Nanolignin for Eugenol Delivery: A Biological Alternative for Sustainable Rice Blast Control

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Abstract

This project was conducted to develop an environmentally friendly bioactive compound delivery system using lignin, a naturally biodegradable biomaterial, as a carrier for encapsulating eugenol. Eugenol is a natural compound with strong antimicrobial potential against plant pathogens. Therefore, this study investigated the release behavior of eugenol under different temperature conditions to evaluate the potential of the developed system for controlling Rice Blast Disease and reducing dependence on chemical pesticides in agriculture. Lignin nanoparticles encapsulating eugenol (LNPs-EUG) were synthesized and characterized. The prepared nanoparticles exhibited an average particle size of 67.57 nm and high stability, with a zeta potential of −43.2 mV. Chemical structure analysis using FTIR and XRD confirmed the successful encapsulation of eugenol within the amorphous lignin matrix. The release behavior was examined using UV–Vis spectrophotometry by determining the maximum absorbance wavelength, with analysis performed at 282 nm. The results showed that the developed delivery system provided sustained and controlled release for more than 20 hours, while release rates increased at higher temperatures. In conclusion, the developed lignin nanoparticles encapsulating eugenol demonstrate strong potential as a stable controlled-release bioactive delivery system. This system may improve the efficiency of natural bioactive compounds for sustainable agricultural applications while supporting environmentally friendly crop disease management and efficient natural resource utilization for future sustainable farming development worldwide.

Keywords: Eugenol, Nanolignin, Encapsulation