

ADVANCING GREEN CHEMISTRY IN BIO-BASED PLATFORM CHEMICAL SYNTHESIS

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The development of green synthetic methodologies is a fundamental challenge in replacing fossil-based chemical production with renewable alternatives. In this context, bio-derived platform molecules obtained from lignocellulosic biomass—such as furan derivatives, isosorbide, levulinic acid derivatives, sugar alcohols, and other oxygen-rich building blocks—have emerged as valuable precursors for the synthesis of advanced polymers, pharmaceuticals, fine chemicals, and functional materials. Despite their potential, the conversion of these renewable substrates frequently depends on hazardous reagents, toxic solvents, and labor-intensive multistep procedures that compromise the overall environmental performance of the process.

Our research addresses these limitations through the development of green synthetic strategies based on the use of organic carbonates as both reaction media and sustainable reagents. Among these, dialkyl carbonates—and especially dimethyl carbonate (DMC)—have proven to be highly effective for the selective transformation of biomass-derived substrates, including D-sorbitol, D-fructose, galactaric acid, and other renewable feedstocks. Acting simultaneously as solvent and reagent, DMC enables chlorine-free, highly selective transformations under relatively mild conditions while replacing more hazardous conventional reagents.

Beyond the selection of renewable raw materials and benign reaction media, the proposed methodologies are designed according to the principles of green chemistry, with the aim of reducing waste generation, lowering energy requirements, simplifying purification steps, and improving overall process efficiency. These synthetic approaches provide access to high-value platform molecules and functional intermediates that are relevant for the production of bio-based polymers, pharmaceutical ingredients, green solvents, and specialty chemicals.

To assess the environmental performance of the developed methodologies, established green chemistry metrics were systematically applied. These quantitative tools supported process optimization, enabled objective comparison between alternative synthetic routes, and provided valuable guidance for future scale-up and potential industrial implementation.