Plan Overview

A Data Management Plan created using DMPTool

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Title: Sustainable Innovations: The Biorefinery Revolution via Macroalgae Valorization Using Renewable Solvents towards a (Green+Blue)Economy

Creator: Leonardo Mesquita - **ORCID:** 0000-0002-7602-7731

Affiliation: University Of São Paulo

Principal Investigator: Dr. Leonardo Mendes de Souza Mesquita

Contributor: Dr. Fanly Fungyi Chow Ho , Dr. Vitor Sencadas, Dr. Cassamo Ussemane Mussagy, Dr. Silgia Aparecida da Costa , Dr. Sirlene Maria da Costa, Dr. Herminia Domínguez, Dr. Leslie Boudesocque-Delaye

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Template: Digital Curation Centre

Project abstract:

Inspired by the blue economy concept, a globally competitive research avenue centered on the sustainable utilization of macroalgae biomass is emerging. This study will pioneer the utilization of innovative solvents such as eutectic solvents (DES) and eco-friendly alternatives to establish environmentally conscious biorefineries for processing seaweeds. Rather than fixating on singular compounds, this initiative will prioritize comprehensive extraction methodologies, seeking to recover a high-spectrum of valuable bio compounds, including pigments (like carotenoids, chlorophylls, and phycobiliproteins), phenolic compounds, mycosporine-like amino acids, polysaccharides, and fatty acids. The central emphasis is on adopting cutting-edge, comprehensive methodologies like microwave-assisted extraction (MAE), ultrasound-assisted extraction (UAE), and pressurized-liquid extraction (PLE) to significantly increase both the yield and purity of the extracted bioactive compounds. Moreover, these techniques are encouraged to reduce solvent usage and minimize procedure duration. Combining eutectic solvents with modern techniques will enable the implementation of a multiproduct green biorefinery approach, contributing toward a holistic (blue+green)economy. This pioneering project advocates using eutectic solvents as efficient solvents and additives in products poised to rethink the industrial sector. To propel industries towards a greener future, this initiative aims to merge eutectic solvents with algae-based extracts to create innovative prototypes across various domains: cosmetics, food, textiles, coating materials, natural colorants, and biochar. Across these domains lies untapped potential, presenting a powerful opportunity to showcase the transformative capability of eutectic solvents, not just as solvents but as crucial additives in novel products. Their integration stands to amplify both the technological and biological efficacy of the developed prototypes, supplemented with the algal-based extracts obtained with eutectic solvents. This holistic approach not only optimizes the valorization

of algal biomass by extracting its valuable components but also unveils new views for crafting superior products with enhanced technological and biological performance. At the end of this project, we aim to have developed new sustainable methodologies for extracting bioactive compounds from macroalgae and to enable a paradigm shift in viewing eutectic solvents not just as solvents but as technological agents to be wisely implemented in new industrially relevant formulations. This research will lead the nation in pioneering sustainable and holistic approaches to utilizing macroalgae, positioning Brazil at the forefront of cutting-edge advancements in this natural, environmentally friendly modern field.

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Copyright information:

Sustainable Innovations: The Biorefinery Revolution via Macroalgae Valorization Using Renewable Solvents towards a (Green+Blue)Economy

1) Macroalgae Composition Data: Gathering data on the chemical composition of different types of macroalgae;

2) Solvent Extraction Efficiency Data: Conducting experiments to evaluate the effectiveness of different renewable solvents in extracting specific compounds from macroalgae. This involves recording extraction yields, efficiency rates, and optimal conditions for extraction;

3) Biorefinery Process Data: Generating data related to the process of converting macroalgae into valuable products. This includes parameters like conversion rates, energy consumption, process duration, and yields of different end-products;

4) Product Characterization Data: Creating a database of characteristics and properties of end-products derived from macroalgae, including those prototypes designed for cosmetic, food, tectile, coating, natural colorants and biochar;

5) Life Cycle Assessment Data: Gathering data throughout the life cycle of the biorefinery process to assess its environmental sustainability. This involves data on inputs, outputs, energy consumption, and emissions at each stage;

6) Techno-Economic Analysis Data: Collecting technical data (e.g., process parameters, equipment specifications) alongside economic data (e.g., capital costs, operational expenses) to perform a comprehensive techno-economic analysis;

7) Policy and Regulatory Data: Compiling information on existing policies, regulations, and potential incentives or barriers related to macroalgae utilization for sustainable innovations;

8) Innovation and Patent Data: Documenting any novel technologies or processes developed during the research that might be eligible for patenting or commercialization;

9) Articles & reports publication: Covering the obtained data in the above itens;

10) Internationalization of Brazilian science: By publishing articles and participating in international and national conferences.

1) Macroalgae Composition Analysis: Collection methods might include sampling macroalgae from different locations, followed by laboratory analysis using techniques such as chromatography, spectroscopy, and elemental analysis to determine their chemical composition;

2) Solvent Extraction Efficiency: Laboratory experiments would involve extracting compounds from macroalgae using different renewable solvents under controlled conditions. Extraction yields would be quantified and compared to assess efficiency;

3) Biorefinery Process Optimization: Research would involve pilot-scale or lab-scale biorefinery setups to process macroalgae, experimenting with different conditions (temperature, pressure, catalysts) and monitoring parameters (yields, energy consumption) to optimize the process;

4) Product Development and Characterization: Data is created through the synthesis and characterization of end-products derived from macroalgae, involving techniques like mass spectrometry, NMR, and physical property

analysis;

5)Life Cycle Assessment: Gathering data throughout the life cycle involves a comprehensive analysis, including data on resource extraction, transportation, processing, and end-of-life treatment of products;

6) Techno-Economic Analysis: Collecting technical data through experimental setups and equipment specifications, while economic data would involve market analysis, cost estimations, and financial modeling;

7) Policy and Regulatory Analysis: Collection of data involves reviewing existing policies and regulations related;

8) Innovation and Patent Data: Investigating the nolvelty of the produced data and reporting to inovation agency from the institution;

9) Articles & reports publication: Writing and interpreting the obtained data;

10) Internationalization of Brazilian science: By participating in international and national conferences and publishing the obtained data in high-impact journals.

1) Data Description: A detailed description outlining the nature of the data, including the purpose, methodology used for data collection, and its relevance to the research objectives;

2) Data Collection Protocols: Documentation detailing the protocols and methodologies used during data collection. This includes specifics on sampling procedures, experimental setups, instruments used, and any standard operating procedures (SOPs) followed;

3) Metadata Standards: Adherence to established metadata standards in the respective field ensuring consistency, interoperability, and comprehensiveness of metadata;

4) Data Structure and Format: Explanation of the data structure, file formats, and organization, ensuring that users can easily navigate and understand the data files. This might include data schemas;

5) Quality Control and Assurance: Information regarding quality control procedures applied during data collection, including calibration, validation, replicates, and any outlier removal or data cleaning processes;

6) Contextual Information: Detailed contextual information providing background, experimental conditions, environmental parameters, and any other relevant contextual details necessary for understanding the data;

7) Version Control: Implementation of versioning to track changes and iterations of the dataset, ensuring traceability and enabling users to reference specific versions used in analyses;

8) Data Access and Permissions: Information on access rights, licensing, or permissions required for using the dataset, including any ethical or legal considerations related to data sharing;

9) Data Analysis and Processing Methods: Description of data analysis methodologies, algorithms used for processing, transformations, normalization techniques, statistical analyses, and any software or code used in data processing;

10) Associated Publications and Citations: Links or references to associated publications, reports, or presentations where the data has been used or discussed, enabling users to explore further context and findings related to the dataset.

The research team will regularly review ethical considerations together, seeking guidance from ethics committees or experts. Proactively identifying and resolving ethical dilemmas is a priority to ensure the research is conducted ethically and responsibly.

1) Clear Ownership Policies: Establish clear ownership policies early in the research project. Define ownership rights for any intellectual property created during the project, specifying whether it belongs to the institution, researchers, or collaborators;

2) Documentation and Records: Maintain detailed records documenting the creation and development of intellectual property. This includes lab notebooks, invention disclosures, and records of meetings discussing innovative ideas;

3) Non-Disclosure Agreements (NDAs): Implement NDAs when collaborating with external partners, contractors, or consultants to protect confidential information shared during the project;

4) Intellectual Property Agreements: Draft agreements outlining the ownership, management, and potential commercialization of intellectual property arising from the research. These agreements should clarify rights and responsibilities among collaborators and stakeholders;

5) Patent Filings: If the research leads to potentially patentable inventions or discoveries, consider filing for patents to secure legal protection. This process involves engaging patent attorneys or specialists to navigate the complexities of patent law

6) Publication Policies: Understand publication policies of academic journals and conferences regarding intellectual property disclosure. Manage the timing of publication vis-à-vis patent filings to avoid jeopardizing patent rights.

7) Licensing and Commercialization: Explore licensing options if there are marketable products or technologies arising from the research. This involves negotiating licensing agreements with interested parties for the use or commercial exploitation of intellectual property.

8)Training and Awareness: Educate researchers and collaborators about IP/IPR issues, ensuring they understand the importance of protecting intellectual contributions and complying with relevant policies and agreements.

9)Regular Review and Update: Continuously review and update IP/IPR strategies as the research progresses. Adapt strategies based on new developments, collaborations, or changes in project direction.

10) Legal Counsel and Experts: Seek advice from legal counsel or IP specialists to navigate complex IP/IPR issues, especially when dealing with patents, licensing, or disputes.

Research data will be stored securely using dedicated research servers, encrypted cloud-based platforms, and institutionally approved systems. Regular backups will be scheduled to create redundant copies stored in multiple locations, ensuring data integrity and protection against loss.

Access and security measures will include role-based access control, encryption for data protection, multi-factor authentication, regular security audits, firewalls, and intrusion detection. Robust backup strategies, secure transmission protocols, employee training, software updates, and monitoring/logging tools ensure data integrity and prevent unauthorized access or breaches.

Data of long-term value includes raw research data, metadata, published findings, annotated data/code, protocols/SOPs, derived data, historical/contextual data, and legal/ethical documentation. Preserving, sharing, and retaining these ensure future research, reproducibility, and historical context.

The long-term preservation plan involves selecting valuable data, creating comprehensive documentation, storing securely in standardized formats, implementing access controls, regular backups, periodic reviews, adapting to technological changes, and ensuring legal compliance for sustained access and usability.

1) Data Licensing: Apply appropriate licenses (e.g., Creative Commons licenses) defining how others can use, share, or build upon the data, clarifying intellectual property rights and permissions;

2) Data Sharing Agreements: Establish formal data sharing agreements with collaborators or stakeholders, outlining responsibilities, usage rights, and expectations for shared data

3) Data Citation: Encourage data citation by providing persistent identifiers (such as DOIs) and clear guidelines on how to cite the dataset, ensuring proper recognition of contributors.

Restrictions on data sharing may be necessary in cases involving confidential information to embargo periods for ongoing research, legal or ethical obligations, security concerns, or participant consent agreements.

Dr. Leonardo Mendes de Souza Mesquita (PI)

To execute the data management plan, resources required include technological infrastructure, data management software, skilled personnel, training programs, documentation tools, security measures, access to repositories/platforms, legal/compliance support, funding, and collaboration platforms. These resources ensure secure data storage, management, compliance, and accessibility throughout the research.