Quorum Sensing Inhibition via Traditional Chinese Medicinal Plant-Derived Phytochemicals: A Sustainable and Targeted Anti-Virulence Strategy

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Phytochemicals are naturally occurring compounds in plants, relatively understudied for their ability to interfere with bacterial communication mechanisms, and the underlying modes of action remain poorly understood. This study investigates phytochemical inhibition of bacterial quorum sensing (QS) as a sustainable anti-virulence strategy. Tanshinone IIA and Baicalein, chosen for high binding energies for bacterial QS receptors, were respectively tested on E. coli engineered with the V. fischeri lux operon to produce QS-dependent bioluminescence. Optimized concentration ranges, evaluated during pre-trials, were utilized. Tanshinone was applied at 150μM, 175μM, and 200μM, while Baicalein was tested at 175μM, 200μM, and 225μM. Luminescence, OD600 absorbance, pH measurements and imaging assays were performed at 12-hour intervals. Both Tanshinone–treated and Baicalein-treated cultures exhibited significant reductions in bioluminescence relative to the positive control, indicating QS inhibition. Luminescence decreased to undetectable levels within 12 hours until partial signal return was observed at approximately 36 hours, likely due to compound degradation. Reapplication of compounds resulted in renewed suppression of luminescence. Neither compound significantly affected bacterial growth or pH. Statistical significance was assessed using independent t-tests and AUC analysis. Molecular docking supported findings through predicted LuxR interactions. With nominalized concentrations for both phytochemicals, the results of this study are foundational for the development of sustainable treatments for chronic infections that target pathogenic behavior rather than bacterial viability, potentially reducing cytotoxicity and reliance on traditional antibiotic therapies.

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