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A lectin receptor for rhizobial nodulation

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Abstract

The isolation of a putative receptor protein for rhizobial nod factors that is located on the surface of legume roots and also has nucleotide hydrolytic properties is described.

Significance and context

Nod factors are synthesized and secreted by rhizobia when they detect flavonoids released from leguminous plants, and this forms the initial signaling exchange in the establishment of the nitrogen-fixing symbiotic relationship between the legume and bacterium. Many different nod factors can be synthesized by rhizobia, but they all have a chitin oligosaccharide backbone, which is *N*-acylated at the non-reducing terminus. Strain-specific variations occur in the length of the backbone and the chemical compounds that decorate it, and these differences are a major determining factor in whether plants can become nodulated. Nod factor structures and genes are well characterized in a number of rhizobia. This is in contrast to what is known of the plant proteins that bind nod factors and bring about signal transduction within the plant root cells. Fractions of root extracts from the legume *Medicago truncatula* have been shown to bind nod factors, but this paper reports the first identification of a specific nod-factor binding protein.

Key results

The lectin-nucleotide phosphohydrolase (LNP) described in this paper was identified previously as a lectin after isolation from roots of the legume *Dolichos biflorus*. It can also bind chitin, and a competitive binding assay using various carbohydrates showed that nod factors inhibited the binding of LNP to chitin. Tryptic digests of the purified LNP were sequenced; degenerate primers were synthesized, and a full-length cDNA was obtained using standard techniques. Database analysis revealed no homology between LNP and any known animal or plant lectin. There was, however, strong homology to plant apyrases, enzymes that catalyze the hydrolysis of phosphoanhydride bonds of nucleoside diphosphates and triphosphates. Such activity was demonstrated for LNP, and, furthermore, the activity increased upon preincubation of LNP with ligands recognized by its carbohydrate-binding site. Antiserum to LNP was used to show that LNP localizes predominantly to the surface of root hairs. Root hairs are the primary site of rhizobial infection, and pretreating them with the antiserum before inoculation with rhizobia resulted in a decrease in nodule formation.

Conclusions

The analyses of LNP carried out in this paper - its ability to bind nod factors, its location on the root surface and the apyrase activity that may play some role in signaling - suggest that it may have a role in the rhizobium–legume symbiosis.

Reporter's comments

This paper will form the starting point for a number of studies on LNP. Etzler *et al.* argue for a possible role for LNP in the nodulation process and describe experiments needed to confirm such a role. It will be interesting to see the results. The possible presence of LNP on the root hair surface is intriguing given the absence of any predicted transmembrane domains from the sequence. Only the very end of the amino-terminal signal sequence could function as a membrane anchor, which would limit the ability of LNP to function as a cytoplasmic signaling device. As the authors suggest, other membrane proteins may be involved. It will also be interesting to see whether other legumes have homologs of LNP.

Table of links

Proceedings of the National Academy of Sciences of the United States of America

References

1. Etzler ME, Kalsi G, Ewing NN, Roberts NJ, Day RB, Murphy JB: A nod factor binding lectin with apyrase activity from legume roots. Proc Natl Acad Sci U S A. 1999, 96: 5856-5861. 0027-8424