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Editorial: Valorization of biomass: towards the production of fine chemicals and materials

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Editorial on the Research Topic
Valorization of biomass: towards the production of fine chemicals and materials

Introduction

Climate change, along with the high dependence on fossil resources in modern societies, is driving a transition in both industry and society towards a more sustainable model characterized by a lower carbon footprint. In this context, renewable resources, and particularly biomass, are receiving considerable attention due to their abundance, renewability, and relatively low commercial value. This positions biomass as a key source for energy production as well as for the generation of high-value-added products. The present special issue, entitled *"Valorization of Biomass: Towards the Production of Fine Chemicals and Materials"*, compiles several examples that illustrate the remarkable versatility of biomass as a source of various compounds, contributing to a sustainable chemical engineering industry.

Transforming biomass into high-value-added products

The main aim of this Research Topic is to investigate innovative strategies for the valorization of biomass through the production of fine chemicals and materials. This involves employing emerging technologies or the use of unconventional and underexplored feedstocks. These approaches aim to provide sustainable alternatives to fossil-derived products, contributing to the development of a circular bioeconomy by transforming the main components of the biomass into high-value-added products.

The contributions highlighted in this special issue demonstrate the potential of non-traditional biomass sources and present environmentally-friendly and economically viable processes with promising scalability for industrial implementation. Collectively, these contributions underscore the feasibility of integrating novel biomass conversion

pathways into existing value chains, thereby enhancing the sustainability and resilience of chemical and materials manufacturing.

Brewers' Spent Grain Pretreatment Optimisation to Enhance Enzymatic Hydrolysis. With the aim of enhancing the enzymatic hydrolysis of brewers' spent grain (BSG), which is a lignocellulosic by-product abundantly generated by the beverage industry, Castilla-Archilla et al., proposed a novel and environmentally conscious pretreatment. The research focuses on the application of a dilute acid thermal pretreatment using hydrochloric acid (HCl) as an alternative to the conventionally employed sulfuric acid (H_2SO_4), aiming to reduce the generation of compounds typically associated with harsher acid treatments that could inhibit the fermentation of the carbohydrates obtained in the enzymatic hydrolysis.

The pretreatment was optimized to achieve maximal disruption of the lignocellulosic matrix, thereby improving enzyme accessibility, while simultaneously minimizing the reagents and energy requirements. The pretreated BSG obtained exhibited significantly enhanced susceptibility to enzymatic hydrolysis, yielding a high concentration of fermentable carbohydrates. These sugars serve as valuable substrates for microbial fermentation, enabling the biosynthesis of a wide range of fine chemicals. This valorization pathway positions brewers' spent grain not only as a low-cost and sustainable feedstock, but also as a promising candidate for biorefinery applications in the context of circular bioeconomy development.

Bio-Conversion of Waste Paper Into Fermentable Sugars—A Review. In their comprehensive review, Ojewumi et al., explore the diverse strategies employed for the conversion of waste paper, which is an abundant component of the municipal solid wastes, into fermentable carbohydrates. Due to its inherently recalcitrant lignocellulosic structure, waste paper requires an effective pretreatment step to enhance the efficiency of the subsequent enzymatic hydrolysis. The review compiles various sustainable pretreatment methodologies, encompassing chemical, physical, and biological approaches, all aimed at disrupting the structural integrity of the biomass to improve enzyme accessibility. In addition, it provides a critical analysis of enzymatic hydrolysis studies conducted on pretreated waste paper, highlighting the drawbacks of this process and proposing potential strategies to mitigate them.

By offering an integrated perspective on the valorization of waste paper, this review underscores its potential as a renewable carbohydrate-rich feedstock. The liberated sugars can be harnessed for the microbial synthesis of value-added bioproducts, such as bioethanol, positioning waste paper as a viable resource within the circular bioeconomy and biorefinery frameworks.

Comparative Study on Lubrication Properties of Biodiesel and Bio-Lubricant Trans-Esterified from Desert Seed Oil with Conventional Lubricants. In their study, Adeoti et al., present a promising strategy to reduce modern society's reliance on fossil-derived resources through the development of biolubricants as sustainable alternatives to conventional mineral oils. The proposed approach involves the transesterification of oil extracted from the seeds of the underutilized *Desert date* (*Balanites aegyptiaca*), a resilient fruit species adapted to arid environments. The resulting biolubricants were thoroughly characterized, and their properties were evaluated in comparison with those of commercially available petroleum-based lubricants. The analysis revealed that the biolubricants derived from *Desert date* seed oil exhibit performance parameters compatible with automotive applications.

Thus, this study not only highlights the potential of non-edible, underexploited biomass as a feedstock for high-value bioproducts, but also contributes to the advancement of greener technologies in the lubricant industry. By supporting biobased innovation, this research supports the transition toward a more sustainable and environmentally responsible industry.

Exploring Fine Compounds and Biomass Potential in Cabralea Canjerana and Cordia Americana Wood. The study led by Santos et al., investigates the chemical and anatomical characteristics of the wood from two native Brazilian tree species—*Cabralea canjerana* and *Cordia americana*—with the aim of exploring their potential as novel bioresources. While extracts from these species have traditionally been employed as natural dyes, preservatives, and in medicine, their precise chemical profiles had not been thoroughly elucidated prior to this research.

To address this knowledge gap, the authors performed a comprehensive chemical and anatomical analysis and applied gas chromatography–mass spectrometry (GC-MS) to characterize the bioactive compounds obtained through a solvent extraction. This approach enabled the identification of several compounds with known pharmacological properties, shedding light on the therapeutic potential of these wood-derived extractives.

By providing a detailed chemical and anatomical characterization, this study lays the groundwork for the valorization of *C. canjerana* and *C. americana* as promising feedstocks for the development of biobased pharmaceuticals and sustainable materials, contributing to the diversification of biomass sources within green chemistry and bioeconomy frameworks.

Concluding remarks

The collection of studies featured in this special issue not only advances our technical knowledge of biomass valorization but also underscores the pivotal role of scientific innovation in tackling today's urgent environmental and economic issues. By transforming a wide array of biomass, from agricultural by-products and waste paper to underutilized desert flora and native wood species, into high-value chemicals and functional materials, these works highlight the immense promise of biomass as a foundational element of the emerging circular bioeconomy.

Crucially, the research compiled here illustrates the practical integration of biomass-based processes into current industrial systems, often through environmentally responsible and economically viable approaches. Whether through the development of innovative pretreatment methods to boost enzymatic hydrolysis or the investigation of alternative feedstocks for bio-based lubricants and pharmaceuticals, each contribution emphasizes the interdisciplinary scope and real-world applicability of this field.

Beyond their scientific contributions, these studies collectively support global sustainability objectives by enhancing resource

efficiency, reducing dependence on fossil-based inputs, and fostering more resilient and eco-conscious production models.

Looking forward, continued investment in research, innovation, and supportive policy frameworks will be vital to fully realize the potential of biomass and scale these solutions. The momentum generated by this special issue reinforces the need for ongoing cross-disciplinary collaboration to position biomass as a central driver of the green transition.

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