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Plants recognize bacterial flagella

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Abstract

Plant defense responses are induced by recognition of a conserved epitope of the major protein of the bacterial flagellum. This could represent a general perception mechanism for plants to detect infection by eubacteria.

Significance and context

Plants have the ability to detect microbial pathogens and respond to their attack with a variety of defence responses. They are thought to recognize molecules (elicitors) of both plant and pathogen origin that are produced during microbial entry. Many elicitors (generally cell-surface molecules) have been identified from fungal plant pathogens, but fewer bacterial elicitors are known. The best-studied bacterial extracellular elicitors are the harpins, which are synthesized and secreted by certain plant pathogens and trigger defense responses in resistantplants. Bacteria mutant for harpin production, however, still trigger these responses, indicating the presence of additional sensory systems in plants for detection of bacteria. Felix *et al*. set out to characterize harpins from *Pseudomonas syringae*, and in doing so discovered a new general bacterial elicitor - a highly conserved domain within flagellin, the major structural component of the bacterial flagellum.

Key results

Established protocols were used to isolate a crude preparation with elicitor properties from *P. syringae*. The major elicitor was found to be a protein, and amino-terminal sequencing of the purified protein revealed it to be homologous to amino-terminal sequences of flagellins from *Pseudomonas* species. The bacterial flagellum is composed of a rotary motor in the cell membrane and a large extracellular helical filament. Rotation of this filament propels the bacterium. The filament is a protein polymer consisting of 10,000 - 40,000 flagellin monomers. Flagella were purified from *P. syringae* and were shown to be potent elicitors of defense responses when applied to plant cells. The flagellin preparations were cleaved using cyanogen bromide and the fragments were tested for elicitor function. Activity was found only with amino-terminal fragments. The amino-terminal regions of flagellin monomers are conserved among bacterial species, and the authors speculate that plants might have a perception system for this conserved domain as a common determinant of bacteria. A peptide of 22 amino acids, identical to the conserved domain, was synthesized and found to be a potent elicitor. A

number of plant species were treated with this peptide and defense responses were induced in tomato, tobacco, potato and *Arabidopsis* - although there was no response from suspension cultures of rice cells.

Links

An accompanying paper from the same laboratory in the same issue of *Plant Journal* identifies a locus on chromosome 5 of *Arabidopsis* as responsible for perception of the flagellin signal.

Conclusions

A conserved domain of a component of the bacterial flagellum has been identified as the first general elicitor of plant defense responses. The flagellum filament is extracellular to bacteria and is likely to be one of the first structures to contact a plant cell in an attack.

Reporter's comments

This was a chance discovery, perhaps, but nonetheless an important one. The high degree of conservation of the elicitor region is illustrated by the fact that flagellar preparations from *Escherichia coli* (which does not infect plants) can induce plant defense responses. The perception mechanism also seems to be a general plant characteristic, at least within dicotyledons. Within the rhizosphere, depolymerization of the filament is probably required to expose the domain to a putative plant receptor. The authors state that work is under way to identify such a receptor. Intriguingly, sequence alignments show that two highly studied plant-associating bacteria, *Agrobacterium tumefaciens* and *Rhizobium meliloti*, have exceptional divergence in this 'conserved' region, and flagellar preparations from these bacteria did not induce plant defense responses.

Table of links

Plant Journal

References

1. Felix G, Duran JD, Volko S, Boller T: Plants have a sensitive perception system for the most conserved domain of bacterial flagellin. Plant J. 1999, 18: 265-276. 0960-7412