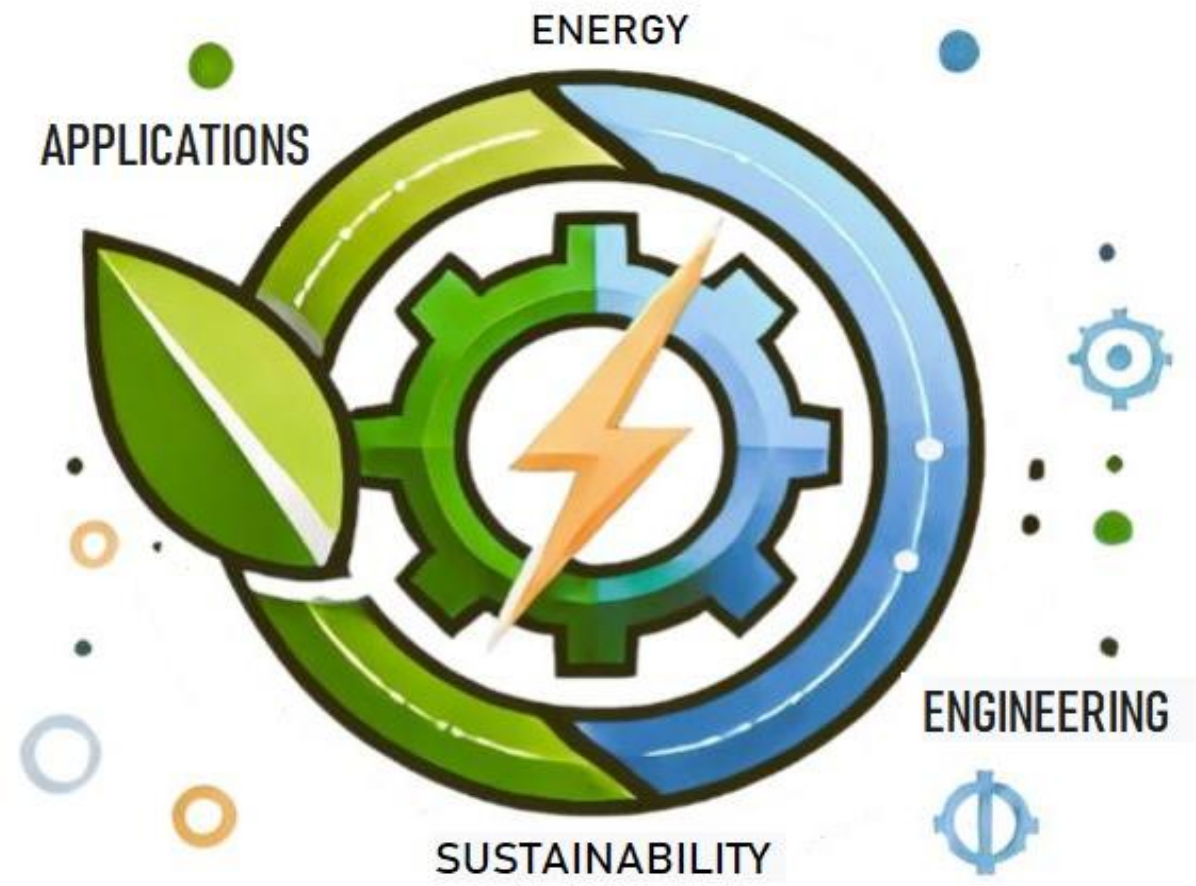
DYCAELS 2025



DYCAELS 2025

"Sustainability and Energy Resources in Engineering Applications"

Organization: G. G. Lenzi, A. M. Tusset, M. E. K. Fuziki, A. Coqueiro, L.M.S. Colpini, O.A.A dos Santos, S. Specchia, J. M. Balthazar.

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https://dycaels.github.io/2025/

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KEYNOTE SPEAKERS

- Dr. Clivaldo de Oliveira “SUSTAINABLE ENERGY RESOURCES: THE POTENTIAL OF ENERGY HARVESTING IN THE ENVIRONMENT”.
- CEO Ariane Mayer and CEO Fernando J. B. Ehrensperger “CLIMATE CRISIS: ECOLOGICAL TRANSITION AND THE ADVANCEMENT OF CLEAN TECHNOLOGIES”
- Dr. Airton Kunz “WASTEWATER TREATMENT FROM ANIMAL PRODUCTION SYSTEMS USING CIRCULAR ECONOMY PRINCIPLES”
- Dr. Rodrigo Brackmann “ADVANCING LOW-CARBON HYDROGEN RESEARCH IN PARANÁ; PESQUISADORES QUE COMPÕEM O NAPI H_2”
- Dr. Francisco das Chagas Carvalho “EFFECTS OF THE ZONAL HARMONICS J2, J3 AND J4 ON OPTIMAL LOW-THRUST TRAJECTORIES”
- Dr. Gustavo Cristante Izar “MACHINE LEARNING ALGORITHMS FOR PREDICTING STRUCTURAL BEHAVIOUR UNDER COMPLEX DYNAMIC LOADING”

ABSTRACTS

- **W. D. P. Siqueira**, D. R. M. Elihimas, C. B. B. Costa, M. A. S. S. Ravagnani and L. V. Pavão “*Mapping the Influence of Process Variables on Environmental and Economic Performance in Intensified Biodiesel Production*”
- **S.E. Krzyuy**, J.M. Balthazar, G.G. Lenzi and A.M. Tusset “*Dynamical Analysis of a Financial System with Chaotic Behavior including Fractional Order*”
- **A.M. Tusset**, J.M. Balthazar and G.G. Lenzi “*Dynamical Analysis of a Non-Linear Model of Cutting Process Subject to Non-Ideal Excitations*”
- **K. Y. G. Angarita**, W. D. P. Siqueira and L. V. Pavão “*Assessment of Hydrogen Production via Gasification of Water Hyacinth (Eichhornia crassipes)* ”
- Ana C. Lazaroto, **Aline E. da Silva Valigura**, Heloisa C. Rodrigues, Airton Kunz, Nédia de Castilhos Ghisi and Marina Celant De Prá “*From Waste to Energy: Scientometric Evidence on Biogas Production from Cattle Manure (2012–2022)*”

- D.R.M. Elihimas, **A.A. Martins**, W.D.P. Siqueira, L.V. Pavão, M.A.S.S. Ravagnani and C.B.B. Costa "*Optimization of Biogas Dry Reforming for Hydrogen Production*"
- **C. H. T. de Lima**, G. G. Lenzi, M. E. K. Fuziki, A. M. Tusset, J. M. Balthazar, E. C. Meurer and L. M. S. Colpini "*Transforming Sugarcane Waste into Biochar: Pathways to Sustainable Environmental Technologies*"
- **Caroline Zarzzeka**, Jonas Goldoni, Filomena Marafon, Margarete D. Bagatini and Leda M. S. Colpini "*Ag/TiO_2 sol-gel photocatalysts: a promising solution for pathogen inactivation*"
- **E. A. Biagio**, O. A. B. Andreo and L. M. M. Jorge "*Hydrotreating of Vegetable Oils over a Ni-Mo/Al_2O_3 Carbide Catalyst: Toward Sustainable Production of Green Fuels* "
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- **T. P. Rosa**, G. G. Lenzi, R. Brackmann and O. A. B. Andreo "*Development of Cu-Zn/Nb_2O_5 Catalysts for Hydrogen Production via Gas-Water Shift Reaction*"
- **T. R. Alves**, Stefani P. da Silva, Lilian C. A. de Oliveira, Larissa R. Matheus, Luiz E. N. Castro, Vanessa C. Ferreira, Tânia F. Carneiro, Dirlei D. Kieling and Leda M. S. Colpini "*Functional nanomaterials based on silver and propolis obtained by modified sol-gel and impregnation*"
- **Thays V. de Oliveira**, Thamires M. Prados, Giane G. Lenzi, Giancarlo A. Lovón-Canchumani and Leda M. S. Colpini "Environmental Impacts of Lithium-Ion Battery Recycling: Integrating Logistics Into a Life Cycle Assessment Model"
- **Vanessa C. Ferreira**, Luiz E. N. Castro, Tiago L. C. T. Barroso, Leda M. S. Colpini and Tânia F. Carneiro "Green Technology for the Valorization of Green Coconut Husk: Extraction with Pressurized Liquids"

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Mapping the Influence of Process Variables on Environmental and Economic Performance in Intensified Biodiesel Production

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Abstract:

Process Intensification (PI) has emerged as a central concept in Process System Engineering (PSE), aiming to redesign equipment and integrate mass and energy flows to enhance system performance. Compared to conventional unit operations, PI strategies can deliver significant improvements in economic viability, product quality, safety, and environmental impact [1]. Biodiesel and other biofuels often rely on subsidies and incentives to remain competitive, which highlights the necessity of PI application while ensuring compliance with the fuel quality standards [2]. In this context, understanding how process variables influence economic and environmental performance is essential to support more effective design and operation strategies. To address this challenge, two intensified processes (reactive distillation with and without heat pump integration) combined with vacuum distillation for glycerol purification to pharmaceutical grade were simulated in Aspen Plus version 14.0. Latin Hypercube Sampling (360 points) and Spearman correlation matrices were used to assess the influence of process variables on costs and CO_2 emissions. The results revealed that, for the reactive distillation configuration without heat pump integration, the distillate-to-feed ratio was the most influential variable, strongly affecting both economic and environmental indicators. This variable also governs the necessary alcohol-to-oil ratio at the reactive distillation column inlet to achieve high conversion levels as reported in experimental studies [3]. In contrast, when a heat pump was applied, the boil-up ratio became the key driver of economic performance, as it directly influences vapor circulation in the column and compression requirements. However, its relevance to emissions was less pronounced, since the primary source of steam consumption (supplied by natural gas combustion) is the reboiler of the vacuum distillation column. Nonetheless, as the results are based on assumptions inherent to thermodynamic models and simulations, they should be complemented by experimental validation on a larger scale.

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Dynamical Analysis of a Financial System with Chaotic Behavior including Fractional Order

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Abstract:

Evidence from recent research indicates that the modeling of financial and economic systems with chaotic behavior, treated as nonlinear systems, has aroused growing interest among various fields. These systems are complex, interact dynamically with the environment, and involve multiple factors, which makes accurate economic forecasting practically unfeasible, highlighting the importance of analyzing their dynamics. In this context, there has been an increase in investigations dedicated to understanding how structural changes, irregularities in microeconomic and macroeconomic fluctuations, irregular growth, and parametric effects influence the dynamics of economic and financial systems, as well as how they foster the emergence of chaotic behaviors. Studies indicate that contemporary behaviors of these systems can be profoundly influenced by the history of key variables such as interest rates, Gross Domestic Product, exchange rates, production and stock prices. This memory effect can extend over long periods, implying that past variations in these variables are correlated with future fluctuations, making fractional order suitable for studying such behavior. Within this scope the present research investigates the non-linear dynamics of a financial system evolution model incorporating fractional order. Numerical simulations revealed the occurrence of chaotic behavior in certain regions of the parameter space, as characterized through phase portraits, bifurcation diagrams, and the calculation of Lyapunov exponents.

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Dynamical Analysis of a Non-Linear Model of Cutting Process Subject to Non-Ideal Excitations

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Abstract:

In machining processes, controlling tool vibration is critical to ensuring productivity, machining accuracy, and reducing tool wear. Friction and regeneration effects are the main factors contributing to cutting tool vibration. Frictional vibration is caused by the contact of the cutting tool with the machined workpiece. In contrast, regeneration vibration is caused by variations in the cutting force, which depends on the current and past positions of the tool. Mathematical models of machining processes consider nonlinear elements, such as nonlinear forces, with the Duffing oscillator being one of the models considered due to its similarity to the regenerative cutting vibration system. In the cutting process, the regenerative force is represented by a cubic nonlinearity. Another representative component in the modeling is the eccentricity of the unbalanced mass of the workpiece that has undergone turning and grinding. To further analyze the vibration characteristics of the cutting system, this paper presents a nonlinear mathematical model of a machining system subjected to a nonideal vibration source. Computer simulations have shown chaotic behavior for specific parameters of the proposed mathematical model. This chaotic behavior is demonstrated using time histories, phase diagrams, bifurcation diagrams, and the Lyapunov exponent.

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Assessment of Hydrogen Production via Gasification of Water Hyacinth (*Eichhornia crassipes*)

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Abstract:
The transition to a global sustainable energy system and the prospect for a low-carbon economy have positioned hydrogen (H_2) as a central energy carrier that could be exploited for transportation, industrial uses, and energy storage. Despite its great promise, more than 98% of current global hydrogen production depends on fossil fuel feedstocks, primarily through steam methane reforming (76%) and coal gasification (22%). Although economically favorable compared to other routes, steam methane reforming generates approximately 9 kg CO_2 per kilogram of hydrogen produced, raising significant environmental concerns. Currently, only 2% of the hydrogen produced comes from renewable feedstocks, mainly through water electrolysis, which is still maturing and has not yet achieved broad industrial use in combination with plant biomass or algae [1, 2]. This study presents a simulation-based assessment of hydrogen (H_2) production through the thermochemical gasification of *Eichhornia crassipes*, the water hyacinth. As an invasive aquatic plant species, it has great promise as a biomass feedstock material but remains largely underutilized for this purpose. The Aspen Plus® simulation software was employed to develop a detailed model that was guided by ultimate and proximate analysis data from literature [3]. The performance of the gasification reaction at a steam-biomass ratio of 1, augmented with supplemental oxygen input, produced a dry syngas composition of 54.77 vol.% H_2, 9.62 vol.% CO, 27.81 vol.% CO_2, and 2.07 vol.% CH_4. These results are consistent with literature values for similar biomass feedstocks, thus verifying the technical viability of exploiting water hyacinth as a renewable hydrogen gas fuel. The study demonstrates the potential of gasification to convert an ecological problem into a valuable resource, supporting the development of a circular and sustainable bioeconomy.

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From Waste to Energy: Scientometric Evidence on Biogas Production from Cattle Manure (2012–2022)

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Abstract:
Biogas derived from the anaerobic digestion of cattle manure has emerged as a sustainable alternative strategy for both waste management and renewable energy generation. To map the global research landscape and identify key trends and knowledge gaps, this study conducted a scientometric analysis of publications on biogas production from cattle manure between 2012 and 2022 using the Web of Science database with the keywords “biogas production,” “cattle manure,” and “anaerobic digestion,” retrieving 454 documents. The data was analyzed with CiteSpace software, which enabled the identification of research trends, citation bursts, and collaboration networks. Results revealed a continuous growth in research output, with publication peaks in 2019, 2020, and 2021. The most prominent subject areas were Energy Fuels, Environmental Sciences, and Green and Sustainable Technology, highlighting the interdisciplinary nature of this field. Geographical distribution showed that China, Italy, and Germany were leading contributors, reflecting their large-scale cattle production and interest in reducing the environmental impacts of manure. Keyword citation bursts (temperature, energy crops, lignocellulosic biomass, cow manure, and livestock manure) emphasized the increasing relevance of co-digestion of cattle manure with energy crops, a common practice in these countries to enhance biogas yields and provide an alternative to fossil fuels. Overall, the findings demonstrate the consolidation and expansion of scientific research on biogas from cattle manure, while also identifying knowledge gaps. The study reinforces the importance of anaerobic digestion as a strategy for emission reduction and its role in advancing a circular and sustainable economy.

Acknowledgements
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Optimization of Biogas Dry Reforming for Hydrogen Production

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Abstract:

Dry reforming of biogas has emerged as a promising technology for sustainable hydrogen production, offering the advantage of simultaneously valorizing methane and carbon dioxide while reducing greenhouse gas emissions. In this study, the optimization of the dry reforming process was carried out with the objective of maximizing hydrogen production by varying reformer temperature and pressure. The process simulation and optimization were performed in Aspen Plus, using the process flowsheet previously described by Elihimas et al. (2024), and considering a biogas feed of 6,333 kg/h with a dry basis composition of 60% CH_4 and 40% CO_2. Operational ranges from 400 to 1500 K for reformer temperature and from 1 to 20 atm for reformer pressure were investigated to evaluate their influence on hydrogen generation. In addition to the full pressure range, a constraint was later imposed to analyze only high-pressure conditions, above 15 atm, reflecting industrial operation. The optimization procedure identified operating points that favored hydrogen generation in both scenarios. Across the general pressure range, the maximum hydrogen production obtained was 791 kg/h at 1 atm and 1440 K. When the constraint to pressures equal or above 15 atm was applied, the process achieved a maximum hydrogen production of 782 kg/h at 15 atm and 1500 K, confirming the adverse effect of pressure on the equilibrium that required compensation by higher temperature. These results confirm the strong dependence of process performance on temperature and pressure, and emphasize that appropriate adjustment of these variables can significantly improve hydrogen output while enhancing CO_2 utilization. The findings provide valuable insights for dry reforming systems and reinforce the potential of this pathway as an industrially feasible option for clean hydrogen production in integrated biorefineries.

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Transforming Sugarcane Waste into Biochar: Pathways to Sustainable Environmental Technologies

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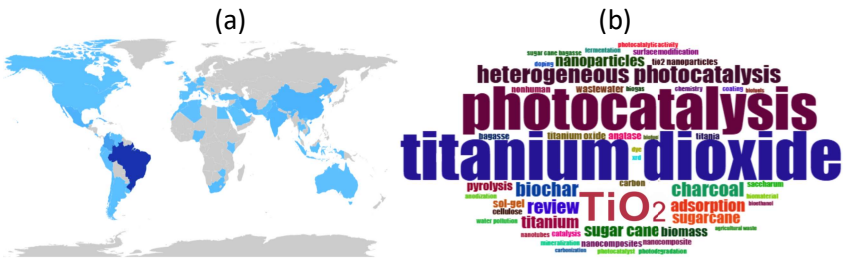
Abstract:

This study presents a bibliometric analysis of scientific literature on biochar, sugarcane, and titanium dioxide (TiO_2). The goal is to map research trends, identify countries with the greatest contributions, and pinpoint emerging themes. The search was conducted in the Web of Science and Scopus databases using the descriptors “biochar” AND (“sugarcane” OR “sugar cane”) OR (“titanium dioxide” OR “TiO_2”) from 2014 to September 2025. After removing duplicates, 662 documents remained. The analysis was conducted in RStudio with the Bibliometrix package, which allowed for the generation of performance indicators, international collaboration networks, and keyword co-occurrence networks. The results revealed Brazil as the most productive country, reflecting its leadership in researching the reuse of waste from the sugar and alcohol industries. China, India, and the United States followed, standing out for developing advanced technologies in functional materials. Figure 1(a) shows the geographic distribution, revealing a strong concentration in Latin America and Asia. This suggests that research is driven by regions with high biomass availability and environmental challenges related to agricultural production and wastewater treatment. The word cloud (Figure 1(b)) highlights the importance of terms such as titanium dioxide, photocatalysis, biochar, and sugarcane. This indicates a convergence of studies on producing biochar to adsorb pollutants and applying TiO_2 in photocatalytic processes to degrade organic contaminants. Co-occurrence analysis revealed two main clusters: a technological cluster focused on improving material and process efficiency and an environmental cluster focused on impact mitigation and the circular economy. Together, these findings demonstrate the evolution of literature toward the integration of solutions based on agro-industrial waste and nanomaterials, reinforcing the role of these technologies in development.

Figure 1 – Geographic distribution of publications (a)/Word cloud (b).



Ag/TiO_2 Sol-gel Photocatalysts: A Promising Solution for Pathogen Inactivation

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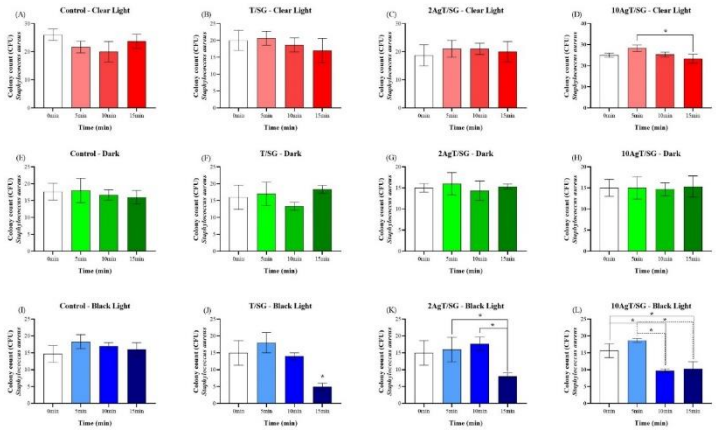
Abstract:
Antimicrobial photoinactivation is a promising strategy for combating infectious diseases, particularly in light of rising antibiotic resistance. This technique uses light-activated photocatalysts to generate reactive oxygen species (ROS), which eliminate microorganisms. One of the major advantages of photoinactivation is its broad-spectrum action and low likelihood of microbial resistance. In this context, the addition of silver (Ag) to the titanium dioxide (TiO_2) support reduces electron-hole recombination, expanding its photocatalytic efficiency toward the visible spectrum. It influences the crystalline phases of TiO_2, exhibiting more anatase phase, leading to improved performance. The combination of Ag and TiO_2 enhances their individual characteristics, exhibiting optimized photocatalytic and antibacterial properties attributed to the synergistic effects of Ag and TiO_2. To explore this technology, we synthesized Ag/TiO_2 oxides (2% and 10% by mass, designated 2AgT/SG and 10AgT/SG) using the sol-gel method. The synthesis route is simple and efficient, involving hydrolysis, condensation, drying, and calcination steps. The antimicrobial action of the catalysts was evaluated under clear light (9 W), black light (36 W), and in the dark. The results revealed that the bactericidal action of the catalysts was significantly more effective when activated by black light, especially against *Staphylococcus aureus*. Inactivation was remarkably rapid, occurring in just 10 minutes (**Figure 1**) for the 10AgT/SG catalyst. These catalysts did not exhibit bacterial inactivation under visible light or in the dark. This effectiveness is attributed to the production of ROS, which damage bacterial cells. These findings demonstrate that AgT/SG catalysts have a superior antimicrobial effect than pure TiO_2, offering great potential for applications in disinfection devices, biomedical treatments, and water purification.

Figure 1 – Antibacterial activity test (*S. aureus*) of the catalysts T/SG, 2AgT/SG and 10AgT/SG photoactivated by clear light (A-D), dark (E-H) and black light (I-L).



Antibacterial action against *S. aureus* of the control (A, E and I) and the catalysts T/SG (B, F and J), 2AgT/SG (C, G and K) and 10AgT/SG (D, H and L) in the clear light (A-D), dark (E-H) and black light (I-L) tests, according to the time variation 0, 5, 10 and 15 minutes. Asterisks indicate $p<0.05$ (one-way ANOVA, post-Tukey test).

Hydrotreating of Vegetable Oils over a Ni-Mo/Al_2O_3 Carbide Catalyst: Toward Sustainable Production of Green Fuels

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Abstract:

Growing demand for renewable energy carriers requires catalytic platforms capable of converting biomass-derived feedstocks into renewable hydrocarbon fuels with high efficiency. Six vegetable oils (canola, coconut, sesame, sunflower, corn, soybean) were hydrotreated in a stirred batch reactor (5 MPa H_2, 360–400 °C)[1] using a Ni–Mo/γ-Al_2O_3 carbide catalyst. Structural characterization confirmed β-Mo_2C and Ni^0 phases dispersed on a high-surface-area mesoporous support (BET 669 $m^2\ g^{-1}$, 1.22 $cm^3\ g^{-1}$, 7.55 nm), enabling enhanced accessibility. In the presence of 2 wt% catalyst, liquid hydrocarbon production increased substantially versus blanks, reaching 5.49 g h^{-1} and a specific activity of 9.15 h^{-1} at 400 °C. Simplified kinetic analysis showed pseudo-zero-order behavior for five oils, with apparent activation energies of 26–91 kJ mol^{-1}. Temperature acted as a selectivity lever: lower temperatures favored C15–C18 (green diesel), while higher values promoted C8–C16 (sustainable aviation fuel) and C5–C12 (green gasoline). Canola oil exhibited the highest diesel selectivity, coconut favored aviation-range hydrocarbons, and soybean showed multipurpose versatility. The obtained distributions match industrial specifications for renewable fuels, highlighting the practical relevance of the approach.[2] Overall, the Ni–Mo carbide/sol–gel alumina catalyst provides a selective, hydrogen-responsive, and scalable route to tailor low-carbon fuel slates from accessible feedstocks. These findings bridge laboratory kinetics with application-grade hydrocarbon cuts, reinforcing the role of carbide-based catalysts in the industrial implementation of sustainable energy transition pathways.

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Circular Economy and Decarbonization: Integrated analysis of global, national and regulatory frameworks with an emphasis on the agricultural sector

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Abstract:

Agriculture is the foundation of food systems but faces growing challenges. According to the United Nations, 40% of the world's land is already degraded, affecting both agricultural productivity and global food security. In this context, understanding regulatory and policy instruments focused on sustainability is essential to identify pathways for the agricultural sector's transition to circular and low-carbon models. This study aimed to conduct a triangulated technical analysis of the evolution of international and national frameworks, highlighting their contributions and connections with agribusiness. The methodology was based on a documentary and bibliographic review of plans, standards, and reference reports. The analysis showed that the Brundtland Report (1987), the Kyoto Protocol (1997), and the Paris Agreement (2015) laid the foundations for sustainable development and shaped policies such as emissions accounting mechanisms, strengthening national commitments (NDCs) and advancing low-carbon strategies. In Brazil, the National Circular Economy Strategy and the Ecological Transformation Plan (2025) establish guidelines for integrating circular practices into the sector, including the use of organic waste, reverse logistics, bioeconomy, and agri-food systems. The ABNT NBR ISO 59010 standard and PR2030 Recommended Practice provide technical frameworks for measuring and standardizing circularity in agro-industrial chains. The discussion converges on a systemic view of sustainability and the institutionalization of policies for transitioning to circular business models. However, gaps remain regarding traceability, the integration of Life Cycle Assessment (LCA), and circularity metrics. It is concluded that legal and regulatory coordination offers strategic opportunities to reposition agribusiness as a driver of the circular economy, decarbonization, and resource regeneration.

Table – Synthesis of literature review and research gaps

Nº	Key Studies	Key Findings	Research Gap	Contribution of this study
1	**Brundtland Report (1987/1991)**	Introduced the concept of sustainable development; conceptual basis for global environmental policies.	Broad conceptual framework, but lacks operational indicators for the agricultural sector.	Provides the ethical foundation to link sustainability with the agri-food sector in a circular perspective.
2	**Kyoto Protocol (1997/2004)**	Established binding GHG reduction targets and market mechanisms (CDM).	Limited scope of application to agriculture; focus mainly on developed countries.	Examines how carbon accounting mechanisms can be adapted to agriculture for emissions traceability.
3	**Paris Agreement (2015)**	Established national commitments (NDCs), transparency, and sectoral mitigation.	Weak implementation in agriculture and absence of standardized metrics.	Assesses the role of NDCs in integrating agriculture into decarbonization and circular economy policies.
4	**National Circular Economy Strategy – Brazil (2025)**	Establishes guidelines for transition from linear to circular economy.	Still in initial phase; lacks sector-specific implementation in agriculture.	Explores how agriculture can become a key driver in national circularity strategies.
5	**Ecological Transformation Plan – Brazil (2025)**	Proposes green industrialization, financing, and technological innovation.	Lacks robust metrics for agricultural applications.	Analyzes opportunities for technological modernization and circular financing in agri-food systems.
6	**ABNT NBR ISO 59010 (2024)**	Provides technical framework to measure circularity in value chains.	Very recent standard; limited practical application in agriculture.	Proposes integration of ISO metrics into agri-food systems, combining circularity and traceability.
7	**PR2030 / Agenda 2030**	Translates global SDG targets into national guidelines and ESG reporting.	Absence of specific agricultural indicators.	Links national sustainability targets with circular practices in agro-industrial chains.

Electrical Components Obtained via 3D Printing: A Review

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Abstract

The demand for sustainable materials as substitutes for conventional materials has led to the need for sustainable manufacturing practices that can effectively balance the use of limited resources and reduce the environmental impact, maintaining economic viability and promoting human well-being. [2]. Manufacturing in 3D printers offers the opportunity to manufacture highly complex parts capable of providing improved performance [1]. In this sense, the present work aims to carry out a systematic literature review addressing the manufacturing of electrical components via 3D printer. One of the most used materials is polylactic acid (PLA). This material is a thermoplastic for 3D printing, particularly in the Fused Filament Fabrication technique [3]. The topics that will be described are: general introduction, 3D printing technologies [2], types of manufactured components [1], Processing and Performance Parameters [3].One of the main challenges in the printing process is the generation of waste and, although PLA is compostable, the possibility of recycling it provides ecological and economic benefits [3].

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Random Forest Surrogate Modeling of Hydrogen Purification via Pressure Swing Adsorption

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Abstract:

The development of accurate surrogate models has become increasingly relevant to accelerate the analysis and optimization of adsorption-based gas separation processes. In most process simulations, Pressure Swing Adsorption (PSA) is often simplified as an ideal separator, neglecting the direct influence of operating conditions on its performance. This study aims to develop and validate a Random Forest (RF) surrogate model for hydrogen purification via PSA, providing both computational efficiency and a realistic representation of process behavior. The PSA process was configured with two adsorption columns operating alternately. The mathematical model and column bed characteristics were based on the description of Xiao et al. (2016). The database was generated using Aspen Adsorption®, considering a feed stream derived from biogas reforming (0.3% CO, 30.4% CO_2, 61.5% H_2, and 7.8% CH_4) and systematically varying adsorption pressure (2 to 20 bar), desorption pressure (1 to 9 bar), product flow rate (8.79×10^{-4} to 264.63×10^{-4} mol/s), and adsorption and desorption times (60–400 s), resulting in 262 samples. The RF model was implemented in Python through the Scikit-learn library, employing 70% of the dataset for training and 30% for testing. Strong predictive accuracy was observed, with a coefficient of determination (R^2) of 92.02% and 98.86% for recovery and purity, respectively, in training, and 96.58% and 99.08% in testing. These results demonstrate the capability of the RF surrogate to capture nonlinear relationships between operating conditions and PSA outcomes, offering a reliable and computationally efficient alternative to repeated dynamic simulations. The proposed model provides a basis for optimization studies aimed at identifying optimal operating parameters for hydrogen purification. Future work will focus on benchmarking the RF approach against other metamodeling techniques and integrating the surrogate into process optimization frameworks.

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Development of Cu-Zn/Nb_2O_5 Catalysts for Hydrogen Production via Gas-Water Shift Reaction

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Abstract:

The growing global concern for the environment and the increasing demand for energy are driving the search for sustainable and clean energy sources. The emissions of gases responsible for global warming reinforce the importance of adopting renewable resources to mitigate these environmental impacts. In this context, several methods for obtaining hydrogen (H_2) have been studied to contribute to this energy transition. The Water-Gas Shift Reaction (WGSR) is of great relevance, as it enables hydrogen production and represents a crucial step toward sustainable energy sources. Recent studies have focused on obtaining H_2 through heterogeneous catalysis. However, further research is still needed regarding the most suitable catalysts for this application, since the synthesis of catalysts applied to the WGS reaction involves multiple variables that affect the physicochemical properties of these materials. Therefore, with the aim of evaluating the performance of copper- and zinc-based catalysts supported on niobium in the WGSR, metallic catalysts (33%Cu/Nb_2O_5 and 34%Zn/Nb_2O_5) and bimetallic catalysts (33%Cu-34%Zn/Nb_2O_5) were prepared using the incipient wetness impregnation method, employing two approaches for metal contact: one through vacuum rotary evaporation and the other through mixing in a shaker. The obtained catalysts were dried at 120 °C for 12 hours and calcined in a muffle furnace following a controlled heating ramp, with the final temperature determined by thermogravimetric analysis (TGA). The synthesized materials will be characterized using different techniques to assess their elemental composition, as well as their structural, morphological, and textural properties.

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FUNCTIONAL NANOMATERIALS BASED ON SILVER AND PROPOLIS OBTAINED BY MODIFIED SOL-GEL AND IMPREGNATION

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Abstract:

Research into silver oxides has stood out due to its potential for self-cleaning and, more importantly, antimicrobial applications. In this context, innovative and sustainable synthesis routes have been developed, such as using cassava starch in the modified sol-gel process and the TiO_2 impregnation technique. These techniques incorporate propolis as a reducing and bioactive agent. This approach yields functional nanomaterials that combine high antimicrobial efficiency with green chemistry principles. The methodologies employed included impregnation synthesis with an excess of solvent and modified sol-gel synthesis using cassava starch as a natural gelling agent. Both methods were followed by drying and calcination steps. Propolis was incorporated into both processes as a natural alternative to enhance the antimicrobial effect. The efficacy was evaluated against Escherichia coli ATCC 25922 through inhibition assays in a liquid medium and counting the colony-forming units (CFU/mL) in PCA agar. The results were compared between the control, pure TiO_2, the syntheses (impregnation and sol-gel), and propolis associated with silver. The results confirm silver's role as an excellent microbial inhibitor, significantly reducing bacterial growth when applied in the absence of propolis. However, its effectiveness was enhanced when combined with propolis. As shown in Figure 1, the samples impregnated with propolis exhibited nearly zero growth, while the sol-gel modified with silver and propolis exhibited total inhibition. These data prove the intrinsic antimicrobial power of silver and the synergistic effect of its association with propolis. Thus, integrating silver with propolis and using cassava starch as a renewable resource resulted in promising materials for antimicrobial and self-cleaning applications that combine technological innovation and environmental sustainability.

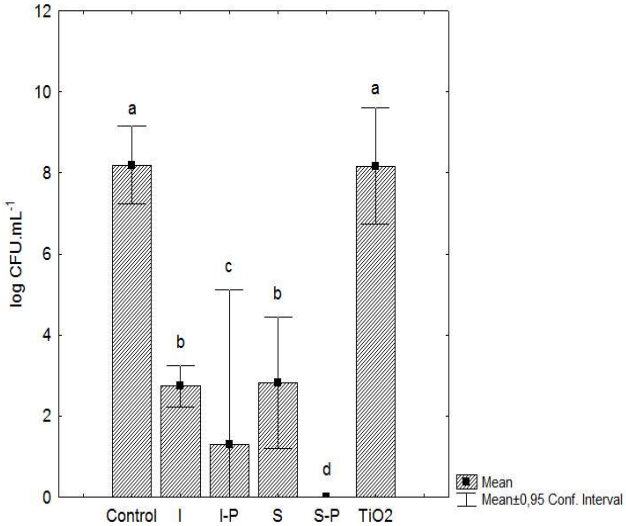

Figure 1. Antimicrobial activity of synthesized materials against Escherichia coli ATCC 25922.

Caption: C (Control), I (impregnation synthesis), I-P (impregnation synthesis with propolis), S (sol-gel synthesis), S-P (sol-gel synthesis with propolis), and TiO_2 (titanium dioxide).

Environmental Impacts of Lithium-Ion Battery Recycling: Integrating Logistics into a Life Cycle Assessment Model

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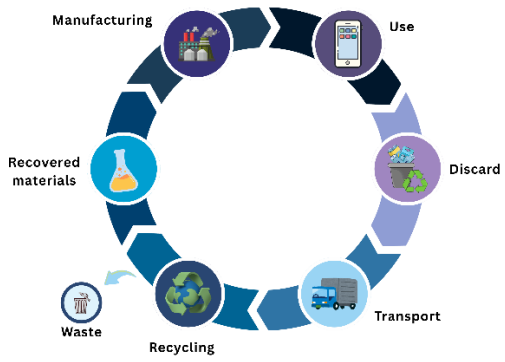
Abstract:

The growing expansion of electric mobility and energy generation from renewable sources has driven demand for lithium-ion batteries, which are essential for electric vehicles and storage systems. This growth, however, has raised concerns about improper disposal and the environmental impacts associated with the life cycle of these batteries. Recycling is a strategic alternative for reducing these impacts and recovering critical metals such as lithium, cobalt, and nickel. However, the environmental and economic viability of this process depends significantly on the logistical stages, which include collection, transportation, and storage. This dimension is often neglected in technical assessments, even though it represents a significant portion of costs and emissions. In this sense, the present study aims to assess the environmental impacts of lithium-ion battery recycling by integrating logistics data into a Life Cycle Assessment (LCA) model. The methodology included mapping logistics flows in the Brazilian context, preparing a Life Cycle Inventory (LCI) with data from 2023, and applying LCA in SimaPro software, using the ReCiPe and IPCC methods. Preliminary results indicate that the logistics stage can make a significant contribution to categories such as atmospheric emissions and energy consumption, influencing the comparison between recycling and primary production. This finding reinforces the need to optimize reverse logistics models, incorporating decentralized collection solutions and more efficient transportation. Thus, the research contributes to broadening the understanding of the sustainability of the battery chain and to supporting public policies and industrial strategies aimed at energy transition. The figure below shows the life cycle diagram for lithium-ion batteries.

Figure 1- Diagram for lithium-ion batteries



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Green Technology for the Valorization of Green Coconut Husk: Extraction with Pressurized Liquids

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Abstract:

The increasing generation of agro-industrial residues represents one of the main environmental challenges today. Among these residues, green coconut husk stands out due to its high availability and limited use in value-added applications. In this context, it is necessary to develop alternatives that promote the sustainable use of these materials, reducing environmental impacts and generating new products of interest. This work focuses on the valorization of green coconut husk, an abundant agro-industrial residue, through the recovery of bioactive compounds. The extraction was carried out using pressurized liquids with water as the solvent, considered a green, safe, and sustainable option. This approach eliminates the need for organic solvents, reduces environmental risks, and promotes cleaner processes. Different extraction conditions were evaluated by varying temperature and time, while maintaining a constant flow rate. The extracts obtained were analyzed for the presence of phenolics, flavonoids, tannins, and sugars. Antioxidant activities were also assessed using the FRAP and DPPH methods. The results indicated that higher temperatures favored the release and solubilization of compounds. Phenolics, flavonoids, tannins, and sugars showed progressive increases under more intense conditions. In particular, the high sugar content observed in the extracts highlights their potential application not only in the food and pharmaceutical sectors but also in energy generation, for example, through fermentative processes. Antioxidant activity also followed this trend, with higher values at elevated temperatures. Overall, temperature proved to be a determining factor in improving process efficiency. Water has been demonstrated to be an effective, selective, and environmentally friendly solvent. The technique showed feasibility for sustainably obtaining functional extracts, reinforcing the potential of clean and innovative technologies to support sustainable development and the circular economy.

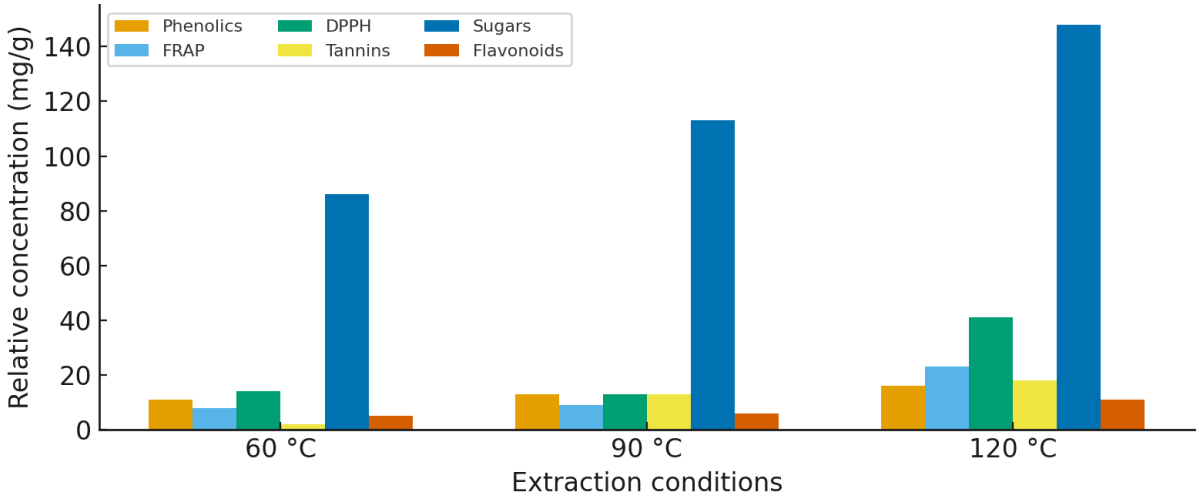

Figura 01: Effect of Extraction Temperature on Bioactive Compounds from Green Coconut Husk.