Talk

Molecular analysis of the symbiosis between Nostoc punctiforme and Oryza sativa

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ABSTRACT

Nostoc punctiforme is a filamentous, diazotrophic cyanobacteria capable of forming symbiotic relationships with diverse plant species (Álvarez et al., 2020; Álvarez et al., 2023). Given the widespread use of synthetic nitrogen fertilizers in rice cultivation and their associated environmental issues, biological nitrogen fixation (BNF) by cyanobacteria presents a promising alternative (Álvarez et al., 2023). However, the molecular mechanisms underpinning the symbiotic association between N. punctiforme and rice remain poorly understood. In well-characterized symbiotic interactions, such as those occurring between legumes and nitrogen-fixing rhizobial bacteria, the common symbiotic signalling pathway (CSSP) is activated. This process begins with Rhizobium secreting Nod factors in response to flavonoids released by compatible plants. Álvarez et al. (2022) demonstrated for the first time the expression of Nod-like proteins in N. punctiforme and the participation of the CSSP pathway in rice during symbiosis.

Based on these previous results, this study aims to elucidate the genetic basis of this interaction by characterizing orthologous genes in Nostoc related to the nodD regulatory gene in Rhizobium leguminosarum, which play a pivotal role in symbiosis by regulating the expresion of the genes involved in the generation of nod factors. Bioinformatic analyses were conducted to identify homologous sequences of nodD from R. leguminosarum in N. punctiforme, and structural modelling compared their potential functional roles. Three key nodD homologs with conserved DNA-binding and inducer recognition domains were found in N. punctiforme, called nodD1, nodD2 and nodD3. Using homologous recombination, loss-of-function nodD gene mutants were generated in N. punctiforme and characterized. Genetic characterization revealed the maintenance of wild type copies of genes nodD1 and nodD3 in their respective mutants, suggesting that those genes may be essential.

Preliminary symbiosis analysis results with different symbiotic plant species seem to indicate reduced root adherence, highlighting their possible involvement in stablishing symbiosis. Further symbiosis assays with rice are needed to evaluate endophytic colonization efficiency. These insights contribute to understanding microbial symbiosis and support the development of cyanobacteria-based biofertilizers for sustainable agriculture.

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