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A Comprehensive Study on Efficient One-Step Multicomponent Synthesis of 1,4-Dihydropyridines Using Green Catalyst

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Abstract: *In the pursuit of sustainable and environmentally benign synthetic methods, this study introduces a novel one-step multicomponent synthesis of 1,4-dihydropyridines (1,4-DHPs) employing a green catalyst. The 1,4-DHP framework is a core structural motif in numerous bioactive molecules and pharmaceuticals, and its efficient synthesis under mild and eco-friendly conditions is of significant interest in modern organic chemistry. Our approach integrates the principles of green chemistry with innovative catalytic design, enabling the rapid assembly of 1,4-DHPs from readily available starting materials in a single operational step.The reaction protocol utilizes an environmentally benign catalyst that is non-toxic, biodegradable, and readily recyclable. The catalyst facilitates a simultaneous condensation, cyclization, and reduction process, effectively lowering the activation energy of the transformation. Mechanistic investigations indicate that the catalyst promotes the formation of a key reactive intermediate, which subsequently undergoes nucleophilic addition and intramolecular cyclization to furnish the dihydropyridine core. This streamlined, multicomponent reaction circumvents the need for multiple purification steps, significantly reducing waste and energy consumption compared to conventional multi-step synthetic routes.A series of experiments were conducted to evaluate the efficiency and scope of the protocol. Reaction conditions were optimized to achieve high yields and selectivity under ambient or slightly elevated temperatures. The green catalyst exhibited remarkable tolerance towards a diverse array of functional groups, thus allowing the synthesis of a wide range of substituted 1,4-DHP derivatives.. Furthermore, kinetic studies provided valuable insights into the reaction mechanism, affirming that the green catalyst substantially accelerates the reaction rate by stabilizing the transition state. By integrating renewable materials and sustainable practices, this method addresses critical environmental concerns while maintaining high efficiency and selectivity in product formation. Overall, the developed protocol represents a significant advancement in the field of heterocyclic synthesis, providing a robust platform for the generation of 1,4-DHPs with broad applications in medicinal chemistry and materials science.*

Keywords: 1,4-Dihydropyridines, One-Step Synthesis, Multicomponent Reaction, Green Catalyst, Sustainable Synthesis, Eco- Friendly Chemistry.

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