# Studies on Chemical Communication among Microbes

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Chemical communication by diffusible signaling molecules is a common mechanism to all living organisms from bacteria to eukaryotic cells. Microorganisms use a number of molecules as their hormones/pheromones to regulate the expression of specific genes involved in the production of secondary metabolites and exoenzymes, cell motility, and/or sporulation. Especially, bacterial cells possess a mechanism that regulates gene expression in accordance with population growth. This bacterial phenomenon is called quorum sensing (QS), which is defined to affect the diversity of group behaviors in a number of bacterial species through the exchange of signaling molecules. These molecules are specially called QS signals.

*R. solanacearum* is a β-proteobacterium that causes a lethal disease called "bacterial wilt" in more than 200 plant species, which include agronomically important crops such as the tomato and potato. When this pathogen invades host vascular tissues, it grows vigorously and produces large amounts of extracellular polysaccharide (EPS), a loose slime with a heterogeneous composition. The accumulation of EPS prevents water flow in vessels, eventually causing severe wilting symptoms in infected plants. The production of EPS is regulated by QS systems. *Ralstonia* has developed a genus-specific QS system consisting of *phc* regulatory elements; however, the QS signal has not been fully elucidated. We identified (*R*)-methyl 3-hydroxymyristate as a new QS signal that regulates the production of virulence factors and secondary metabolites. In addition, ralfuranones, aryl-furanones, were identified as QS-dependent metabolites.

Many bacteria have developed close associations with eukaryotes including mammals, insects, and plants. The ability to enter into and inhabit eukaryotic cells has given the bacteria specialized niche environments that are stable, nutrient rich, and enemy free. In the past decade or so, it has been revealed that some bacteria inhabit fungal cells. We found that *R. solanacearum* enters fungal tissues through the chlamydospores induced by ralstonins. Ralstonins are unusual lipodepsipeptides composed of 11 amino acids (containing unique amino acids such as β-hydroxytyrosine and dehydroalanine) and a 3-amino-2-hydroxyoctadecanoic acid, and their production is controlled by QS in *R. solanacearum*.

Many natural polyynes, unique molecules with alternating triple and single carbon–carbon bonds, from plants, basidiomycetes, and insects have been reported. However, examples of polyynes of bacterial origin are very limited. Bacterial polyynes are unstable and thus require caution when handled. In addition, these compounds possess one to several chiral centers, which are formed as a result of oxidation. The isolation and structure elucidation of collimonins A−D from the fungus-feeding bacterium *Collimonas fungivorans* Ter331 were accomplished. Collimonins are new derivatives of polyoxygenated hexadecanoic acid, including an ene−triyne moiety. Their absolute configurations were fully determined by combining spectroscopic, chemical, and crystalline sponge methods. Collimonins showed antifungal or pigmentation activities against the fungus *Aspergillus niger* ATCC 9029.

1) Kai K (2019): Bioorganic chemistry of signaling molecules in microbial communication. *Journal of Pesticide Science*, 44, 200.
2) Kai K (2018): Bacterial quorum sensing in symbiotic and pathogenic relationships with hosts. *Bioscience, Biotechnology, and Biochemistry*, 82, 363.