A Rhizobium leguminosarum CHDL- (Cadherin-Like-) Lectin Participates in Assembly and Remodeling of the Biofilm Matrix

In natural environments most bacteria live in multicellular structures called biofilms. These cell aggregates are enclosed in a self-produced polymeric extracellular matrix, which protects the cells, provides mechanical stability and mediates cellular cohesion and adhesion to surfaces. Although important advances were made in the identification of the genetic and extracellular factors required for biofilm formation, the mechanisms leading to biofilm matrix assembly, and the roles of extracellular proteins in these processes are still poorly understood. The symbiont Rhizobium leguminosarum requires the synthesis of the acidic exopolysaccharide and the PrsDE secretion system to develop a mature biofilm. PrsDE is responsible for the secretion of the Rap family of proteins that share one or two Ra/CHDL (cadherin-like-) domains. RapA2 is a calcium-dependent lectin with a cadherin-like β sheet structure that specifically recognizes the exopolysaccharide, either as a capsular polysaccharide (CPS) or in its released form [extracellular polysaccharide (EPS)]. In this study, using gain and loss of function approaches combined with phenotypic and microscopic studies we demonstrated that RapA lectins are involved in biofilm matrix development and cellular cohesion. While the absence of any RapA protein increased the compactness of bacterial aggregates, high levels of RapA1 expanded distances between cells and favored the production of a dense matrix network. Whereas endogenous RapA(s) are predominantly located at one bacterial pole, we found that under overproduction conditions, RapA1 surrounded the cell in a way that was reminiscent of the capsule. Accordingly, polysaccharide analyses showed that the RapA lectins promote CPS formation at the expense of lower EPS production. Besides, polysaccharide analysis suggests that RapA modulates the EPS size profile. Collectively, these results show that the interaction of RapA lectins with the polysaccharide is involved in rhizobial biofilm matrix assembly and remodeling.
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