Muting Messages: Boronic Acids Reduce Quorum Sensing and Associated Fitness in E. coli

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Quorum Sensing (QS) is a bacterial communication pathway that mediates population-based activity such as virulence and biofilm formation. Specifically, QS affects biofilm maturation, including the production of Extracellular Polymeric Substances (EPS), and competence, leading to increased antibiotic-resistance. QS also strengthens bacterial metabolic activity in the presence of selective pressures. Escherichia coli is an opportunistic pathogen that performs QS through the luxS/lsrR-mediated system utilizing Autoinducer-2 (AI-2) as the primary signal. The LuxS synthase is present among various WHO priority pathogens while AI-2 acts as a “universal autoinducer” that bridges interspecies communication, making E. coli a model organism for QS research. This study explores the effects of boronic acids indole-4-boronic acid and 6-Bromo-3-pyridinylboronic acid on QS-induced E. coli fitness, focusing on EPS protein density, competence, and metabolic activity. Crystal Violet and Bradford assays were performed on Biofilm of E. coli grown in media containing boronic acids and were normalized against calibration curves to quantify biofilm and protein, respectively. Competence was tested by measuring post-transformation growth of cultures through OD600. Cultures were stained with alamarBlue® to measure metabolic activity. Both boronic acids decreased both total biofilm and EPS protein quantities, but increased protein density; decreased competence; and decreased metabolic activity. Overall, both boronic acids significantly affect biofilm mechanisms to decrease adaptability for selective environments and overall fitness. As low-resistance-risk supplements to traditional antibiotics, these boronic acids introduce a novel approach to treating chronic or recurring infections.

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