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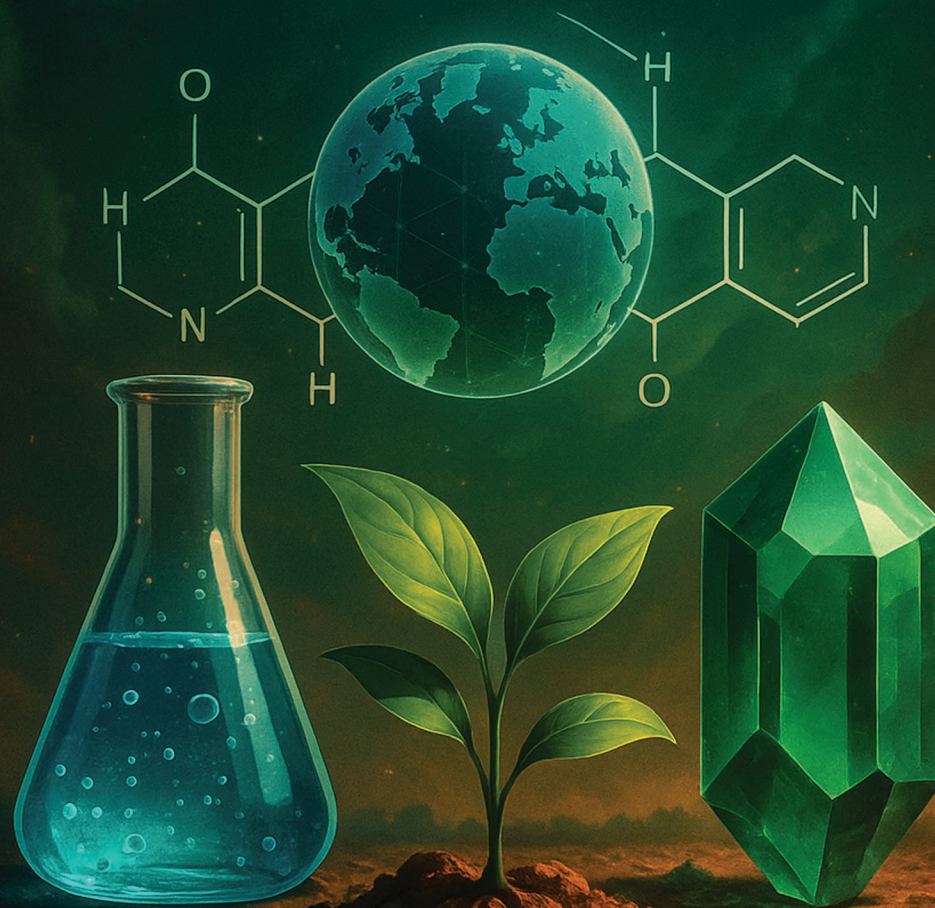
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Perspectives of Medicinal, Material and Environmental Chemistry

PERSPECTIVES OF MEDICINAL, MATERIAL AND ENVIRONMENTAL CHEMISTRY



Editors:
Dr. Saimah Khan
Dr. Naseem Ahmad
Dr. Firoz Hassan



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Green Nanotechnology for Sustainable Development: Plant-Mediated Nanoparticle Synthesis and Applications

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Abstract

Nanoparticles (NPs) have emerged as a transformative technology with diverse applications across various industries such as environmental science, healthcare, renewable energy, and agriculture. The UN's Sustainable Development Goals (SDGs) can be achieved by harnessing the unique attributes of nanoparticles, including their elevated surface-area-to-volume ratio and enhanced reactivity, to address crucial sustainability challenges. However, traditional methods for synthesizing nanoparticles often involve energy-intensive processes and hazardous chemicals, prompting concerns about resource utilization and environmental impact. In turn, there has been a growing interest in the sustainable alternative of green synthesis, particularly through plant-mediated production, which utilizes naturally-occurring plant biomolecules as stabilizers and reducing agents. Furthermore, this process offers a sustainable and cost-effective method to produce biocompatible nanoparticles while also minimizing their impact on the environment.

This chapter delves into exploring how green-synthesized nanoparticles, such as gold (AuNPs) and silver (AgNPs), contribute to advancing sustainable development projects. The discussion focuses on the role of bioactive substances such as polyphenols, flavonoids, and terpenoids in reducing metal ions and

maintaining the stability of nanoparticles in the production of plant-based NPs. The quality and safety of these nanoparticles rely on various characterization techniques such as UV-Vis spectroscopy, TEM, XRD, FTIR, and DLS. These methods offer insight into the size, shape, crystalline structure, and surface chemistry of the particles.

Nanoparticles produced through green synthesis show great potential for various sustainable applications. They have the ability to purify water from pollutants, enhance the efficiency of solar cells, improve crop resilience through the use of nano-fertilizers, and offer antibacterial properties for medical purposes. Nevertheless, several barriers impede their widespread adoption. The variability of plant biochemistry influences the reproducibility of synthesis, making it challenging to scale up production for industrial purposes. Moreover, there is uncertainty regarding the potential impact of NPs on the environment and human health over time, highlighting the need for comprehensive ecotoxicological studies and regulatory guidelines.

Keywords: Nanoparticles, green method, characterizations, & applications

Introduction

The unique environmental, social, and economic challenges facing the twenty-first century require innovative solutions to advance sustainable development. To surmount these challenges, the field of nanotechnology, focusing on the exploration and utilization of nanoparticles (NPs), is emerging as a crucial area of research. Nanoparticles possess unique characteristics that set them apart from their larger counterparts, due to their size falling within the range of 1 to 100 nm [1]. These properties include a high surface area-to-volume ratio, enhanced reactivity, and distinctive quantum effects. Aligned with the United Nations Sustainable Development Goals (SDGs), these characteristics are opening opportunities for