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Synthesis and Characterization of Nano-formulations of Gallic Acid, Vanillin, and Quercetin to Enhance Antibacterial Activity

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Recently, the misuse of antibiotics has led to the developement of resistance against many synthestic antibiotics in pathogenic bacteria, necessitating alternative approaches like the development of novel antibiotics using natural sources. However, many phytochemicals have not shown expected activity due to their hydrophobicity, poor absorption and their large size. The present study aimed to synthesis nanoparticals of three pure phytochemicals: gallic acid, vanillin, and quercetin in order to improve their antibacterial activity. Nanoparticles of selected bioactive compounds were synthesised by the nanoprecipitation method using polyvinylpyrrolidine and alginate as stabilizers. The antibacterial potential of pure compounds and nanoparticles was assessed against *Escherichia coli* and *Staphylococcus aureus* by the agar-well diffusion method and the micro broth dilution method. Scanning Electron Microscopic images indicated that the size of the procuded particals ranged between 100 and 200 nm confirming the sysnthesis of nanoparticals. Notably, among the nano formulations, polyvinylpyrrolidine-coated gallic acid had the highest zone of inhibition against E. coli (0.67 ± 0.12 cm) in agar-well diffusion assay. Importantly, when compared with pure Gallic acid (100 $mgmL^{-1}$), nano-formulation had reduced minimum inhibitory concentrations agaisnt both *S. aureus* (84.37 $mgmL^{-1}$) and *E. coli* (63.28 $mgmL^{-1}$). Sodium alginate-coated gallic acid demonstrated significant efficacy against both *E. coli* and *S. aureus*, showcasing its potential as an antibacterial agent. The present study reveals that synthesis of nanoparticals with using certain stabilizers enhances the antibacterial activity of natural physochemicals, paving the way for future development of novel anti-bacterial agents.

Keywords: *nanoparticles, antibacterial activity, gallic acid, vanillin, quercetin*