizers can not only decrease CO_2 emission but also convert the waste CO_2 into valuables. These valuables include commodities like renewable biodiesel and commercially important bioactive molecules like carbohydrates, proteins, lipids (PUFA, MUFA) and antioxidants for nutraceutical applications.

For enhanced algal growth a CO_2 gas scrubber or intermediate CO_2 sequestration agent may be used to enhance CO_2 capture. Some mineral industry wastes with high alkalinity like LD slag and red mud were introduced into the growth medium individually and its effect on pH of the medium and subsequent algal growth was studied. Results show that the biomass growth was best with NaOH followed by LD slag. In case of red mud the biomass growth was hampered.

***Keywords*:** Algal biomass, Mineral industry waste, LD slag, Red mud, CO2 sequestration

IL023

Transcriptional Engineering Of Chlamydomonas Reinhardtii For The Production Of Carbon Storage Metabolites

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ABSTRACT

Microalgae are diverse microorganisms that are continuously explored as novel sources of metabolites for nutraceuticals, pharmaceuticals and the biofuel industry. However, the optimal yield and productivity of metabolites such as carbohydrates and lipids from natural strains still remain a big challenge. The cultivation conditions, such as nutrient starvation, can boost the accumulation of carbon storage metabolism, such as carbohydrates and lipids, but simultaneously compromise the overall algal growth. To overcome these limitations, strain improvement through genetic engineering could play an essential role in improving the production of metabolites without compromising the growth. The continuous advances in genetic engineering tools are slowly paving the way for algal industries to have high-yielding microalgae strains with the capacity to produce desired metabolites. Transcription factors (TF) are gaining continuous interest as a potential target for genetic manipulations as their engineering could provide stronger up-regulation of desired metabolic pathways. In an effort to identify key TFs involved in carbon storage metabolism, here we have characterized the function of phosphate stress induced TF PSR1 in Chlamydomonas reinhardtii in regulation of carbon storage metabolism.

Keywords: Microalgae, Transcription factors, Genetic engineering, Carbohydrate, Lipids, Biofuels.

IL024

Bioactive Potential Of Macroalgal Oligosaccharides Produced Using Enzymes From Macroalgae-Associated Bacteria

Algae-Derived Therapeutics And Functional Foods

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ABSTRACT

Global requirements for functional foods are increasing progressively. Macroalgal polysaccharides are used as an additive in various formulations to delay and prevent the onset of chronic diseases and as an active pharmaceutical ingredient. However, enzymatic hydrolysis of these polysaccharides into oligosaccharides can greatly improve the bioutilisation efficiency of algal products. These macroalgal oligosaccharides with good bioactivity can be efficiently used in healthcare applications. To estimate the potential of macroalgae associated bacteria, approximately 500 isolates were qualitatively characterised for polysaccharide hydrolyzing activity and only about 5 to 15% of the isolates were found to have the potential for the production of enzymes to break down the complex macroalgal polysaccahrides. Two potential macroalgae associated bacteria, Bacillus subtilis NIOA181 and Bacillus australimaris, NIOA284 were isolated from green and red macroalgae showed the highest ulvan lyase and porphyranase activity. These enzymes were partially purified and used to hydrolyse ulvan and porphyran into their respective oligosaccharides. Structural characterization of these oligosaccharides showed that ulvan and porphyran oligosaccharides were predominantly composed of di-, tri-, and tetrasaccharides of backbone monomers. Results showed that the enzymatically produced oligosaccharides exhibited prebiotic activity by promoting the growth of probiotic bacteria and suppress enteric pathogens which were higher than parent polysaccharides and equivalent to commercial prebiotic compound fructooligosaccharides. Results showed that the enzymatically produced oligosaccharides exhibited prebiotic activity by promoting the growth of probiotic bacteria and suppressing the enteric pathogens. These bioactive enzymatically produced can be widely used as active pharmaceutical ingredients in nutraceutical and healthcare applications.

Keywords: marine; oligosaccharides; porphyranase; seaweed; ulvan lyase

IL025

Implications Of Quorum Sensing Mechanisms In Synthetic Ecology Inspired Models Of Algae-Bacteria And Prospective Lipid Amelioration

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ABSTRACT

Quorum sensing (QS) of bacteria in the phycosphere affect algal physiology through two important ways: 1. Intervention in host physiology through growth promoting and algicidal compounds 2. Changing microbiome structure of the phycosphere of the hosts. However, the knowledge is highly restricted in physiology of host microalga in relation to the respective quorum sensing molecules of phycospheric bacteria. This presentation will include the synthetic ecology model of algae- bacteria for biofuel competence through understanding quorum sensing activity in Chlorella sp. and Tetraselmis striata culture and, independent effect of QS molecules on metabolism.

Further, investigated the impact of bacterial quorum sensing precursors- N-(3-Oxododecanoyl)-L-homoserine lactone and N-(3-Hydroxyoctanoyl)-DL-homoserine lactone on the lipid metabolism of microalgae, specifically Chlorella sp., under axenic and xenic conditions. Results show that these precursors change lipid composition, increase lipid productivity (2-4.5 times), and improve biomass productivity (~2-4.2 times). They also improve fatty acid composition, affecting biodiesel properties. The study also reveals that these precursors mediate antioxidant levels, key enzymatic activity, accumulate lipids, and encourage biomass amelioration, highlighting the potential of quorum sensing in improving biofuel competence.

Keywords: Algae; Bacterial Quorum Sensing; Biodiesel; Lipid metabolism; Synthetic ecology

IL026

Transforming Challenges Into Solutions: The Prebiotic Benefits Of Chlorella Sp. For Shrimp Health

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Dr. N.S. Sampath Kumar's research emphasizes extracting bioactive compounds from underutilized fish resources, with applications in food and biomedical industries. His innovative work extends to aquaculture, where he explores herbal extracts to boost the health of cultured fish and shrimp. His team is currently working on developing synbiotics using microalgal polysaccharides as prebiotics. Dr. Sampath has published over 60 peer-reviewed articles, with 1718 citations, an i10 index of 22, and an h-index of 30. He currently oversees two DST projects worth of Rs. 1.783 Lakhs, mentors Ph.D., B.Tech., and M.Tech. students, and has successfully awarded one Ph.D. under his guidance.

ABSTRACT

Chlorella sp. is one of the most widely cultivated eukaryotic green microalgae, prized for its rich nutritional profile, which includes proteins, polysaccharides, carotenoids, phycobiliproteins, vitamins, and sterols. Beyond cultivated ponds, it thrives in various water bodies and can bloom rapidly when nutrients are available. This resilience has posed challenges for mass production of cyanobacteria at VFSTR-STI HUB. However, after extensive studies on Chlorella's growth capabilities, we identified strategies to turn this challenge into an opportunity for aquaculture.

Our investigation focuses on the prebiotic potential of polysaccharides from Chlorella sp., laying the groundwork for a sustainable and nutritious food source for shrimp. We prepared the polysaccharides and analyzed their physicochemical characteristics. The digestibility and fermentation properties were assessed using in vitro models. The findings revealed that the polysaccharides consist of five non-starch fractions with monosaccharide compositions including Man, Rib, Rha, GlcA, Glc, Gal, Xyl, and Ara. While these polysaccharides remained intact under in vitro midgut digestion conditions, their molecular weight and levels of residual carbohydrates and reducing sugars significantly decreased under hindgut digestion conditions. Importantly, the polysaccharides from Chlorella sp. were found to effectively modulate gut microbiota, promoting the growth of beneficial bacteria while inhibiting harmful ones, thereby supporting intestinal health and disease prevention.

Keywords: Chlorella; Gut microbiota; Polysaccharides; Prebiotic; Shrimp.

IL027

Microalgae Biorefinery Towards A Circular Economy: A Path For Harnessing Multiple Products For Sustainable Development

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ABSTRACT

Transition to a circular bioeconomy to meet global material and energy concerns is essential for achieving sustainability. Photosynthesis, a natural biological process has potential to convert solar energy into biomass, bioproducts, and biofuels. Photosynthetic cultures can fix approximately 40% of CO_2, and utilize nutrients from carbon sources for growth and energy production. This unique capacity requires utmost emphasis to harness to generate a diverse range of products across food, feed, energy, agriculture, and health sectors, emphasizing self-sustainability within an integrated biorefinery framework. The research was initiated by screening and isolation of microalgae from various water bodies. Sequentially designed studies assessed the role of isolated microalgae for biomass and bioproducts generation, specifically emphasized for wastewater treatment. The results based on objective-based research supported the looping of individual bioprocesses to optimize nutrient-rich

biomass, enhance product and energy generation, and facilitate resource recovery with minimal discharge. Eventually, microalgae biorefinery with target approach was developed, integrating photosynthesis and fermentation to maximize the utilization of biomass and its derivatives for multiple products. The established self-sustainable biorefinery platform leverages sunlight, atmospheric CO_2, and wastewater through photosynthesis to produce biomass that can serve as direct feed for livestock or as feedstock for various bioprocesses aimed at generating biobased products (biofuels, bioalcohols, biomolecules), while also contributing to waste remediation, carbon neutrality, and environmental sustainability. Collectively, aligning microalgae biorefineries with the UN Sustainable development goals (SDGs) boosts sustainability with the aforementioned applications and fostering towards circular economy.

***Keywords*:** Circular Bioeconomy; Carbon-neutral; Net-zero Emissions; Photosynthesis; Sustainability.

Abstracts of Contributory Presentations

SOP 001 - Palette of colours from a novel, non-model green alga: stress based modulation of carotenoid production in Graesiella emersonii

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ABSTRACT

This study aims to investigate the effects of stress conditions, such as salinity, nutrient starvation, osmotic stress, oxidative damage, and the growth profile of a novel strain, Graesiella emersonii, under different trophic states. The strain, isolated from a heavy metal contaminated site, exhibited carotenoid accumulation in the late stationary phase under photoautotrophic conditions. As the carotenoid accumulation was observed in the late stationary phase, it was hypothesized that carotenoid synthesis was triggered by stress. Therefore, carotenoid accumulation was studied in detail in this strain under various conditions. Under each stress condition, distinct regions of the carotenoid synthesis cycle were activated, leading to the production of various carotenoids, including β-carotene, zeaxanthin, lutein, neoxanthin, violaxanthin, and astaxanthin. This novel strain produces 2.857 mg/g DCW of β-carotene under normal conditions and 3.5 mg/g DCW in F media, which is comparable to the 3 mg/g DCW produced by Dunaliella salina CCAP19 in batch processes[1]. This indicates potential for cultivation in seawater environments. Additionally, lutein production under normal laboratory conditions (BG-11 media) reaches 3.027 mg/g DCW, which aligns with the highest reported yields from marigold flowers—widely used for commercial lutein production—ranging from 0.17 to 5.7 mg/g DCW[2]. There is a proportional increase in astaxanthin production with rising salinity. Astaxanthin levels double from 0.11 mg/g DCW at 1% salinity to 0.25 mg/g DCW at 3% salinity. This behavior is similar to other high-yielding commercial carotenoid-producing strains, such as Dunaliella salina and Haematococcus pluvialis. This study represents the first report of a single microalgal species capable of producing such a diverse array of carotenoids in response to environmental stress. The versatility of Graesiella emersonii suggests its strong potential for further commercial exploitation, particularly in the nutraceutical and cosmeceutical industries.

Keywords: Carotenoids, cosmeceuticals, microalgae, nutraceuticals.

SOP 002 - Impact of Stress and Carbon Sequestration on Polyhydroxybutyrate (PHB) Production in Synechococcus elongatus

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ABSTRACT

Algae-based biopolymers such as Polyhydroxybutyrate (PHB) present sustainable alternatives to conventional plastics due to their biodegradability and non-toxic nature. **Synechococcus elongatus** (S.E) was selected for its high CO_2 sequestration potential, rapid growth, and tolerance to elevated temperatures. This study examined PHB production in **S.E** cultures grown under varying salt stress concentrations (50-200 mM) in BG-11 medium, as well as the effects of additional carbon supplementation. Cultivation in 250 mL flasks at 35°C, 87.75 µmol $m^{-2}s^{-1}$ light, and 120 rpm shaking revealed PHB production of 6.09 mg/L in standard BG-11 medium. Acetate (0.1%) and bicarbonate (0.1%) supplementation enhanced PHB yields to 22.84 mg/L and 18.66 mg/L, respectively. Under 100 mM salinity combined with bicarbonate (0.1%), PHB concentration increased to 22.03 mg/L compared to 11.25 mg/L under salinity stress alone.

A subsequent scale-up study in a 30L photobioreactor, utilizing 50% BG-11 medium enriched with 40% CO_2, revealed similar trends. The culture's pH was maintained at 8-8.5 using an automated CO_2-nitrogen control system. Biomass growth, measured as dry cell weight (DCW), increased from 310 mg/L on Day 6 to 630 mg/L by Day 18. PHB accumulation followed a similar trajectory, rising from 4.82 mg/L on Day 6 to 13.23 mg/L by Day 18. These findings highlight the potential of **S.E** for scalable PHB production, particularly under optimized salinity and carbon supplementation conditions.

***Keywords*:** CO_2 sequestration, PHB, Salinity, Synechococcus elongatus

SOP 003 - Optimizing algal biofilm efficiency with HRTs for wastewater remediation: An experimental solution

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ABSTRACT

This research focuses on selecting the most suitable algal strain for biofilm formation and the ability to develop appropriate cultures using different strains and different wastewater concentrations (WWT) to further improve nutrient removal and biomass accumulation for wastewater treatment. Four algal strains including, Chlorella vulgaris, Chlamydomonas reinhardtii, Scenedesmus vacuolatus and Chlorococcum humicola were tested at 0%, 25%, 50%, 75% and 100% wastewater concentrations. Algal biofilm cultivation over a 20-day period with a 16:8 light-dark cycle was analyzed on plexiglass sheets, that had been used before as substrates to reduce confounding factors in previous experiments. Biofilm development was determined by measurements of biomass increase together with other physicochemical and biochemical factors including chlorophyll concentration in different strains and at different concentration levels of wastewater. Chlamydomonas reinhardtii strain showed biofilm formation highest for the 75% WWT concentration. Lower wastewater concentrations were stimulatory for algal growth but lower biofilm densities were observed at these concentrations and 100% wastewater concentration reduced biofilm formation probably due to the inhibitory effects of high organic load and possible toxicity. Moreover, the utilization of plexiglass as the choice of substrate material for biofilm maintenance seemed efficient; hence an idea that by offering some encouraging possibility, could make biofilm setup in a scaled environment cost-efficient. The results of this study provide crucial information on the desirable maximum strain and wastewater concentration for algal biofilm based systems and establishes a starting point for future investigations into issues of longer term stability and practical performance of such systems in real-time wastewater.

***Keywords*:** Algal biofilm, HRT, Substrate, Wastewater concentration

SOP 004 - Salt stress induced metabolite accumulation and Extracellular Polymeric Substances (EPS) secretions in microalgae: A potential mechanism for cell survival

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ABSTRACT

Microalgae are reservoirs of natural compounds with wide range of applications in various industries. These natural compounds include both intracellular and extracellular compounds produced by microalgae. In addition to primary and secondary metabolites produced and stored inside the cells, microalgae can also secrete various extracellular polymeric substances (EPS) into their surrounding environment during their life cycle. Microalgal EPS mainly consist of polysaccharides, proteins, nucleic acids and lipids. The composition and the amount of EPS secretion varies among species and cultural conditions. EPS secretion is a complex process involving cell signaling and the components of EPS act as secondary messengers. EPS play a significant role in cell protection by cell aggregation particularly when the cells are subjected to stress. EPS also possess several applications in pharmaceutical and food industries along with its role in autoflocculation. In this study, we aim to analyse the change in metabolite accumulation and EPS secretion among the selected three freshwater microalgal strains (Chlamydomonas reinhardtii, Scenedesmus obliquus and Chlorella pyrenoidosa) with respect to salt stress. We observed significant changes in lipid, total carbohydrate accumulation and EPS (bound and secreted) majorly in Chlamydomonas and Scenedesmus species with increasing salt stress. Further, Light Microscopy results showed that the increase in EPS secretion is associated with cell aggregation, conferring protection against induced stress. These primary metabolite analyses were validated using FTIR and GC-MS. The antibacterial and antioxidant activity of the extracted EPS will be performed to identify their industrial applications.

***Keywords*:** Autoflocculation, Cell aggregation, Extracellular Polymeric Substances, Microalgae, Salt stress.

SOP 005 - Comparative Evaluation of Pyrolysis and Hydrothermal Liquefaction for Bio-Oil Production from Seaweed Wastes

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ABSTRACT

Seaweed or macroalgae have received huge attention as a viable renewable source for "third-generation" biofuel production. Seaweed is an underutilized renewable marine biomass resource for the production of specialty chemicals. Cultivated seaweeds, wastes accumulated in seashores, and residues generated after recovery of sap and phycocolloid processing can be engaged as feedstock for the conversion of biomass into specialty chemicals and energy using thermo-chemical conversion. In this perspective, the present study focussed on the sustainable utilization of beach-cast seaweed wastes (BCS) and seaweed residues after extraction of biostimulant (SRBS) as feedstock for the production of bio-oil using slow pyrolysis (SP), microwave pyrolysis (MP) and hydrothermal liquefaction (HTL). The proximate, ultimate, and biochemical analysis of both seaweed biomass was carried out. Thermal analysis was performed to determine the thermal decomposition regime and phase transitions. Py-GC-MS was employed to study the pyrolysis characteristics of the seaweed biomass wastes. Seaweed wastes were subjected to SP and MP at 600℃ and HTL at 300 and 350℃. The bio-oil yield is higher with SRBS (26.9%) using slow pyrolysis followed by HTL at 350℃ (20.8%). Microwave pyrolysis resulted in similar yields of bio-oil (~12%) for both wastes. Further, the composition of the bio-oil was analyzed using GC-MS. The major chemical constituents of bio-oil derived from these seaweed wastes include phthalate derivatives (SP), ketones, saturated hydrocarbons, and aromatic compounds ($HTL_{350,}$ $HTL_{300,}$ and MP). Hence this study demonstrates that thermochemical conversion would be a sustainable choice for the seaweed waste valorization.

***Keywords*:** Biorefinery; Hydrothermal Liquefaction; Macroalgae; Pyrolysis; Thermochemical Conversion.

SOP 006 - Iron Stress-Induced Mixotrophic Cultivation of Coelastrella sp. SVMIICT5 for Enhanced Lipid Accumulation

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ABSTRACT

Microalgae, as versatile photosynthetic organisms, hold significant commercial potential in the food, feed, and biofuel industries due to their ability to convert CO_2 into a range of bio-based products, including triacylglycerols (TAGs), saturated (SFA), monounsaturated (MUFA), and polyunsaturated fatty acids (PUFA). In this study, the microalga Coelastrella sp. SVMIICT5 was cultivated using a dual-stage approach, aiming to enhance lipid production and evaluate photosynthetic performance. Seven distinct treatment conditions (-N+C, -N-C, -Fe+C, -Fe-C, -Fe-N+C, -Fe-N-C) along with a control were employed to induce stress responses. Nutrient deficiency, particularly iron and nitrogen deprivation, led to a significant increase in lipid accumulation, particularly TAGs, as cells responded metabolically to stress by converting membrane lipids into fatty acids. Photosynthetic performance was monitored through chlorophyll a fluorescence parameters (Fv/Fm, ETo/RC, Abs/RC), net CO_2 fixation, and pigment levels and electron transport at the plastoquinone complex. The fatty acid profile predominantly consisted of saturated fatty acids, followed by unsaturated ones.

***Keywords*:** Bioeconomy, Dual-Pulse Amplitude Modulator (DUAL-PAM), Nutrient deficiency, Photosystems, Triacylglycerol (TAG)

SOP 007 - Metabolic Adaptations of Chlorella saccharophila to Elevated CO_2: Implications for Carbon Capture

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ABSTRACT

Microalgae, with their rapid growth rates and high photosynthetic efficiency, are emerging as promising alternatives for carbon capture. They utilize CO_2 for growth and convert it into biomass and high-value added renewables, offering a sustainable solution to mitigate greenhouse gas emissions. In this study, we are investigating how Chlorella saccharophila UTEX247 adapts its metabolism to thrive in a high CO_2 environment. We found that the strain significantly increased the production of carbon metabolites (up to 5.0-fold), like sugars and organic acids, indicating enhanced carbon utilization. Additionally, we discovered unique metabolites such as D-(+)-Turanose and Linoleic acid, suggesting the microalga developed specialized mechanisms to handle excess carbon. These results showcase the potential of this microalga for capturing and converting CO_2 into valuable biomass, which can be used for biofuels and other sustainable products. Such study advances our understanding of microalgal carbon adaptation, paving the way for optimizing strains for industrial-scale CO_2 capture and promoting a circular bioeconomy.

***Keywords*:** Algae; Bioeconomy; Biomass; Carbon capture; Metabolomics

SOP 008 - Explant priming with combination of bio-effectors improves adventitious lateral shoot development in marine red alga Gracilaria dura (C. Agardh) J. Agardh

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ABSTRACT

The use of bio-effectors for sustainable seaweed cultivation has gained much traction lately. This study investigated the effect of priming with 6-benzylaminopurine (BAP), Kinetin (KIN), and Ascophyllum nodusum extract (AMP) on survival, regeneration, and lateral shoot formation in red seaweed Gracilaria dura. Treatment with varying concentrations (0.0001, 0.001, & 0.01%) and exposure times (15, 30, & 60 minutes) was studied. Individual treatments improved survival, regeneration (up to 89.00 ± 5.48%) with BAP (0.01%, 60 min), and shoot formation (up to 5.18 ± 0.84 shoots per explant) with KIN (0.001%, 30 min) compared to controls. The combination of treatments enhanced the adventitious lateral shoot development showing the highest (2.36 ± 0.22 shoots per explant) lateral shoot formation was reported in BAP (0.01%, 60 min): KIN (0.0001%, 60 min): AMPEP (0.001%, 30 min) treatment. The study would benefit sustainable seaweed aquaculture. However, open-sea performance and agar quality studies require further evaluation.

***Keywords*:** AMPEP, Biostimulant, Gracilria dura, Adventitious laterals, Seaweed production, Priming

SOP 009 - Kinetic modeling and experimental investigation on Lipid and Polyhydroxybutyrate production in Chlorella and Co-culture cultivated in dairy wastewater

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ABSTRACT

Lipid and polyhydroxybutyrate (PHB) are two significant extracellular metabolites that algae produce in their cells and transported through the cell wall to the liquid culture upon suitable cell rupturing means. Algae store lipids in cell wall and intracellular organelles which serve as future food under nutrient deprivation. In this study chlorella/co-culture grown in open ponds are studied under nutrient deprived condition when cells produce polyhydroxybutyrate through acetyl-coA pathway and solvent extraction/hydrothermal method has been utilized to get the polymer available in aqueous phase. This polyhydroxybutyrate serves as a natural biodegradable polymeric material and has a comparable characteristic with poly lactic acid (PLA). Three main governing parameters towards PHB generation are carbon source, light intensity and nutrient availability in water in which algae are grown. Kinetic modeling on production and transportation of these two metabolites is tricky as their metabolic pathway of formation differs and parameters regarding intracellular mass flux of the intermediate metabolites formed are not easily identified in literature. We attempted the production kinetics based on Monod Model and incorporated the mass transport studies through the cell wall. This study will be helpful in predicting average yield of lipid/PHB from chlorella and co-culture grown in natural environment/ wastewater which in turn is related with specific growth rate of algae. Parameter estimation technique has been adapted in the model framework and lotka-voltera equation has been incorporated for depicting algal-bacterial interaction in co-culture.

***Keywords*:** Algae, co-culture, lipid, PHB, Kinetic modeling

SOP 010 - Algal-bacterial granules for remediation of wastewater containing emerging contaminants

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ABSTRACT

Tributyl phosphate (TBP) is a phosphate triester used as an extractant, plasticizer and flame-retardant in industries. Algal-bacterial granules were developed in a lab-scale bioreactor inoculated with activated sludge and operated in 24 h photo-sequencing batch reactor (SBR) cycle by feeding acetate-containing synthetic wastewater. The developed granules were compact and had excellent settling properties. NH_4^+-N, PO_4^{3-}-P and TOC removals were observed to be 95%, 80% and 83 %, respectively. Three photo-SBRs were setup for determining the effect and fate of TBP and its degradation products (i.e., dibutyl phosphate (DBP) and n-butanol). These photo-SBRs were inoculated with algal-bacterial granules and fed with 0.25 mM of TBP, DBP or n-butanol. Marked changes in the granules morphology and color were noticed in the TBP-fed photo-SBR. Apparent discoloration and chlorophyll content reduction up to 94.5 % was noticed by week 6 in TBP exposed granules. However, a significant improvement in the compactness and settling properties of granules of the granules was noticed in TBP-fed photo-SBR. In contrary, no major changes in the color and settling properties was noticed in DBP or n-butanol fed photo-SBRs. Distinct changes were observed in the nutrient removal properties in the photo-SBRs fed with TBP, DBP or n-butanol as compared to control. A significant decrease in TOC, N and P removal efficiencies was observed in TBP-fed photo-SBR. However, the impact of DBP and n-butanol on N and P removals were not significant as compared to control. These paper presents first-time results on the effect of TBP on algal-bacterial granules.

***Keywords*:** Algal-bacterial granules; Tri-butyl phosphate; Bioremediation; Wastewater; Emerging contaminant

SOP 011 - Studying effect of heat shock to algae with purpose to overcome afternoon short duration high temperature summer during outdoor cultivation

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ABSTRACT

Outdoor growth of microalgae in raceway ponds is only method by which large scale algal based CO_2 sequestration may be cost effective and biotechnologically possible considering high volume of CO_2 gas generated by industries. The most part of India experiences significant high temperature specially in summers (March to July). During this period the afternoon temperatures may peak above 40°C for 2 to 3 hours. This has adverse effect of growth of algae cultivated outdoor under the sun. This study examines the thermal tolerance, survivability and adaptive responses of two different algal strains to such temperature shocks in controlled laboratory experiments. Algal samples were subjected to temperature shocks for a fixed duration to mimic afternoon temperature conditions. Growth pattern and key growth parameters were monitored under such adverse conditions. This study aims to understand the potential of algae for survival under increasing global temperatures, and offering guidance for utilizing algae in biotechnological applications under thermal stress.

Keywords: Biomass productivity, Climate change, CO_2 sequestration, Microalgae, Thermal tolerance

SOP 012 - Seaweed biostimulant supplementation for and improved growth high light tolerance of Nannochloropsis oculata under Indian tropical light

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ABSTRACT

The cultivation of Nannochloropsis oculata under Indian tropical light encounters the challenge of oversaturation to high light intensity. The present study emphasized on the supplementation of seaweed biostimulants to improve tropical high light tolerance and biomass production of N. oculata. The N. oculata was supplemented with varying concentrations (0.05%, 0.1%, 0.2%, 0.4%) of three commercial seaweed biostimulants, namely, Sagarika (SG), Trust Basket (TB) and Seed2plant (SP) extracted from red and brown seaweeds. The application of all three seaweed biostimulants has facilitated the enhanced photosynthetic pigment, biomass, lipid, and EPA content of N. oculata. The nutrient uptake profile suggested 77-89% of successful utilization of seaweed biostimulant by N. oculata. The highest biomass was observed by SP 0.4% treatment with 1.37 g. $L^{-1,}$ with a 12% increase compared to the control 0.625 g. L^{-1}. Supplementation of seaweed biostimulant has also exhibited 8-10% increase in chlorophyll content. The improved chlorophyll content confirms that the seaweed biostimulants have positively contributed to the high light tolerance of 1080-1100 µmol photons m^{-2} s^{-1} illumination adapting the photosynthetic machinery. Seaweed biostimulant supplementation upregulated biomass and lipid content, leading to the highest EPA yield of 97.48 mg. g^{-1} amongst the treatments. The supplementation of seaweed biostimulants is a suitable and cost-effective approach and holds potential strategy for large-scale cultivation of N. oculata under tropical high light environments. The investigation demonstrates the integration of seaweed and microalgae cultivation for the purpose of establishing a comprehensive biorefinery.

***Keywords*:** EPA, Media Supplementation, Phototrophic cultivation, Seaweed biostimulants, Tropical Light

SOP 013 - Effect of culture conditions especially culture volume on co_2 sequestration and biomass production by microalgae.

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ABSTRACT

Large-scale cultivation of microalgae offers potential for sustainable biomass production, carbon sequestration, and bioenergy generation. Optimizing large-scale cultivation requires understanding the impacts of culture media, culture volume, and the combined effects of CO_2 concentration and aeration on microalgal growth. This study investigates the optimization of growth conditions for the IMMT-03 algal strain to enhance CO_2 sequestration and biomass production. Initial experiments evaluated different media compositions including Bold Basal Medium (BBM) &NPK and Urea fertilizer-based media. BBM shows the highest growth rate and biomass productivity, but its high cost due to high-grade chemicals limits its use at large-scale operations. The CO_2 enrichment and aeration significantly enhance algal growth and biomass productivity. CO_2 supplementation provided a crucial carbon source, while aeration improved gas exchange and nutrient distribution, creating an efficient culture environment. The scalability of selected algal strain cultivation was tested across volumes from 100 mL to 3000 L, revealing a decrease in productivity as culture volume increased, likely due to limitations in light penetration, nutrient diffusion, and gas exchange. Despite these challenges, large-scale cultivation is crucial for maximizing CO_2 sequestration. This research provides valuable insights into optimizing microalgal cultivation systems focusing on cost-effective media, the synergistic effects of CO_2 and aeration, and scalability for industrial-scale applications.

***Keywords**:* Biomass productivity, CO_2 fixation, Microalgae, Sustainable biomass production.

SOP 014 - Designing Phaeodactylum tricornutum as a host chassis for sustainable aviation fuel biosynthesis

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ABSTRACT

The aviation industry's increasing demand for sustainable and renewable fuel sources has spurred research into alternative options for jet fuel production. Among these alternatives, terpenes have emerged as promising candidates due to their high energy density and compatibility with existing aviation infrastructure. Among terpenes, limonene, a monoterpene abundantly found in plants, holds potential as a renewable jet fuel precursor due to its potential as a drop-in replacement for conventional jet fuel. However, current production methods from plant sources face challenges in yield and feasibility, coupled with limitations in limonene extraction, thus failing to meet the rising demands of the aviation industry. In this study, we explored the synthesis of the monoterpene limonene by heterologously expressing a codon-optimized limonene synthase gene from Mentha spicata in the diatom Phaeodactylum tricornutum. Employing a conjugation-based episomal expression system towards the heterologous expression of Mentha spicata limonene synthase (MsLs) yielded a maximum of 7 µg L^{-1} limonene production in P. tricornutum. Further media engineering resulted in a 5-fold enhancement of limonene concentration, yielding 38.81 µg L^{-1} Limonene in optimized f/2 growth medium supplemented with glycerol when compared to the minimal f/2 medium. The present study documents the first report of limonene expression in diatom aimed at developing renewable and sustainable jet fuels, contributing to global efforts in mitigating climate change and reducing carbon emissions in the aviation industry.

***Keywords*:** Jet fuel; diatom; limonene; monoterpenes; renewable energy.

SOP 015 - Developing Algae-Bacteria Co-culture in Sequencing Batch Reactor for Enhanced Bioremediation and Energy Recovery

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ABSTRACT

The demand for sustainable and efficient wastewater treatment methods has intensified due to increasing environmental concerns. This study introduces a two-step approach using algae-bacteria co-culture in a sequencing batch reactor (SBR) to achieve bioremediation and energy recovery. Algae absorb nutrients and carbon dioxide from wastewater, producing oxygen that supports bacterial growth, while bacteria break down organic pollutants, enhancing nutrient removal. Quorum sensing (QS) and extracellular polymeric substances (EPS) further optimize this symbiotic interaction, promoting biofilm formation and improving overall wastewater treatment efficiency. In the second step, the algal-bacterial biomass produced during treatment is harvested to recover valuable biopolymers such as EPS. This dual-purpose system improves wastewater remediation and contributes to renewable energy production, aligning with circular economy principles by converting waste into useful resources. However, further research will focus on optimizing and scaling up this approach for real-world applications, ensuring environmental and economic sustainability.

***Keywords*:** Algae-bacteria co-culture, Sequencing Batch Reactor, Bioremediation, Wastewater treatment, Energy recovery, Biofuels, and Circular economy

SOP 016 - Dairy wastewater treatment and production of polyhydroxybutyrate from Monoraphidium sp. KMC4 and Scenedesmus microalgae and their consortium

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ABSTRACT

Plastic pollution is currently among the greatest concerns in the world as a result of the rapid growth of civilization and a growing population. Since it is deeply ingrained in our day-to-day lives, it is necessary to find alternatives to fossil-based plastics. One possible solution could be the the sustainable production of polyhydroxybutyrate (PHB). Photoautotrophic microalgae can contribute to the process of bioremediation and accumulate carbon reserves into value-added products like PHB. In this work, two different microalgae and their consortium were used for the treatment of untreated dairy wastewater and studied for their potential for PHB accumulation. The effect of PHB accumulation in microalgae was studied with the addition of nitrate and phosphate in the dairy wastewater. The cultures were able to reduce the organics present in the wastewater in terms of total organic carbon and chemical oxygen demand. Also, the cultures were able to utilize nitrate, phosphate, and ammonium from the wastewater. The maximum accumulation of PHB was obtained in the case of phosphate depletion i.e. with additional nitrate in dairy wastewater in all monoculture and consortium. The FTIR analysis revealed the presence of esters peaks like C=O stretching, asymmetric & symmetric CH_3 stretching & bending, and C–O stretching in the extracted samples compared with commercial polymer. The results offered a pathway for sustainable PHB production from microalgae along with dairy wastewater treatment in a sustainable manner.

Keywords: Microalgae; Dairy wastewater; Polyhydroxybutyrate; Bioremediation; Value-added products

SOP 017 - Pigment Profiling in Coelestrella sp. Under Light and Salinity Stress Conditions and Evaluation of their Antioxidant Potential

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ABSTRACT

Carotenoids, the most prevalent lipid-soluble pigments, play a vital role in protecting cells from oxidative stress caused by singlet oxygen, light, and free radical-mediated peroxidation. These pigments are naturally produced in plants and various photosynthetic organisms, where they function as antioxidants and exhibit significant bioactivity, contributing to immune response modulation, photoprotection, and the management of cardiovascular diseases, inflammation, hypertension, and atherosclerosis. In this study, we explored the production of carotenoids in the microalgal strain Coelastrella sp. SVMIICT3 (NCIM 5794) in the designed combination of light stimuli (red, blue, and white) and salinity stress. The chlorophyll fast kinetics of the culture was assessed to understand photosynthetic activity under these conditions. Following this, the total crude pigment was extracted (solvent based), separated (TLC), and characterized (HRMS, LCMS) based on molecular weight and structure. Furthermore, the bioactivity of the pigments was analyzed using bioinformatics tools, and antioxidant potential was determined through IC50 values for ROS activity, employing ABTS and DPPH radical scavenging assays. The findings highlight the whole pigment profile under specific environmental stimuli and their potential for antioxidant applications in therapeutic and industrial fields. These results contribute to the ongoing efforts to optimize carotenoid productivity and bioactivity in microalgal systems, demonstrating the effectiveness of light and salinity stress as key modulators of pigment synthesis.

***Keywords*:** Astaxanthin, β-Carotent, Chlorphyll a, Column chromatography, Microscopic observation

SOP 018 - Effect of microwave-mediated bacterial disintegration of Chlorella sorokiniana (green microalgae) to enhance biofuel yield

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ABSTRACT

Microwave-mediated bacterial disintegration (MMBD) of Chlorella sorokiniana (green microalgae) is investigated in this study. Microwave was employed for cell wall weakening. Microwave power was varied in the range of 90W, 180W, 270W, 360W, and 450W. Compared to bacterial pretreated alone and control, microwave-mediated bacterial disintegrated samples produced a higher release of biopolymers and organics in the aqueous phase. With a microwave power of 90-450 W, protein and carbohydrate release was observed in two phases: the weakening phase of the cell wall (0–240 sec) and the lysis phase (270-450 sec). Further, DNA and chlorophyll release remained zero until 11571.43 kJ/kg TS, and an abrupt release was observed when specific energy increased. Microwave-mediated bacterial disintegration is essential for recovering biofuel precursors packed within complex double-layered microalgae cell walls. Microwave-mediated bacterial disintegration improves both biofuel yield and composition using a lower microwave power and shorter irradiation time. In addition to improving release, bacterial disintegration reduces energy demand. For 100% biomass conversion to biofuels and value-added products, economical and sustainable approaches are still needed.

***Keywords*:** Biofuel, microalgae biomass, Chlorella sorokiniana, microwave

SOP 019 - Assessment of Macroalgal Hydrocolloids to Enhance Shelf Life of Tomato (Lycopersicum esculentum)

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ABSTRACT

Tomatoes, a staple agricultural product globally, are highly perishable, leading to significant post-harvest losses. Chemical solutions such as 1-methylcyclopropene have been used to delay ripening, but concerns regarding their long-term effects, regulatory issues, and impacts on fruit texture and taste persist. While biofilm-based materials and ethylene inhibitors offer alternatives, few meet sustainability requirements. Moreover, a significant gap exists in developing biodegradable, macroalgal-based materials for ethylene sequestration and ripening delay. Hence, this research focuses on utilizing crude hydrocolloids extracted macroalgae such as Kappaphycus and Gracilaria sp., blended with calcium carbonate ($CaCO_3$) and activated carbon, to develop an eco-friendly coating. These materials aim to provide a green, cost-efficient solution to extend tomato shelf life. Experiments have shown that hydrocolloid-based sprays and coated papers effectively delay tomato ripening while maintaining firmness, demonstrating potential for scalable, sustainable applications in post-harvest management. This study addresses the research gap by developing an innovative solution for delaying tomato ripening using macroalgal-derived materials to provide a green, cost-effective, and scalable solution to enhance the shelf life of tomatoes.

***Keywords*:** Agri-biotech, Fruits, Hydrocolloid, Macroalgae, Shelf-life.

SOP 020 - Insights on factors impacting Microalgal Biofilm towards circular economy

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ABSTRACT

Microalgal biofilms have emerged as affordable and sustainable solution for wastewater treatment, bioremediation, food industries, agriculture and bioenergy production. The microalgae harvesting through dewatering requires substantial energy and represents a major bottleneck limiting the industrial application of biomass. Biofilm, an extracellular polymeric substance produced when freely floating algal cells come together, start to colonize and gradually mature providing a protection to the algal cells that are inhabited. The current study evaluates the qualitative and quantitative formation of microalgae biofilms. A total of 6 accessions of microalgae were screened and selected by growing them in microtiter plates to understand the dynamics of biofilm formation. In all the species, the biofilm volume and thickness increased over time and reached a plateau after 11 days. However, the final biomass did not show a direct correlation. Some of the species generated higher biomass with lower biofilm and vise versa. Half of these strains were classified as strong biofilm formers. Understanding the mechanism involved in biofilm formation like species dependency, substrate specificity, stress, pH etc., will help in devising strategies to generate microalgae biofilm for industrial applications. Optimizing these parameters will serve as a promising alternative to traditional suspension-based culture systems in producing concentrated algal biomass.

***Keywords*:** Algae, biofilm, microalgae, cultivation.

SOP 021 - Innovative approaches in microalgae cultivation and understanding algal health for successful large-scale production.

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ABSTRACT

Pest surveillance and crop protection are integral parts of the microalgae industries. Microscope-assisted pest identification is commonly applied in the most algal cultivation process. Whereas the detection thre

shold is the main barrier to managing algal crops, what if we could quantify the response in algae as a consequence of the invasion of pests in the cultivation system rather than looking for pests? We got encouraging indication of pest invasion by analysing the photosystems II in algae. Quantum yield was reduced from 0.65 to 0.34 during infestation of rotifers in marine microalga Nannochloropsis oceanica cultivation in raceway ponds. We also developed a win-win solution to control rotifers without pesticides using ammonium bicarbonate at a concentration of 200 mg/L with pH at 9.5, which enhances algal yield 38%. Not only pest, understanding algal health is quite essential for successful algal cultivation in field. We distinguished the associations of various nutrient stresses with the photosynthetic parameters by analysing fluorescence kinetics data. For example, trapped energy per reaction center (TR_O/RC) could be a potential indicator of N limitation and explained 80% variation in N deficiency in laboratory experiments. We applied those techniques in field raceway ponds cultivation of N. oceanica and demonstrated biomass productivity of 70 tons/ha/year. The findings suggest that the marine microalga N.oceanica can simultaneously produce 17.6 kg/ha/year carotenoids via supercritical extraction and 24 tons/ha/year bio-crude bio-oil via hydrothermal liquefaction.

***Keywords*:** Algae cultivation, Pest control, Photosynthesis, Photosystems II

SOP 022 - Metal Recovery from Bio-leach Liquor Using Extracellular Polymeric Substances from Synechocystis sp.: A Green Biotechnological Method

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ABSTRACT

Chemical extraction methods like precipitation, solvent extraction, and ion exchange have long been used for downstream processing to recover valuable metals from bio-leach liquors generated during bioleaching processes where microorganisms extract metals from ores into solutions. However, they come with significant environmental, economic, and operational challenges. In attempt to overcome these, an alternative eco-friendly approach is developed and presented in this paper. Extracellular polymeric substances (EPS) produced as a byproduct from the cultivation of Synechocystis sp. were utilized to precipitate manganese from leach liquor (from polymetallic nodule [PMN] ore), which has very low pH. Several tests were performed to determine the impact of pH, concentration of EPS, and metal load on the metal recovery efficiency of EPS. It was observed that the EPS extracted from Synechocystis sp. has an excellent metal recovery efficiency at pH 2 to pH 4.5. The EPS showed a remarkable metal recovery efficiency, achieving up to 84% metal recovery from the leach liquor. For the first time, EPS has been applied to metal recovery from leach liquor of low pH, offering a greener alternative to traditional chemical methods. This approach significantly reduces operational costs and eliminates the production of harmful secondary pollutants, making it a sustainable and eco-friendly solution for metal extraction.

Keywords: Bio-leach liquor, Manganese (Mn), Metal recovery, Synechocystis sp. Extracellular polymeric substances (EPS),

SOP 023 - Utilizing Microalgae for Phosphate Recycling: A study on their Metabolic Shifts and Gene Expression Patterns for Biofertilizer Production

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ABSTRACT

Phosphorus (P) is a key nutrient for plant growth and essential metabolic functions. However, plants are not able to absorb enough phosphorus naturally, so chemical phosphate fertilizers usually made from phosphate rocks are commonly used. The overuse of these fertilizers is quickly depleting phosphate rock reserves, making it crucial to find alternative sources of phosphorus. At the same time, phosphate-rich wastewater from industrial processes and agricultural runoff is polluting water bodies and causing problems like eutrophication. One potential solution is microalgae, which can absorb waste phosphorus and store it as polyphosphates. This makes them ideal candidates for producing phosphate-rich biofertilizers, while also helping to clean up water through bioremediation.

In this study, we examined the growth and metabolism of three freshwater microalgal species Chlorella pyrenoidosa, Scenedesmus obliquus, and Chlamydomonas reinhardtii under phosphorus limited conditions. We found that under phosphorus depletion, protein production decreased, but there was an increase in carbohydrate and lipid production in all three species. Using FTIR (Fourier-transform infrared) analysis, we confirmed these metabolic changes, while gas chromatography (GC) showed a higher ratio of unsaturated to saturated fatty acids, which helps the cells maintain their membrane fluidity under P stress.

We also investigated the polyP storage patterns in these species using both biochemical and lead-sulfide microscopy method. The strains observed with high PolyP content could be utilized to produce phosphate-rich algal biofertilizers. Furthermore, we plan to identify and characterize the genes responsible for polyphosphate storage in Chlamydomonas reinhardtii via transcriptomic analysis and generation of mutant and overexpression lines.

***Keywords*:** FTIR, Gas chromatography, Microalgae, Phosphate biofertilizer, Polyphosphate

SOP 024 - Cultivation of Micractinium reisseri in wastewater for the enhancement of biofuel efficacy, wastewater treatment and value-added production: ongoing achievements

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ABSTRACT

The industrial production of microalgae is restricted due to the high cost of cultivation, use of excess water for bulk microalgae production and several other factors that are influencing the microalgal cultivation. We have established a microalgal cultivation system using wastewater to address this issue. Microalgae cultivation in wastewater not only gives energy recovery but also provides a green and sustainable technology by removing the pollutants from the wastewater. Micractinium reisseri, a green microalga, has been isolated in our laboratory from the wastewater collected from Vasna Barrage, Ahmedabad, Gujarat. In India, M. reisseri is reported for the first time in our laboratory. The M. reisseri was grown in a modified artificial saline medium under controlled environmental conditions to produce the biomass and oil, 2.6 g/L and 1.3 g/L, respectively. Later, the multiple parameters were optimized in wastewater by using Response-Surface-Methodology resulted in the enhanced yield of biomass and oil up to 9.0 g/L and 5.33 g/L respectively, in laboratory conditions. The developed process also resulted in the reduction of various pollutants in wastewater. The laboratory-scale optimized parameters with required modification were used in outdoor conditions in a raceway pond (300 L capacity) to achieve the highest biomass and oil up to 5.2 g/L (0.21 g/L/day) and 2.93 g/L (0.12 g/L/day) respectively (~57% of total biomass) in 24 days. Further improvement of the scale-up technique of M. reisseri cultivation and phycoremediation in an open raceway pond is in progress.

***Keywords*:** Micractinium reisseri, raceway pond, phycoremediation, green technology, water pollutants.

SOP 025 - Extraction and characterization of high-value by-products from Micractinium reisseri: an implication for sustainability and circular economy

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ABSTRACT

Microalgae offer many superiorities over traditional oil crops to produce biofuels and high-value by-products such as robust environmental adaptability, no competition with food or arable land, rapid fixation of environmental carbon, cultivation on wastewater, and year-round cultivation. Micractinium reisseri is one such promising green microalgae isolated from wastewater at Vasna Barrage, Ahmedabad, demonstrating significant potential for sustainable bioprocesses. The FTIR analysis of its oil confirmed the presence of ester groups (C=O) at 1748 cm^{-1}, indicating the oil's suitability as biodiesel feedstock. The significant sugar concentrations, 614 mg/g and 303 mg/g were recorded in the dry oiled and de-oiled biomass respectively confirmed the M. reisseri as a suitable candidate for bioethanol production. Pigment analysis through Thin Layer Chromatography (TLC) detected about eight pigments, including neoxanthin, carotenoids and chlorophylls in microalgal biomass. The purification of carotenoids from crude microalgal extract is in progress. Additionally, the study also includes determination of macro and microelements in de-oiled biomass for potential use as bio-fertilizer and characterizing the oil's heat potential for energy applications. The by-products generated from these processes can increase the potential for circular economy. The integration of M. reisseri cultivation in wastewater with anaerobic digestion, composting and ethanol fermentation processes provides a new model for climate change mitigation of biogenic CO_2 and circular economy. These findings underscore the economic potential of M. reisseri in producing biofuels and high-value products while promoting waste reduction and resource efficiency.

***Keywords*:** Micractinium reisseri, wastewater treatment, biodiesel production, biomass optimization, circular economy.

SOP 026 - Seaweed Biorefineries: Towards a sustainable and resource efficient future

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ABSTRACT

Rapid industrialization and anthropological activity have dented the environment to a great extent. The emission of greenhouse gases is responsible for the increase of earth's temperature thus leading to the global warming. Future fuel should be renewable in nature, carbon neutral and easily accessible. The renewable carbon is basically produced in two systems—terrestrial and aquatic. The amounts of terrestrial biomass that can be spared for these activities are large yet limited and these can support only a fraction of renewable carbon needs. Aquatic biomass production, on the other hand, is less developed but it has a huge potential for delivering renewable carbon. Serious efforts are, therefore, underway targeting cultivation of photosynthetic autotrophic microbes to produce biomass and lipids. In this category, algae appear to offer the most potential for capturing solar energy and atmospheric carbon dioxide, and delivering enough biomass/lipids that can offset the fossilized carbon utilization in a meaningful manner without impacting food supplies adversely. But several advances both technologically as well policy-wise are needed before algae can realize its full potential. A biorefinery integrates biomass conversion processes and equipment to produce fuels, power, heat, and value-added chemicals from biomass. A functional biorefinery operation should encompass efficient technologies for production, extraction, collection of feedstocks, transportation of feedstock and products, life cycle analysis, favourable policies, etc. In order to understand the full potential of biomass, development of the biorefinery concept is essential which would lead us to a sustainable and green future.

***Keywords*:** Algae; Biofuels; Biorefinery; Environment; Sustainability

SOP 027 - Unveiling Organic Selenium Synthesis Mechanism of Nannochloropsis oceanica CASA CC201: Insights from Ultrastructure and Cell Wall Composition

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ABSTRACT

Selenium, an essential trace element associated with selenoproteins, is present in nearly all organisms except higher plants and fungi. Selenoproteins play vital roles in cellular redox balance, intracellular signaling regulation, and thyroid metabolism. With advancements in whole genome sequencing and bioinformatics, genomic data has been accumulated, but identifying and characterizing selenoproteins requires specialized tools. Microalgae possess unique machinery to synthesize selenoproteins, enabling them to biotransform inorganic selenium into organic forms. Through adaptive evolutionary mechanisms, we developed an edible marine microalga strain, Nannochloropsis oceanica CASACC201* (a patented bioprocess), capable of producing organic selenium for human supplementation.

Despite its ability, the mechanisms behind this transformation remain unclear, necessitating deeper investigation into the underlying cellular processes. In this study, we analyzed the cell wall structure and composition of N. oceanica * to understand its selenium conversion efficiency. We compared this strain with wild-type N. oceanica during logarithmic and stationary growth phases. Transmission electron microscopy (TEM) revealed structural differences in cell walls, such as spines, microfibrillar hairs, and distinct layers. Analytical techniques, including Fourier-transform infrared (FTIR) spectroscopy, showed significant shifts in polysaccharide and protein fractions across growth phases. Trimethylsilyl derivatization highlighted notable variations in sugar and protein composition between the patented strain and wild types. These insights into cell wall composition provide a foundation for future biotechnological applications of Nannochloropsis strains and enhance our understanding of selenium translocation.

***Keywords*:** Algae; Functional food; Organic selenium; Selenoprotein; Synthesis

SOP 028 - Exploring the Impact of Glycerol and Yeast Extract on the Biochemical and Antioxidant Profile of Chlorella pyrenoidosa

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ABSTRACT

Microalgal biomass is one of the potential and sustainable sources of bioactive compounds that are highly valuable for their biopolymeric content and antioxidant activities. These properties make them well-suited for applications in therapeutics, nutraceutical, and pharmaceutical industries. In the present study, the effect of glycerol and yeast extract on microalgal growth was tested. The Chlorella pyrenoidosa was supplemented with an optimized concentration of 10% glycerol and 8 g L^{-1} yeast extract for 14 days. The supplemented cultivation shows the highest protein and carbohydrate concentration compared to cultivation in control BG11 media. After harvesting, the supernatant was used for the quantitative and qualitative determination of carbohydrates, protein, and antioxidant activity, whereas the obtained biomass was stored for further biochemical analyses and characterization. The supplemented culture showed a significant increase in protein concentration from 85 mg L^{-1} to 1034 mg L^{-1} and carbohydrate concentration from 9.59 mg L^{-1} to 222.55 mg L^{-1}. However, 77 mg L^{-1} of carbohydrate concentration was obtained by pretreatment of biomass from the control culture (grown in BG11). Moreover, the supplemented culture demonstrates a significant increase in the antioxidant activity from 42.79% in control to 87.84% in the DPPH radical scavenging assay, which gauges its capacity to neutralize free radicals. The results highlight the potential of glycerol and yeast extract as supplements to enhance protein and carbohydrate production and antioxidant activity in C. pyrenoidosa, positioning it as a promising candidate for high-value biotechnological applications.

***Keywords*:** Antioxidant activity; Bioactive compounds; Chlorella pyrenoidosa,

SOP 030 - Effect of Night-time Aeration on Microalgal Bacterial Granular Sludge (MBGS) on the Stability and Treatment Performance For Tertiary Treatment of Textile wastewater

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ABSTRACT

This study investigates the effects of controlled aeration during dark periods on the treatment performance of Microalgal-Bacterial Granular Sludge (MBGS) in Photo sequence Batch Reactors (PSBRs) for polishing anaerobically treated textile effluent. Two reactors (R1 and R2) were operated for 42 days, both with a hydraulic retention time (HRT) of 48 hours and a working volume of 800mL. R1 received aeration during dark periods, while R2 did not. Various parameters, including Sludge Volume Index (SVI5), Mixed Liquor Suspended Solids (MLSS), Average Particle Size, and Extracellular Polymeric Substances (EPS), as well as COD, Nitrate, Ammoniacal Nitrogen, Phosphate, etc., were monitored.

Results indicate similar Nitrate and Ammoniacal Nitrogen removal (~93% &~73%) performance in both reactors. However, enhanced phosphate (23%) and COD (20%) removal were observed in reactor R1. In the reactor R1 also maintained a near-neutral pH and exhibited better granular stability and settleability which was depicted by higher SVI5 values (~ 32 & ~47) and average particle size (2.58 mm & 1.3 mm) for reactor R1 and R2 respectively at the end of this study. The observed trend was attributed due to increased PN/PS ratio and 2-fold increase in EPS production in the reactor R1. Overall, aeration during the dark period significantly enhanced treatment efficiency and granular stability during the polishing of anaerobically treated textile effluent. These findings underscore the importance of optimizing aeration strategies in MBGS based tertiary treatment processes for textile wastewater.

***Keywords*:** COD, Microalgal bacterial granular sludge, Nutrient removal, Textile wastewater,

SOP 031 - Low-Cost Algal Biomass Cultivation in Saline-Reject Water for Useful Pigments and Biopolymer Production

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ABSTRACT

Membrane-based methods are the most common and effective methods for the treatment of saline groundwaters for drinking purposes. These processes generate highly concentrated saline-reject water, which poses serious environmental threats when discharged into the soil and water bodies. Effective management and treatment of this saline-reject water is crucial to alleviate its detrimental effects on the ecosystem. The current study explores the potential of utilizing saline-reject water for low-cost cultivation of microalgae, Chlorella sorokiniana and assesses its impact on the synthesis of pigments and biopolymers. The saline-reject water was filter sterilized for the growth of pure cultures. Further, the effect of supplementation of saline-reject water with additional nutrients was studied to evaluate the impact on microalgal growth in comparison to the conventional media. The results showed that saline-reject water alone did not support the growth of the microalgal cells. However, when supplemented with additional nutrients, it stimulated the growth of microalgae, achieving high biomass levels comparable to those from the conventional media. Additionally, the effect of saline-reject water on pigment and biopolymer production was also evaluated. In conclusion, this study showed that saline-reject water could be reused to help microalgae grow economically instead of using high-cost commercial-grade chemicals and freshwater inputs. This work supports the safe and effective use of saline-reject water.

***Keywords*:** Biopolymer; Chlorella sorokiniana; Microalgae; Pigments; Saline-reject water

SOP 032 - Utilizing residual microalgae biomass under biorefinery framework for extraction of valuable biocompounds and bioenergy production

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ABSTRACT

Microalgae have emerged as a promising resource due to their rapid growth, biomass production, high photosynthetic efficiency, and ability to withstand the extreme environmental conditions. Algal biomass after extraction of valuable compounds still holds significant potential to be used for the production of additional products with significant importance in aquaculture, agriculture and energy sector. The integration of residual biomass and extraction of valuable biocompounds enhances resource utilization and efficiency, minimizes waste generation and improves the viability of microalgae-based systems. However, to augment the economic feasibility of microalgae-based system for commercial production, an impeccable biorefinery strategy is crucial to utilize biomass for extraction of diverse products. The present study focused on utilizing residual biomass of Spirulina after phycocyanin extraction for estimation and extraction of different biocoumpounds. The residual biomass typically considered as waste was evaluated and characterization using biochemical profiling involving chlorophyll, carbohydrate, protein and lipid estimation revealed that it has immense potential to be used in agriculture, aquafeed, food and pharmaceutical sectors. Moreover, proximate and ultimate analysis reflected the suitability of residual Spirulina biomass as a potent feedstock for bioenergy production. The study highlights the multilevel benefits of producing high-value biocompounds and bioenergy from the same biomass feedstock making microalgae an indispensable component of biorefineries. This study suggested that developing promising models can further transform residual algal biomass into high-value products and eventually enhances the techno-economic feasibility of microalgae for commercial production of industrially important valuable-biocompounds. Additionally, panoramic strategies involving technological advancement, flexible policies and government initiatives can position microalgae as an important component of sustainable bioeconomy.

***Keywords*:** Microalgae, Residual biomass, Biocompounds, Bioenergy, Bioeconomy

PP 001 - Optimization of growth media for enhanced biomass and PHB production in Synechocystis pevaleikii

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ABSTRACT

Synechocystis pevaleikii, a cyanobacterial species, shows promising potential for producing chemicals, biofuels, and biopolymers like Poly-β-hydroxybutyrate (PHB) using carbon dioxide and sunlight. However, optimization studies on culture media for enhancing growth and biopolymer production in S. pevaleikii are limited. This study investigates the effect of varying sodium acetate concentrations in BG11 medium on biomass production and PHB yield. Cultures were grown in BG11 with sodium acetate concentrations ranging from 1 to 30 mM over 12 days, assessing growth rate, chlorophyll content, cell count, and dry cell weight. The addition of 20 mM sodium acetate significantly enhanced growth, with a chlorophyll content of 8.62 µg/mL, dry cell weight of 850 mg/L, and cell count of 9.50×10^6 cells/mL. This concentration also maximized PHB production at 90.31 µg/mL, demonstrating its strong positive impact on biomass and PHB yield. These results indicate that BG11 medium supplemented with 20 mM sodium acetate is optimal for large-scale S. pevaleikii cultivation and PHB extraction. Future research will explore the potential use of PHB in biodegradable packaging materials.

***Keywords*:** Synechocystis pevaleikii; Growth media; Chlorophyll content; Biomass production, and Poly-β-hydroxybutyrate (PHB).

PP 002 - Investigating The UV-Protective Potential Of Mycosporine-Like Amino Acids And Scytonemin From Lyngbya.

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ABSTRACT

The increasing prevalence of UV-radiation poses a significant threat to humans and ecosystem. Cyanobacteria being the most primitive organism on earth have evolved intricate mechanisms to survive, including the production of secondary metabolites like Mycosporine like amino acids (MAAs) and scytonemin, which acts as potent UV filters. Lyngbya, a genus of cyanobacteria are commercially significant due to the production of secondary metabolites that show a range of biological activities including antibacterial, , anticancer rand antifungal. Scytonemin and mycosporin-like amino acids have enormous potential to be used in cosmeceutical, biotechnological, pharmaceutical, biomedical sectors and other related manufacturing industries. MAAs are small water-soluble compounds that absorb UV radiation in the range of 310-360 nm whereas scytonemin, a unique UV-absorbing pigment, is a high-molecular-weight compound that provides long-term protection against UV radiation. These compounds have been shown to have antioxidant and anti-inflammatory properties, making them potential candidates for various applications, such as sunscreens and pharmaceutical products.

This study aims to optimize the extraction and purification of MAAs and scytonemin from Lyngbya, and characterize the structure of these compounds using spectroscopic techniques and highlight the possible use of the UV-protective activity of MAAs and scytonemin in vitro.

By characterizing the UV-absorbent properties of scytonemin and MAAs, this study underscores their significance as potent natural sunscreens. These compounds could be harnessed as eco-friendly alternatives to synthetic UV blockers, potentially reducing the environmental impact of conventional sunscreens.

***Keywords*:** Cyanobacteria, lyngbya ,mycosporine-like amino acids, natural sunscreen, scytonemin

PP 003 - Microalgae - Derived Phycocyanin: Sustainable Solution and it's Multifaceted Applications

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ABSTRACT

Pigments are exceptionally colored substances that are used to color other materials in a variety of industries. Naturally synthesized pigments are in greater demand, and circular bioeconomy strategies can include their manufacturing. Microalgae, macroalgae, cyanobacteria, plants, and animals all produce natural pigments. Photosynthetic microorganisms known as microalgae are becoming a valuable and sustainable source of pigments with a wide range of applications. Algae include three primary forms of pigments: phycobiliproteins, carotenoids, and chlorophylls. A water-soluble, non-toxic pigment called phycocyanin is effectively extracted from cyanobacteria. Certain characteristics of C-PC, a naturally occurring blue dye, give the protein a number of diverse functions that are useful in a variety of industries, such as the food and cosmetics sectors, as a fluorescence probe for immunodiagnostic purposes, and as a potential therapeutic agent in diseases caused by oxidative stress. C-PC's anti-inflammatory, antiviral, anti-cancer, immunostimulatory, and antioxidant qualities are the basis for its medical uses. The production of phycocyanin from microalgae have several benefits, including as relatively fast growth rates, adaptability to freshwater, saltwater, or brackish water, and the capacity to be grown on unarable ground. The freeze-thaw process can be used to extract C-PC from Spirulina and Oscillatoria sp. The study's main objectives are to optimize the extraction conditions and to purify the crude extract.

***Keywords*:** Freeze – thaw; Oscillatoria sp.; Phycocyanin; Pigments; Spirulina

PP 004 - Algae for Sustainable Agriculture and Food Security

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ABSTRACT

Traditional agricultural practices and food production systems are facing significant challenges due to climate change and a rapidly growing global population. Consequently, food originated from biological sources, and products derived from microalgae are expected to compete effectively in the market place. Therefore, the transition to sustainable food sources presents a highly attractive option for the production of microalgae. In these instances, microalgae serve as an excellent source of nutrition due to their substantial reserves of digestible proteins and lipids. They are currently employed as food additives to enhance the nutritional profile of cereal-based items, dairy products, and even meat products. These algae possess a protein level that matches or exceeds that of standard crops, providing all the essential amino acids necessary for human health. Currently, there is a notable increase in the popularity of protein-rich foods among consumers, a trend influenced by urbanization and the expansion of population. For thousands of years, the cultivation of both macroalgae, like seaweed and kelp, and microalgae, which are unicellular, has been practiced. This group of algae has been employed by humans in various capacities, such as food, feed for livestock, medicinal substances, fertilizers, cosmetics, and as raw materials for a multitude of industries. The evolution of algae has led to their exceptional efficiency in utilizing resources, making them a viable source of nutritious biomass that can help mitigate several current food production challenges. Furthermore, microalgae can be employed as feedstock in fish farming and poultry. They can be transformed into a nutritious meal or oil, providing substitutes for conventional feed ingredients like fish meal and soybeans. This could promote more sustainable practices in livestock farming, simultaneously alleviating the strain on coastal ecosystems. Microalgae have emerged as a viable sustainable food source, particularly in light of the increasing demand for protein among the global population. From a sustainability perspective, these potential protein sources offer numerous advantages compared to currently used raw materials. One significant attribute of microalgae is their capacity to generate bioactive compounds that may positively impact human health. Since microalgae can thrive in environments such as saltwater, wastewater, or brackish water rather than on arable land, they hold the potential to generate substantial quantities of valuable resources in a sustainable manner. The components and products derived from microalgal biomass have the potential to cater to various commercial food industries. Specifically, microalgal biomass can yield significant amounts of carbohydrates, proteins, and lipids. Ongoing research in this field is paving the way for the creation of innovative health products by enhancing the ability of microalgae to serve as a source of essential nutrients, minerals, trace elements, and other bioactive substances. Microalgae can be effectively employed in anaerobic processes, such as the production of bioethanol, biogas digestion, and biohydrogen. After the oil extraction process, the residual biomass can be utilized to produce biomethane, bioethanol, biosorbents for wastewater treatment, and biofertilizer. Although microalgae offer compelling solutions, there are ongoing challenges that need to be tackled, including the enhancement of production efficiency, cost reduction, and waste minimization. The advancement of microalgae cultivation is becoming progressively more practical due to ongoing research and technological innovations, presenting a promising avenue for the sustainable generation of food, feed and energy.

PP 005 - Analysis of three-decade change in global seaweed statistics revealed its emergence as a major aquaculture commodity

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ABSTRACT

The rapid growth of the global population, urbanization, and industrial expansion is poised to push the world into a nutritional crisis and environmental degradation in the near future. As food, feed, and a source of high-value bioactive compounds, seaweeds may serve as an emerging and sustainable alternative to support economic development, carbon capture, and global food security. FishStatJ database of Food and Agriculture Organization of the United Nations (FAO) was used to get data on global aquaculture production from 1992, 2002, 2012, and 2022. The data was filtered out from other aquatic organisms and products. Substantial growth in production volumes, from 6.58 million tonnes in 1992 to 35.14 million tonnes in 2022, soared from 6 to 16% of global aquaculture production. Aquaculture has predominantly driven this growth, which accounts for 97% of total seaweed production. Additionally, the market has seen a notable shift from brown to red seaweeds, with the latter now comprising 58.21% of the total output due to its commercial value, especially for carrageenan and agar extraction. China has emerged as the leading contributor, representing 60% of global production and exhibiting a 12-times rise in the total value of the produce, followed by Indonesia, Japan, and the Republic of Korea. This change reflects a move towards more commercially viable species and marks a significant evolution in production techniques and species composition. Notably, species like Saccharina sp. and Eucheuma sp. saw massive production increases, highlighting the growing role of seaweeds in food security, economic development, and environmental sustainability.

***Keywords*:** FAO, Seaweeds, Seaweed production, Seaweed statistics, Seaweed value

PP 006 - Enhanced DIC for CO_2 biofixation and lipid production in Chlorella sp. BRE5 through combined NaOH and strategic carbon dioxide supply

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ABSTRACT

Alternative strategies are needed to capture and mitigate carbon dioxide using microorganisms as carbon dioxide (CO_2) emissions rapidly increase. To enhance CO_2 fixation and biomass production in microalga Chlorella sp. BRE5, this study focuses on increasing dissolved inorganic carbon (DIC) through the strategic supply of sodium hydroxide (NaOH) and CO_2. Under shake flask study, the highest specific growth rate (0.195 d^{-1}), biomass productivity (123.2 mg/L/d), and CO_2 biofixation rate (231.6 mg/L/d) were found at NaOH dose of 0.25 g/L with CO_2 (1%, v/v) supplementation. Further optimized NaOH with different supply strategies of 1% CO_2 was conducted in photobioreactor (PBR) study. The best result was observed in PBR, where 1% CO_2 was strategically sparged (3-day intervals) with optimum NaOH dose. Under this condition, biomass yield, CO_2 consumption rate, lipid content, and lipid productivity were found to be 2.25, 2.25, 1.87, and 4.19 times higher than the control. The outdoor microalgae cultivation using a DIY bottle bioreactor (DIY BBR) was performed, resulting in less biomass and lipid productivity than that of the PBR study due to uncontrolled environmental conditions. The FAME (fatty acid methyl ester) profile comprised of C16-C18 (84.86% - 90.69%), indicating the suitability for biodiesel production. This strategic supply of combined NaOH and CO_2 enhances DIC in the medium, facilitating both the CO_2 biofixation rate and biomass production.

***Keywords*:** Biomass productivity, Dissolved inorganic carbon, FAME, Microalgae, Sodium hydroxide

PP 007 - Role of Algae for Sustainable Agriculture and Food Security

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ABSTRACT

The agricultural system is directly under strain from the rapidly expanding human population and the pervasive hunger, which in turn poses a major danger to biodiversity. Algae have evolved to be highly efficient at resource utilization and have proven to be a viable source of nutritious biomass that could address many of the current food production issues. Algae production, although a relatively new area of agriculture, is frequently seen as a solution to a number of issues pertaining to food security, including land scarcity, climate change, inefficient and unsustainable fertiliser use, as well as linked nutrient leakage and water pollution. Algae may be grown without the need for arable land, and several microalgae in particular can generate biomass that is rich in protein and/or oil with a spatial efficiency that is significantly higher than that of terrestrial plants. Algae and goods generated from them, however, are virtually entirely produced for high-value, low-volume markets and are therefore in no way competitive with low-cost commodities like fossil fuels or plant-based proteins. Lack of financial incentives for sustainable production and CO2 reduction should not be disregarded, even though high investment and production costs are thought to be the primary cause of this. A sustainable "algae industry" could play a key role in the bioeconomy of the future by facilitating the production of food and fuel with fewer resources and generating new goods, businesses, and jobs. In addition to being a promising source of nutrient-dense biomass that could help with many of the present problems in food production, algae have developed into extremely efficient resource users. Studies of microalgae's large-scale growth in particular. By lowering the carbon footprint of its production, algae's capacity to sequester CO2 contributes to its sustainability. Furthermore, non-potable water, such as brackish or seawater, can be used to grow algae on non-arable soil, allowing them to supplement rather than replace conventional agriculture. Since algae generate highly digestible proteins, lipids, and carbs and are abundant in vitamins, minerals, and vital fatty acids, they naturally possess the desirable characteristics of a sustainable food supply. Even though algae are not yet completely domesticated as food sources, there are a number of breeding and culture techniques that can be used to enable the higher production as well as improved nutritional and organoleptic properties that will be necessary to introduce algae into the general population.

PP 008 - Impact of Microplastics on Chlorophyll Production in Microalgae: Assessing Ecological Disruption

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ABSTRACT

The increasing accumulation of microplastics in aquatic ecosystems, including polymers like PMMA (Polymethyl methacrylate), PVA (Polyvinyl alcohol), PS (Polystyrene), and PE (Polyethylene), poses a significant ecological threat. Chlorophyll, essential for photosynthesis, plays a crucial role in sustaining algal productivity, and its inhibition can have cascading effects on ecosystem health and carbon cycling. These synthetic pollutants, pervasive across marine environments, may disrupt vital biological functions. This study examines how microplastics inhibit chlorophyll production in microalgal species, which drives photosynthesis and primary productivity. Over a 35-day period, microalgae were exposed to different concentrations of microplastics, and chlorophyll content was measured at intervals. The results showed a marked reduction in chlorophyll levels, with PS, PE, and PMMA causing the most severe inhibition, while PVA exhibited a comparatively lower effect. These findings underscore the potential for microplastics to impair photosynthetic processes, calling for further investigation into their long-term ecological impact.

Keywords: Algae, Aquatic Environment, Chlorophyll inhibition, Microplastic.

PP 009 - Implementation of Waste almond shells to harvest two different Chlorella sp.

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ABSTRACT

Algal biofuels can easily trigger energy security but the harvesting cost of algae from culture medium has hindered algal biofuels commercialization. Removal of this stumbling block by incorporating low-cost, ecofriendly, highly efficient bio-based materials can help in realization of Algal biofuels as fuel for future. Utilization of bio-based waste materials for algae harvesting can promote waste reduction and circular economy. Effectiveness of waste almond shells-based bioflocculant (ASB) for algae harvesting from cultures has been evaluated in this study. For application of ASB, Chlorella vulgaris and Chlorella pyrenoidosa were cultivated in specific wastewater. On 20th day of cultivation, both the algae from their cultures were harvested by using ASB. Several test experiments were conducted to optimize ASB dosage with respect to time and pH. Results of experiments revealed that ASB dosage range (1-100 mg/L) and pH range (6-8) within 30 minutes duration can offer excellent flocculation efficiency (>99%) for both Chlorella vulgaris and Chlorella pyrenoidosa. The possible phenomenon underlying beneath algal harvesting through ASB might be the adsorption process. ASB processing involved activation of organic matter (carbon) resulting into formation of stable form of carbon having great tendency to aggregate colloidal particles and promote their settling. Scanning electronic microscope (SEM) images of ASB has showed surface area larger enough to adsorb algal cells over it. Other instrumental analysis like FTIR, XRD and zeta potential also revealed significant findings. This study endorses zero waste, circular economy and environmental sustainability model.

Keywords**:** Algae**;** Bioflocculant; Bio-based waste; Circular economy; Flocculation.

PP 010 - Valorization of anaerobic digestate for enhanced biomass production in Chlorella sorokiniana: a circular economy approach

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ABSTRACT

Microalgae are fascinating systems that can be employed in a variety of ways to create biorefineries that operate on a circular economy concept. One significant strategy is resource recovery via microalgal growth in anaerobic digestates. Cultivation of microalgae in nutrient-rich digestate obtained from anaerobic digestion of food waste offers a sustainable waste management solution while also contributing to the bioeconomy by producing value-added products that can be used in a range of applications. The objective of the present study is to enhance the biomass productivity which can act as the substrate for other processes that can generate green energy, simultaneously addressing the current environmental issues. One of the key goals of this strategy is to optimize process parameters to increase biomass productivity. Activated carbon-based clarification of the digestate was performed in order to facilitate mixotrophic growth of Chlorella sorokiniana. The C/N ratio, pH, substrate to inoculum ratio, temperature, and nutritional balance are all important elements to consider when determining the digestate's impact on microalgal productivity. Further statistical optimization has been done utilising multiparameter approach by Taguchi method. This provides an insight into the interactions between different process parameters. The present study will help in the conversion of organic waste, which is otherwise considered as a risk to the environment, into value-added products.

***Keywords*:** Algae; Anaerobic digestate; Bio economy; Biomass; Process optimization

PP 011 - A Green and Efficient Pretreatment Strategy for Unlocking Algal Potential

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ABSTRACT

Algae, rich in metabolites and bioactive compounds, hold immense potential for sustainable industries. However, their rigid cell walls impede the efficient extraction of intracellular compounds. Pretreatment techniques are crucial to enhance extraction efficiency and yield. Microwave-assisted enzymatic pretreatment, a green and cost-effective method, combines microwave energy with enzymatic digestion to enhance metabolite extraction. This approach offers several advantages, including faster processing times, improved yields, and reduced environmental impact compared to conventional methods. This study focuses on optimizing microwave-assisted enzymatic pretreatment of microalgae biomass to extract valuable products. A freshly produced fungal crude enzyme (Aspergillus sp.) with cellulase and xylanase activities was used for the pretreatment investigation. Pretreatment efficiency was assessed in terms of total soluble sugar release, COD solubilization, and lipid yield. Microwave

-assisted enzymatic pretreatment demonstrated high cell disruption efficiency. Pulsed microwave irradiation followed by enzymatic pretreatment significantly improved cell solubilization, resulting in a high COD release of 2688.33±63.55 mg g-1. Continuous microwave irradiation, on the other hand, led to higher lipid yield (111.94±7.03 mg g-1). Additionally, microwave-coupled enzymatic pretreatment under a controlled pH (5.3) environment showed significantly high sugar release (166.57±4.39 mg g-1) and COD solubilization (8320.0±169.90 mg g-1).

In conclusion, the findings of this study highlight the potential of microwave-assisted enzymatic pretreatment as a green and highly efficient method for cell disruption and metabolite extraction from microalgae, offering significant commercialization potential.

***Keywords*:** Algae, Microwave pretreatment, Enzymatic pretreatment, Fungal-crude enzyme,

High-value products, Metabolites

PP 012 - Microbial Community Assessment of Sohna hot spring (Shiv Kund), India through culture-independent and culture-dependent study: A special attention on thermophilic cyanobacteria for potential benefits

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ABSTRACT

In the present study, microbial diversity of Shiv Kund, Sohna hot spring, Gurugram, India was examined with a special focus on thermophilic cyanobacteria. Both culture-dependent and culture-independent approaches were utilized for the microbial community diversity analysis and their potential benefits in the biotechnological industry. The raw data obtained through paired-end shotgun metagenome sequencing based on Illumina Hiseq 4000 platform was analysed through MG-RAST online server. It was submitted on NCBI portal under the accession number: SRX16388697-Neha Saini project. Kraken2 analysis of the metagenome reads classified algal classes into four phyla i.e., Bacillariophyta, Cyanobacteria, Chlorophyta and Rhodophyta with predominance of Chlorophyta followed by Cyanobacteria. Further, the isolation was performed via meticulous procedure of spreading and streaking in the BG-11 medium until the axenic growth was attained. The isolate was identified via polyphasic approach and studied for their biochemical profiling to understand its potential in the industry. In order to achieve a sustainable algal bio-refinery, evaluation of the growth kinetics and complete biochemical profile is vital to be understood to select an efficient strain. The growth performance of the isolate was studied under different nitrogen concentrations and growth phases (15^{th} and 20^{th} day) up to 30 days. The highest mean dry biomass production achieved was 1041.6 mg/L at 30^{th} day under 0.1875 g/L nitrogen (N/8) concentration. Also, biochemical profiling (pigments, total proteins, total lipids and total carbohydrates) and different functional groups were studied. The cyanobacterium showed potential to be studied further for biofuel production.

***Keywords*:** Biofuel, Hot spring, Shotgun metagenomics, Thermophilic cyanobacteria

PP 013 - Implementing semi-continuous cultivation strategy for enhanced biomass and lipid production performance of indigenous microalga Chlorella sorokiniana

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ABSTRACT

Microalgae have gained global interest as a promising feedstock for biofuel production. This present study aimed to evaluate the potential of indigenous microalga, Chlorella sorokiniana BRE5 for enhanced biomass production by implementing a semi-continuous cultivation strategy (SCCS). The varied start replacement points (SRP) for SCCS were performed under an optimized renewal rate (RR) and renewal period (RP) for enhanced lipid production. The biomass yield of C. sorokiniana with RP of 2d and 3d and RR of 25% showed an elevated trend. The maximum yield in total biomass (7.27 g L^{-1}) and total lipid (1.66 g L^{-1}) was observed with SRP9 (9th day as SRP) with RP of 2d and RR of 25%. Semi-continuous cultivation with SRP9 shows 4.35 and 3.69 times higher total biomass and lipid yield respectively, than batch cultivation. The fatty acid methyl ester (FAME) composition of C. sorokiniana primarily consists of palmitic and oleic acids. The fuel characteristics such as high heating value, better oxidative stability, and cetane number met ASTM and EN14214 indicating its suitability for biodiesel production. The current work will pave the way for largescale microalgal cultivation, thereby incorporating cohesive strategy for achieving sustainable development goals.

***Keywords*:** Biofuel, Biomass, Microalgae, Semi-continuous cultivation strategy, Start Replacement point

PP 014 - Seaweed as a source of therapeutic activity and functional foods

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ABSTRACT

Seaweeds are commonly used as hydrocolloids, emulsifiers, and gelling agents in various food product and pharmaceutical formulations. Globally, the commercial utilization of seaweeds had a market value of 11.7 billion USD, accounting for 27.3% of the total marine aquaculture production (FAO, 2018). Beyond the benefits of regular seaweed consumption, their medicinal properties have been historically recognized for producing bioactive substances with a wide range of nutritional, therapeutic, and nutraceutical properties. Several studies have linked seaweed consumption in Asian countries like Japan and Korea to a lower incidence of chronic diseases such as cancer, cardiovascular disease, osteoporosis, neurodegenerative disorders, diabetes mellitus, inflammation, obesity, goiter, hypertension, and viral infections. Bioactive compounds from seaweed have the potential to play a significant therapeutic role in human disease prevention. These bio-actives, which included polysaccharides (alginate, fucoidan, agar and carrageenan); proteins (lectins, glycoproteins (GPs), and phycobiliproteins (PBPs) ; pigments (carotenoids -beta-carotene and fucoxanthin); secondary metabolites (phlorotannins, tannin, saponin, terpenoids, oxylipins, sterols and other phenolic compounds); essential amino acids (EAAs) ; essential fatty acids (polyunsaturated fatty acids (PUFAs), eicosapentaenoic (EPA) and docosahexaenoic (DHA); minerals (sodium, potassium, calcium, iodine), peptides, vitamins , volatile hydrocarbons, and products of mixed biogenetic origin , have demonstrated a range of biological activities, including antioxidant (Benslima et al. 2021; Rajauria et al. 2021), antimicrobial (Martelli et al. 2020; Rajauria et al. 2021), anticancer (Gutiérrez-Rodríguez et al. 2018; Smyrniotopoulos et al. 2020), antidiabetic (Zhong et al. 2020; Kim et al. 2021; Gheda et al. 2021), antiviral (Cirne-Santos et al. 2020; Wang et al. 2020), anti-inflammatory (Cui et al. 2019; Chakraborty and Dhara 2020), anti-photoaging (Pangestuti et al. 2021), anti-aging (Cao et al. 2020), anti-obesity (Lu et al. 2020; Lee et al. 2020), anti-quorum sensing (Tang et al. 2020), anti-leukemic (Almeida et al. 2020), anti-tumor (Yan et al. 2019), and cardioprotective effects (Pereira 2018b). Additionally, seaweed polysaccharides, particularly fucoidan and ulvan, and their derivatives, have shown promise in the treatment of Alzheimer's and other neurodegenerative diseases (Bauer et al. 2021) in both in vitro and in vivo model systems (Ganesan et al., 2019).These various beneficial biological properties, making them valuable for the development of functional foods and nutraceuticals.

Many specified therapeutic activities identified in various seaweed species such as N. yezoensis and Pyropia columbina exhibits significant anticoagulant properties has demonstrated for further research in the prevention of blood clots. P. palmata has been reported to exert both antidiabetic and anti-obesity effects. The seaweeds Grateloupia chiangii, Griffithsia sp., and Kappaphycus alvarezii have shown antiviral activity. Acanthophora spp., Asparagopsis taxiformis, Gracilaria corticata, Gelidium pusilum have shown antibacterial activity. Champia parvula, and Hypnea valentiae exhibited antifungal properties suggesting their possible application in developing antimicrobial therapies. Soliera filiformis, Gracilaria lemaneiformis, and Portieria hornemannii have been studied for their antitumor properties, indicating their potential in cancer treatment. Bryothamnion seaforthii has been recognized for its wound healing properties, providing a natural approach to enhance tissue regeneration. The seaweeds Sargassum fusiforme and Saccharina japonica are known for their strong antioxidant properties, which may help mitigate oxidative stress and promote overall health. Undaria pinnatifida has demonstrated

antidiabetic activity, making it a valuable resource for dietary strategies aimed at blood sugar regulation. Porphyra dioica has been noted for its antihypertensive effects, suggesting its potential utility in managing high blood pressure. A.subulata demonstrates anti-obesity effects. Caulerpa cupressoides has been noted for anti-inflammatory and analgesic properties (Echave et al., 2022). Additionally, frequent intake of dietary seaweeds has been associated with a reduced risk of diabetes mellitus in the Korean population. Moreover, a clinical study found that regular consumption of Undaria seaweed can effectively reduce the risk of breast cancer in women (Ganesan et al., 2019).

Among the brown seaweeds, the most extensively studied species are Ecklonia (21.3%), Sargassum (20.2%), and Fucus (9%). In the red seaweed category, Gracilaria (20.8%) and Gelidium (16.7%) are the most researched species for potential applications in chronic disease treatment. The leading green seaweed species investigated include Ulva (47.4%), Codium (26.3%), and Caulerpa (15.8%). Notably, the phylum Phaeophyta has been the most extensively studied regarding various chronic diseases, with research showing involvement in cancer (40%), diabetes (85%), arthritis (67%), neurodegenerative diseases (71%), obesity (59%), osteoporosis (46%), liver disease (80%), and cardiovascular disease (84%). These research efforts encompass in-vivo, in-vitro, in-silico studies, and clinical trials (Meinita et al., 2022).

***Keywords*:** Seaweed, bioactive, Pharmaceutical, anti-diabetic, Glycoprotein, Undaria

PP 015 - Harnessing Microalgae for CO_2 Mitigation and Biomass Valorization

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ABSTRACT

The rapid rise in CO_2 emissions from fossil fuel use, industrial activities, and deforestation is a major driver of climate change, causing global warming, extreme weather, and ecosystem disruptions. To mitigate these effects, it is essential to develop innovative, sustainable, and cost-effective carbon capture and utilization methods. Microalgae offer significant potential for efficient carbon capture and utilization, simultaneously sequestering CO_2 and producing valuable biochemicals in their biomass, making them an attractive option for sustainable carbon management. An effort was made to cultivate the microalgae species Scenedesmus on a large scale (approximately 3000 L capacity) in outdoor conditions using low-cost media. Biomass yield and carbon fixation rates were assessed during the cultivation cycle. The harvested microalgae were characterized for their biochemicals content, physicochemical properties, and fuel properties to assess their potential for bioenergy and biochemical recovery. Additionally, pyrolysis experiments were conducted on the microalgal biomass to investigate its thermal decomposition profile and to characterize the resulting liquid (bio-oil) and solid (biochar) products obtained during the process. Understanding the thermal decomposition process and the properties of these resulting products is crucial for enhancing the valorization potential of microalgal biomass, thereby contributing to sustainable bioenergy applications.

***Keywords*:** Carbon dioxide; Microalgae; Cultivation; Pyrolysis; Bioenergy

PP 016 - Boosted Lipid Production and their Oxygenated Derivatives from Novel Microalgae through Molecular Techniques

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ABSTRACT

The increasing demand for sustainable biofuels and valuable chemicals has led to a focus on microalgae as a promising source due to their high lipid content. This research aims to boost lipid production from new microalgae strains using genetic methods, specifically by increasing LOX gene expression. The researchers will screen microalgae strains to identify those naturally good at producing oxylipins, and then use genetic engineering to boost LOX gene expression in these chosen strains. The effects of increased LOX gene expression on oxylipin production, microalgae growth, and lipid metabolism will be assessed using molecular biology, biochemistry, and analytical methods. The results show a notable increase in oxylipin production with LOX gene overexpression, suggesting this method's potential for sustainable oxylipin production from microalgae.

The CRISPRa system will be used to activate native LOX genes in selected microalgae strains without changing their DNA sequences. The efficiency of LOX gene activation and its effects on oxylipin production, microalgae growth, and lipid metabolism will be assessed using molecular biology, biochemistry, and analytical techniques. This research offers valuable insights into using CRISPRa-mediated gene activation for metabolic engineering in microalgae, showing its potential as a powerful tool for boosting the production of valuable bioactive compounds like oxylipins from microalgae biomass. These findings advance innovative biotechnological strategies for sustainably producing bioactive compounds using microalgae as a renewable resource.

Key words: Microalgae, Oxylipins, LOX, Metabolic engineering, Omics technologies

PP 017 - Exploring Biohydrogen production using microalgae towards sustainable green technologies

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ABSTRACT

Hydrogen is an energy-dense (120MJ/kg) clean energy resource that emits water as an end product upon energy generation with no carbon emissions. However, 90% of the hydrogen is derived from depleting energy resources and accounts for an indirect way of carbon emissions. As the Paris Agreement demands limiting the global temperature increase by 2℃ and reducing carbon emissions, developing an alternative renewable energy resource with green technology and zero carbon emission is necessary. Microalgae are autotrophic micro-organisms involved in the carbon sequestration process. It can produce hydrogen under anaerobic conditions employing the bio-photolysis method. This mechanism can utilize atmospheric carbon dioxide to produce hydrogen. A two-step approach to cultivating microalgae biomass can be explored. The microalgae biomass involved in the carbon fixation process produces biomass. This cultivated biomass can be subjected to anaerobic conditions that support the microalgae to produce oxygen for its metabolism and release molecular hydrogen as a by-product. As the hydrogenase enzyme is oxygen-sensitive, maintaining an anaerobic environment is important. Methods such as microalgae bacteria consortium, genetic engineering, and immobilization can be explored to overcome oxygen sensitivity and enhance the production of biohydrogen. These mechanisms ultimately lead to a green technology of hydrogen production thereby reducing the carbon footprints.

***Key Words*:** Bio-photolysis, Carbon sequestration, Green hydrogen, Sustainability

PP 018 - Algae: Sustainable Alternative to Traditional Food, Medicine, and Agricultural Practices

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ABSTRACT

Algae is believed to be sustainable alternatives to traditional food due to its high nutritional content. It contains 60% proteins compared to soybeans which has 36% proteins. It has vitamins A, B, C, E and K while spinach has just vitamin A, C, E and K. Minerals such as iron, magnesium, zinc, and calcium are present and fatty acids such as omega-3 and omega-6, and even antioxidants as well. These many nutrients are never present in a single food source. It is a sustainable alternative to traditional medicine as it can treat many diseases such as cardiovascular diseases such as atherosclerosis, hyperlipidemia, and hypertension, neurodegenerative diseases such as Parkinson, Alzheimer and even cancer to certain extent as well with lesser amount of side effects. The cultivation of algae is highly sustainable in nature as it can grow in freshwater/saltwater, as well in wastewater. Along with that it is known for sequestering CO2 which improves the environment compared to traditional agriculture. It is also used as Biofertilizer due to its high nutritional content which also improves soil health. The biggest disadvantage to all these benefits is the high cost of production. For example, spirulina powder costs 1500 to 3000 rupees per kilogram compared to traditional foods like rice which costs around 50 to 200 per kilogram. In future if everything proves to be beneficial, then algae-based products can be seen in market with nearly $4.5 Million worth of value.

Keywords: Algae; Agriculture; Environment; Food; Medicine

PP 019 - Synergistic Impact of Potassium Persulfate on the Efficiency of Microwave mediated Cell Lysis of Macroalgal Biomass for Bioenergy Generation

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ABSTRACT

Marine macroalgal biomass is a promising renewable resource for a wider range of compound production due to the capability of photosynthesis and higher growth rate. Macroalgal biomass contains biopolymers (Carbohydrate, Protein, Lipids, etc.), which could be utilized to fulfill the demand for food, medicines, cosmetics, and bioenergy. The rigid or complex structure of the cell wall of macroalgae limits the availability of biopolymers for various applications. Some of the pretreatment methods, such as mechanical, physical, chemical, or combinative pretreatment, could help to disintegrate the cell wall structure of macroalgae and enhance the organic release in the aqueous phase, which could be utilized for the production of bioenergy. The present study explores the "synergistic effect of microwave (MW) irradiation and potassium persulphate (KPS) on seaweed (macroalgae) for bioenergy production".

In the first phase of the study, 60% of MW intensity on seaweed biomass yields the organic release of 500mg/L and Total Organic Carbon (TOC) of 270mg/L. While combining the potassium persulphate dosage of 0.15g/g of total solid, the yield was increased to 712 mg/L of organic release and 450 mg/L of TOC. Biochemical methane potential assay revealed the generation of biogas of pretreated sample higher than the control.

***Keywords*:** Macro algae, Microwave irradiation, Potassium Persulphate, Cell lysate, Biomethane,

PP 020 - Microalgae: "A Sustainable Solution for Producing Biobased Products"

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ABSTRACT

In the face of the significant environmental challenges posed by fossil fuels, microalgae have emerged as a promising and sustainable alternative. These photosynthetic organisms convert sunlight and atmospheric carbon dioxide into various biomolecules that can be transformed into valuable products like biodiesel and bioplastics. Key factors in the commercial production of these biobased products include biomass, lipid content, and polyhydroxyalkanoate (PHA) levels in microalgae. PHA is a natural polymer accumulated by the microbes. This study aimed to identify a microalgal isolate with high lipid and PHA content by screening 20 freshwater microalgal isolates. The screening process evaluated the growth kinetics, lipid, and PHA content. The fuel properties of biodiesel were studied by transesterifying the extracted lipids. The most prevalent fatty acids identified through FAME analysis were palmitic, palmitoleic, oleic, linoleic, and linolenic acids. The extracted biopolymer (PHA) was chemically characterized using FTIR. A multicriteria decision analysis (MCDA) was performed to identify the most efficient isolate. The results revealed that S1 and S2 exhibited higher lipid productivity among the isolates, while S6 had a higher lipid content. However, isolate S8 demonstrated an optimal balance of lipid and PHA content as well as a high level of saturated and monounsaturated fatty acids. The significant presence of neutral lipids in S8 suggests it is a promising candidate for sustainable biodiesel and bioplastic production.

Keywords: Biodiesel; FAME profile; Fourier transmission infrared spectroscopy; Polyhydroxybutyrate; Microalgae; MCDA

PP 021 - Algal-Mediated Synthesis of Multifunctional Nanocomposite for Sustainable Approach Towards Environmental Remediation

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ABSTRACT

Over the last decades, nanotechnology has significantly impacted society in various fields, including the environment. The nanomaterials synthesis using traditional methods limits their applicability, produces toxic by-products, and has high energy expenditure. Biological synthesis of nanomaterials is possible using bacteria, algae, fungi, and tree leaves that have developed as viable alternatives to traditional methods. However, algae are among the fastest-growing green routes for the biosynthesis of nanomaterials due to their faster growth rates, low energy consumption, adsorption of heavy metals, and sustainably high CO_2 sequestration. In this study, we greenly synthesized iron oxide/titanium dioxide/reduced graphene oxide nanocomposite using Chlorella vulgaris multifunctional applications such as sensing of heavy metals, photocatalytic degradation of Rhodamine B, adsorption of heavy metals, and antibacterial activity. The synthesized nanocomposite was characterized by UV-Vis, FT-IR, XRD, BET, Zeta Potential, TGA, Raman, FESEM with EDX, and others. We found the great potential of greenly synthesized nanomaterials for sensing and eliminating environmental pollutants. These nanocomposites show the cost-effectiveness and sustainable approach towards ecological remediation.

***Keywords*:** Dye, Heavy Metals, Nanocomposite, Phyco-nanotechnology, Sensing .

PP 022 - Influence of agricultural fertilizer and glycerol under different trophic modes of Chlorella sp. BRE4 cultivation for wastewater treatment and biomass production

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ABSTRACT

Microalgae have the potential to serve as a dependable feedstock for the generation of commodity bioproducts, depending upon the establishment of economically viable production methods. Enhanced microalgal growth performance under heterotrophic and mixotrophic conditions can facilitate the production of environmentally sustainable, lipid-rich third-generation biofuels. The biomass production and changes in biochemical composition of a locally isolated microalga (Chlorella sp.) were investigated in mixotrophic and heterotrophic conditions, using glycerol as a carbon source and municipal wastewater as the growth medium. The microalgae Chlorella sp. was cultivated in municipal wastewater under NPK supplementation, followed by optimization of appropriate glycerol concentration to augment the biomass, lipid, and carbohydrate contents. Under optimized conditions, namely of 5 g L^{-1} glycerol and simultaneous CO_2 sparging, Chlorella sp. showed higher increments of biomass with 3.16 g L^{-1} dry cell weight, achieving biomass productivity of 0.316 g L^{-1} d^{-1}. The biomass accumulated 34.6% total lipid, 29.5% carbohydrate, and 38.7% proteins. Moreover, the cultivation of Chlorella sp. in glycerol-supplemented low-cost media removed 92.9% total nitrogen and 94.1% total phosphate during the microalgal growth period of 10 days. We demonstrated that biodiesel by-product glycerol could be repurposed to promote algae growth and lipid accumulation. Such an attempt forwards a stepping-stone for developing sustainable future energy and wastewater treatment infrastructure.

***Keywords*:** Microalgae; Biomass; Glycerol; Lipid; Phycoremediation

PP 023 - Cultivation of Chromochloris spp. for value added products under different mode of cultivation

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ABSTRACT

Microalgae are widely being explored for its potential of producing various value-added products with a range of applications in pharmaceutical and nutraceutical industries. The major bottleneck in cultivation of microalgae is longer life cycle and comparatively lower productivities. The present study addressed the cultivation of Chromochloris spp. under different growth regime for production of value-added compounds. Cultivation of Chromochloris spp. was conducted using modified BG-11 media and further assessed under heterotrophic, mixotrophic and phototrophic growth mode. The BG-11 was modified with optimized N and P concentration to induce N deplete stress condition for production of lipid and carotenoids. The stress induction by nutrient deplete condition resulted in accumulation of variety of carotenoids viz. astaxanthin, canthaxanthin, zeaxanthin and β- carotene. The optimized C/N ratios successfully resulted in accumulation of lipid where 50% of PUFAs were observed in total fatty acids under both the heterotrophic and mixotrophic conditions. Additionally, the pigment and lipid production cycle of the microalgae was reduced to 6 days under mixotrophic and heterotrophic mode in contrast to 15 days period for phototrophy suggesting them to be the preferred mode of cultivation.

Key words: Canthaxanthin, Chromochloris spp., Heterotrophy, Mixotrophy, PUFAs

PP 024 - Advanced microalgae cultivation using algal turf scrubber technology for biohydrogen production: A Review

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ABSTRACT

Algal turf scrubber technology implies biofilm-based attached growth of algal cells on an inclined surface. This review explores the potential of advanced microalgae cultivation using algal turf scrubber (ATS) technology for biohydrogen production. Compared to conventional culturing techniques, ATS offers several advantages, including reduced energy requirements, minimized land use, and a simplified harvesting process. The review highlights the efficiency and low cost associated with harvesting microalgae from biofilms compared to traditional methods. Furthermore, the paper discusses the environment-friendly nature of biohydrogen production from microalgae. Unlike fossil fuel-based hydrogen production, microalgae utilize sunlight and carbon dioxide, significantly reducing greenhouse gas emissions. This review emphasizes the potential of ATS cultivation for sustainable and cost-effective biohydrogen production, positioning it as a promising avenue for clean energy generation.

***Keywords*:** Algal turf scrubber (ATS), Biohydrogen, Biofilm based cultivation, Circular economy, Green production

PP 025- Physicochemical and biological characterization of extracellular polysaccharide from isolated microalgae

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ABSTRACT

Microalgae are well known organisms due to their significant biological importance in production of various compounds. Besides various intracellular biomolecules, extracellular polysaccharide (EPS) is one of the highlighted external biomolecules which play significant roles in their survival, growth, and interaction with the environment. Extracellular polysaccharides (EPS) of microalgae play a crucial role in various biological processes, including biofilm formation, cell adhesion, and protection against environmental stress. EPS of microalgal strains composed of different types of organic macromolecules such as polysaccharides, proteins, nucleic acids, phospholipids etc. This study focuses on the biochemical and morphological characterization of EPS produced by Chlorococcum sp.. EPS was extracted from the harvested broth using acetone as extracting solvent. Biochemical analysis was conducted to evaluate the composition of the EPS, including carbohydrate, phosphate, sulfate, and uronic acid content. Analysis has revealed carbohydrate composition in crude EPS was 30.67%. However, sulphate, uronic acid and phosphate content of EPS were 0.48%, 0.42% and 0.18% respectively. Analysis of the FTIR spectrum revealed the presence of β-glycosidic linkages at 880 Cm^{-1}. XRD analysis of EPS has revealed 51.73% crystalline nature of the EPS. However, Morphological analysis showed that EPS has an unsmoothed surface with no fixed shape of strips. In the conference, physicochemical and biological potentials of EPS from Chlorococcum sp. would be discussed.

***Keywords*:** Algae; Biological potentials; Extracellular polysaccharide; physicochemical.

PP 026 - Biodiesel Production from freshwater microalgae Chlorococcum sp.

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ABSTRACT

With rapid increase in renewable energy demands, biofuels such as biodiesel have potential to meet the energy requirements. Microalgae as biodiesel feedstock address various challenges such as land, food and environmental security. In this study Chlorococcum sp. was selected and optimized for high lipid and biomass productivity. Biochemical characteristics were determined by analyzing the carbohydrate, protein and pigments (chlorophyll and carotenoids). Selected conditions were optimized for increased biomass and lipid productivity (1) photoperiod (2) Light intensity (3) Nitrogen ($NaNO_3$) concentration. It was found that stress promotes lipid accumulation but reduces cell growth. Microalgae was grown in optimized condition and biomass was harvested. This biomass was pretreated using different pretreatment methods and ultrasonication was found to yield the highest lipid. Extracted lipid was transesterified using a novel bionanocatalyst to obtain biodiesel. The bionanocatalyst was synthesized using eggshell and residual microalgal biomass. The obtained biodiesel was characterized using ^{1}H NMR and ^{12}C NMR.

***Keywords*:** Biodiesel; Bionanocatalyst; Chlorococcum sp.; Growth-optimization; Transesterification

PP 027 - Synergistic Microalgal-Bacterial Treatment Approach for Secondary treatment of Legacy Landfill Leachate

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ABSTRACT

Phycoremediation of legacy landfill leachate is often a promising and economical approach but the performance is often obstructed by the presence of complex recalcitrant compounds and high salt content. To overcome this hindrance, few advanced oxidation processes (AOPs) like electrooxidation, electrocoagulation and ozonation can be used to initially degrade the complex compounds in legacy landfill leachate and then the sample is subjected to microalgae remediation. In this study, legacy landfill leachate collected from a local landfill dumpsite was subjected to a series of treatment techniques. The initial Chemical Oxygen Demand (COD) of legacy landfill leachate was 18,000mg/L. Lab scale experiments were conducted on legacy landfill leachate with the optimized conditions of Electrocoagulation followed by electrooxidation followed by ozonation. The COD of the so treated legacy landfill leachate was reduced by 97% (400mg/L). The experiments were arranged in three setups as I-standalone microalgae, II-standalone bacteria and III-microalgae & bacteria co-culture using the treated landfill leachate. The treated sample was subjected to microalgae remediation using Chlorella vulgaris collected and isolated from nearby sewage contaminated lake water. Initially, the treated leachate samples were mixed with sewage wastewater in ratio of 1:1. The microalgae cultivated from this setup is used for inoculation for the further experiments. The samples were collected at regular intervals to analyze for the growth of microalgae and various parameters. The three setups of treated leachate have shown an effective growth of microalgae and bacterial growth. The COD removal upto 80mg/L, 110mg/L and 60mg/L were observed in setups I, II and III respectively. Therefore, this study have demonstrated the feasibility of combination of AOPs and synergy of microalgae and bacteria co-culture remediation for the effective treatment of legacy landfill leachate.

Keywords: Advanced Oxidation Processes, Chemical Oxygen Demand, Electrooxidation, Electrocoagulation, Legacy landfill leachate and Microalgae and bacteria co-culture.

PP 028 - Exploration Of Dermo Cosmetic Effects Of Polyunsaturated Fatty Acids (Pufa) Derived From Marine Macroalgae For Anti-Aging Applications

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ABSTRACT

This study explores the dermo-cosmetic effects of polyunsaturated fatty acids (PUFAs) derived from marine macroalgae, focusing on their potential applications in anti-aging skincare. Employing the Folch method for lipid extraction and isolation, we successfully obtained PUFAs from selected macroalgae species. The extracted lipids were then confirmed and purified using chromatographic techniques to ensure high quality and concentration.To evaluate the antioxidative effects of the isolated PUFAs, a series of in vitro cell assays were conducted. These assays assessed cellular viability, oxidative stress response, and collagen synthesis in skin cells. Results demonstrated that the PUFAs significantly reduced the production of reactive oxygen species (ROS), enhanced antioxidant enzyme activity, and promoted collagen synthesis, all of which are crucial for maintaining skin integrity and combating aging.Furthermore, safety assessments were performed to ensure the biocompatibility of the PUFA extracts, confirming their non-toxic nature at effective concentrations. The study emphasizes the therapeutic potential of marine macroalgae-derived PUFAs as a natural, safe alternative for anti-aging formulations.In conclusion, this research highlights the efficacy of marine macroalgae PUFAs in enhancing skin health and their promising role in developing innovative, sustainable anti-aging cosmetic products. These findings contribute to the growing field of natural dermo-cosmetics, underscoring the importance of harnessing marine resources for skincare applications.

***Keywords*:** Algae; Anti-aging; Folch method; Lipids; PUFA

PP 029 - Synergistic Effect of ZnO Nanoparticles and Light Conditions on Microalgae Growth, Lipid Accumulation, and Carotenoid Biosynthesis for Potential Industries

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ABSTRACT

Microalgae offer vast potential for sustainable biofuels, nutraceuticals, cosmetics, and pharmaceuticals, but low biomass yields and inefficient production processes hinder commercialization, necessitating further research and innovation. Integration of nanotechnology in the algal system can enhance biomass yield and productivity of valuable compounds, such as lipids, pigments and carotenoids by optimizing cell growth, stress resistance, and biomolecule extraction. Zinc oxide nanoparticles (ZnO-NPs), known for their complex influence on biological systems due to their broad surface area, suitable band gap energy and high biocompatibility. Hence, the interaction between ZnO-NPs and microalgae under broad light wavelength and intensities may play a pivotal role in regulating cellular growth and biosynthesis of lipids and carotenoids. In the present study, Monoraphidium sp. (MP) was inoculated in the series of ZnO-NP concentrations ranging from 10 mg/L to 100 mg/L out of which 70 mg/L identified as the optimal threshold for stimulating biomass growth and highlighting its promise for scalable bio-production. In addition to nanoparticle effects, light parameters significantly influence the metabolic processes in microalgae. Specific light wavelengths can modulate the production of key carotenoids in different manners. Moreover, the intensity and duration of light exposure further affect microalgae growth, lipid content, and fatty acid composition, offering additional avenues for optimizing biomass production for biofuel and nutraceutical industries. The interplay between ZnO-NPs and light conditions is thus crucial for fine-tuning microalgal cultivation strategies, maximizing both lipid accumulation and carotenoid biosynthesis, paving the way for more efficient industrial applications.

***Keywords*:** Microalgae, ZnO-Nanoparticles, Light conditions, lipids, carotenoids

PP 030 - Biorefinery approach for evaluating microalgal extracts as biostimulant

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ABSTRACT

Microalgae have a number of intriguing characteristics that make them a viable raw material aimed at usage in a variety of applications when refined using a bio-refining process. Haematococcus pluvialis is being cultivated at large scale for an important nutraceutical, astaxanthin. However, just a single explicit compound is separated, while other conceivably significant biomass is disposed of, otherwise underestimated. Thus, the aim was to utilize this left-over biomass towards the greener alternative of synthetic stimulant and fertilizers in agriculture due to an increasing demand for sustainability.

The present study focusses on the utilization of H. pluvialis biomass, post-astaxanthin extraction, as a bio stimulant for the growth of tomato plant using various methods. Characterization of algal extract showed the presence of 291.3 mg/L carbon, 11.2 mg/L nitrogen and 49.85±2.95 ppm auxin (Indole acetic acid), that could potentially act as precursors for bioactive compounds to stimulate plant growth. Depending upon the extract concentration, various experimental set ups were studied. The seeds dipped in water and treated with cellular extracts (ME) showed faster plant growth rate in terms of shoot length and root length of 7.36 ± 0.6 cm and 7.52 ±1.8 cm, respectively. In comparison to control, 37.8% higher plant length was observed for this set. Treated plants also exhibited higher pigment content, indicating enhanced photosynthesis. The findings suggest that microalgal extracts, following carotenoid separation, could serve as a natural and sustainable alternative to synthetic fertilizers, contributing towards a sustainable agriculture and circular bioeconomy.

***Keywords*:** Biostimulant, Germination, H.pluvialis , Plant growth, Sustainable agriculture

PP 031 - MICROALGAE DERIVED ASTAXANTHIN IN THERAPEUTICS AND FUNCTIONAL FOODS

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ABSTRACT

Algae, recognized as one of the most diverse and sustainable natural resources, have become pivotal in the development of therapeutics and functional foods. The diverse bioactive compounds in both microalgae and macroalgae—including carotenoids, polysaccharides, omega-3 fatty acids, and phenolic compounds—offer a wide range of health benefits. Among these, astaxanthin, a powerful carotenoid antioxidant, has garnered significant attention due to its significance in human health, aquaculture, and cosmetics. Sourced primarily from the microalgae Haematococcus pluvialis, astaxanthin's potent antioxidant and anti-inflammatory properties have driven extensive research into its benefits. However, several challenges impede the widespread commercialization of algae-derived astaxanthin. Optimizing cultivation and extraction processes remains a major hurdle for large-scale production, affecting both the yield and quality of bioactive compounds. Moreover, the commercialization of astaxanthin-enriched functional foods is limited by its low bioavailability, stemming from its lipophilic nature, which reduces absorption in the human body. To tackle these issues, advanced biotechnological methods like genetic engineering and metabolic optimization could improve the yield and quality of algae-derived compounds. This review aims to examine the latest progress in algae-based therapeutics and functional foods, while highlighting key research gaps to be addressed for product development.

Keywords: Astaxanthin, Haematococcus pluvialis, Functional foods, Therapeutics.

PP 032 - Multivariable optimization of cultivation parameters for enhanced lipid production in Scenedesmus obliquus and Chlorella pyrenoidosa fermentation using Box-Behnken design

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ABSTRACT

Microalgae-based lipid production presents a promising avenue for sustainable quality biofuel production, yet achieving optimal yields requires precise control over cultivation parameters to maximize metabolic efficiency and lipid bioaccumulation. In this study, a multivariable optimization approach was employed to enhance lipid production in Scenedesmus obliquus and Chlorella pyrenoidosa microalgae cultures using Design-Expert, Stat-ease, USA. The mixotrophic cultivation parameters were optimized varying pH from 7.0 to 8.5, temperature 25 to 30°C, EDTA concentration from 0.05 to 0.15 g/L, inoculum size of 5 to 20% (v/v), vitamin solution containing thiamine, biotin, and Vit B_2 from 0.5 to 5 mL, carbon dioxide input rate from 0 to 8% (v/v of air), and illumination 30,000 to 60,000 lux. These factors were chosen for their critical role in microalgae growth and lipid bioaccumulation, pH and temperature significantly influence enzymatic activity and metabolic rates, while EDTA concentration regulates trace metal availability, crucial for cellular processes. Inoculum size impacts biomass productivity, and the vitamin solution enhances the overall metabolic efficiency. CO_2 % in air input serves as an inorganic carbon source, and illumination is a key driver of photosynthesis. Box-Behnken design in response surface methodology was employed to systematically explore the interactions between multiple cultivation interactive parameters and their combined effects on lipid production in Scenedesmus obliquus and Chlorella pyrenoidosa, with lipid yields exceeding 70% (g/g of biomass). The study demonstrates the impact of systematic optimization in microalgae, providing valuable insights for quality biofuel production. The results suggest that precise control over cultivation conditions can drastically improve lipid bioaccumulation, making microalgae an attractive source for sustainable bioenergy.

***Keywords*:** Chlorella pyrenoidosa; Enhanced lipid; Multivariable optimization; Quality biofuel; Scenedesmus obliquus.

PP 033 - Sustainable Valorization of Green Macroalgae Biomass: Conventional Pyrolysis and Hydrothermal Carbonization Approaches

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ABSTRACT

The increasing interest in sustainable waste management and renewable resources has led to the exploration of biochar derived from macroalgae biomass, as a promising material for environmental applications. This study provides a comparative analysis of two prominent thermochemical processes-conventional pyrolysis and hydrothermal carbonization (HTC) for converting macroalgae into biochar or hydrochar. Conventional pyrolysis, performed under an inert atmosphere at elevated temperatures (450-650°C), produces biochar characterized by a highly porous structure, increased aromaticity, and a stable carbon matrix. However, pyrolysis often requires substantial energy inputs, which may limit its overall efficiency for wet macroalgae biomass. In contrast, HTC operates under moderate temperatures (180-280°C) and high pressures in an aqueous medium, making it better suited for high-moisture feedstocks like macroalgae. Hydrochar produced via HTC typically has a higher oxygen content and lower carbon stability but offers advantages in nutrient retention and functional group diversity. This study highlights key differences in product yields, energy efficiencies, and physicochemical properties of biochar/hydrochar derived from macroalgae through these processes. Pyrolysis tends to yield biochar with a higher fixed carbon content and greater long- term environmental stability, suitable for carbon sequestration. HTC, on the other hand, produces hydrochar that can be more effective for soil conditioning due to enhanced nutrient availability and surface functionality. The findings provide critical insights into optimizing these processes for sustainable biochar production, informing decisions based on energy efficiency, product quality, and environmental benefits for specific applications.

Keywords: Biochar; Green macroalgae; Hydrochar; Hydrothermal Carbonization; Pyrolysis

PP 034 -Assessing Diatom Distribution in Cambay Basin, Western Arabian Sea: Impacts of Oil Spillage and Chemical Variables

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ABSTRACT

Diatoms are the sensitive microalgae that shows variation in the diversity based on geographical and environmental conditions as well as the physicochemical characteristics of the habitat. This study assesses the distribution of diatom assemblages in the Cambay Basin, Western Arabian Sea, with a focus on the impact of oil spills and environmental variables on diatom diversity and abundance. Water samples were collected from nine oil field sites. The samples were analyzed for various physicochemical parameters, including Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Dissolved Solids (TDS), pH, Dissolved Oxygen (DO), and temperature. Fourier Transform Infrared (FTIR) spectroscopy and Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP-OES) were used to identify oil concentrations and trace elements like silica and aluminium. Results showed that oil field sites had higher concentrations of COD and TDS, with aluminium negatively affecting diatom growth, while silica promoted it. Two diatom species, Gomphonella pseudosphaerophorum and Nitzschia palea, demonstrated high tolerance to oil contamination. The study does not display a cause-and-effect relationship, but we observed a positive correlation between increasing silica concentrations and diatom growth in oil fields. In contrast, high aluminium concentrations in oil fields negatively impacted the growth of diatom assemblage and abundance.

Keywords: Cambay Basin ,Crude oil toxicity, Diatom assemblages, Environmental factors , ICP-OES, Trace elements.

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