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In Vitro Evaluation of the Synergistic Antibacterial and Antibiofilm Activities of *Parietaria muralis* Extract and Chitosan Nanoparticles

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Abstract

Herbal medicines incorporated with nanomaterials have garnered considerable attention in biomedicine; however, the antibacterial potential of combining chitosan with *Protoparmeliopsis muralis* (*P. muralis*) extract has not yet been investigated. The present study aimed to evaluate the synergistic effect of *P. muralis* and chitosan nanoparticles (CS/NPs) against selected pathogenic bacteria. Antibacterial activity was assessed using the minimum inhibitory concentration (MIC) assay, while antibiofilm effects were determined by the crystal violet assay. A mixture containing 10% *P. muralis* extract and 0.5% CS/NPs was prepared, and the synergistic interaction was further examined by the checkerboard titration method. The results revealed that CS/NPs exhibited stronger antibacterial activity than *P. muralis* extract alone. Furthermore, the checkerboard assay confirmed a synergistic effect between *P. muralis* and CS/NPs. The combined treatment also significantly enhanced antibiofilm activity, highlighting its potential as a promising strategy for controlling bacterial growth and biofilm-associated infections. In conclusion, these findings indicate that the combination of *P. muralis* extract and chitosan nanoparticles may serve as a potential candidate for further studies focused on the identification and development of novel antibacterial and antibiofilm compounds. Future research, including mechanistic studies and in vivo evaluations, is necessary to better understand and validate the observed effects.

Key words: Chitosan, Lichen, Antibacterial, Antibiofilm

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