SUSTAINABLE FORMULATIONS FROM BIOMASS: MAKING LIGNIN PROCESSING GREENER

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Lignin, a highly abundant biopolymer characterized by its elevated carbon content and substantial aromaticity, holds immense potential as a valuable resource for fuel production and the synthesis of platform chemicals. However, despite its promising attributes, lignin remains underutilized within the spectrum of lignocellulosic biopolymers. Lignin's innate versatility can be harnessed through various chemical modifications at both "upstream" and "downstream" stages following its extraction [1, 2]. The chemically modified lignin exhibits the potential to serve as a precursor for the development of nanomaterials tailored for drug delivery, contingent upon its source, chemical alterations, and physicochemical properties.

Efforts to improve lignin's utility have predominantly involved "upstream" chemical modifications, which either target the hydroxyl groups for alteration or introduce new chemically active sites, thereby expanding its applications. Yet, the quest for a versatile and environmentally friendly method for these modifications persists. In this context, the concept of a greener chloromethylation process, currently experiencing renewed interest and offering extensive prospects for "greener" applications, remains unexplored within the realm of lignin.

A novel route for the chloromethylation of lignin was designed, which has paved the way for the creation of a diverse range of lignin-based products utilizing chloromethylated lignin as the starting material [3]. The resulting lignin-based materials encompass catalytic agents, antibacterial formulations, and thermoplastic additives. Our lignin-based catalyst exhibits several advantages over other catalysts, including straightforward synthesis, heterogeneity, recoverability, and recyclability. Furthermore, we have substantiated the efficacy of the lignin-based catalyst in a range of carbon-carbon bond formation reactions, such as Suzuki-Miyaura, Sonogashira, Heck, hydrogenation reactions, and the click reaction. The introduction of various quaternary amines with variable chain lengths has resulted in a series of innovative surface-active materials with enhanced antibacterial activity against both Gram-negative and Gram-positive clinical isolates [4]. The esterification of the chloromethylated lignin leads to a series of prospective plastic additive altering properties of the biobased plastic composites, e.g., PLA.

This research holds the promise of shedding new light on lignin valorization, rendering it economically attractive and environmentally benign.

References

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