Do fimbriae and flagella mediate specific interactions between human pathogenic enterobacteria and plant hosts?

Nicola Holden
Plant Pathology, Scottish Crop Research Institute, Invergowrie, Dundee DD2 5DA.

Background

Adherence to host tissue is a pre-requisite for bacteria-host interactions, whether the relationship is pathogenic, benign or mutualistic, and no matter which kingdom the host belongs to. There are a variety of adherence mechanisms that confer differing strengths of attachment as well as specificity in the interaction. The organelles that can adhere to host tissue are: flagella; fimbriae; type three secretion apparatus; agglutinins; outer membrane proteins and lipopolysaccharide. This work focuses on fimbriae and flagella of human pathogenic enterobacteria.

Fimbrial (or pili) adhesins mediate specific interactions with host tissue, by recognition of glycans that decorate host proteins. Bacteria often posses multiple fimbrial types which in turn mediate binding to a number of different host receptors (*1*). Flagella are required for motility and chemotaxis, although a number of studies have shown a role in adherence to plant and mammalian tissue which, like fimbriae appears to be mediated by specific interactions.

Results

We are investigating adherence factors of human pathogenic enterobacteria that may be involved in binding to plant tissue. We have identified two fimbrial clusters of enterohaemorrhagic *Escherichia coli*: F9 and Ecp (*E. coli* common pilus) (Fig. 1).

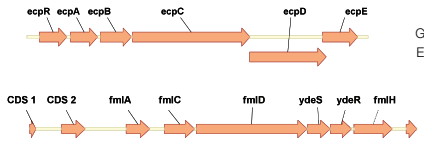

Figure 1. Genetic organisation of the EHEC fimbrial clusters Ecp and F9 (*fml*)

F9 is only present in pathogenic *E. coli* isolates, while Ecp is more widely distributed. While both have been shown to bind mammalian tissue (*2, 3*), we have found that deletion of the major fimbrial subunit (*ecpA*, *fmlA*) reduces the number of bacteria bound to plant roots (Fig. 2). Competition assays confirm the phenotype. Furthermore, both fimbrial clusters were identified following bacterial transcriptome analysis of adherence. Work is on-going to complement the mutant phenotypes.

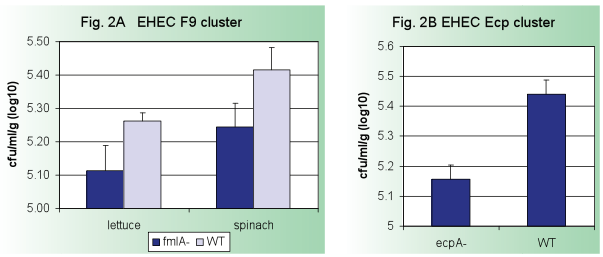

Figure 2. Number of bacteria recovered following a two hour binding assay to detached roots, expressed as cfu/ml/g (fresh weight). (A) EHEC *fmlA* mutant and wild type binding to ~ 18 day old lettuce or spinach roots; (B) EHEC *ecpA* mutant and wild type binding to ~ 18 day old spinach roots.

We are also investigating the role of *Salmonella enterica* serovar Typhimurium flagella in adherence to root tissue. Although flagella have been reported to adhere to basil leaves (*4*), adherence to root tissue has not been definitively demonstrated. This is important because human pathogenic enterobacteria colonise the roots more readily than foliage and flagella are required for internalisation (*5*). Our preliminary analysis shows that flagella appear to mediate binding to root tissue (Fig 3). Future work will confirm the role of flagella in root binding and be expanded to screen a number of outbreak strains associated with fresh produce.

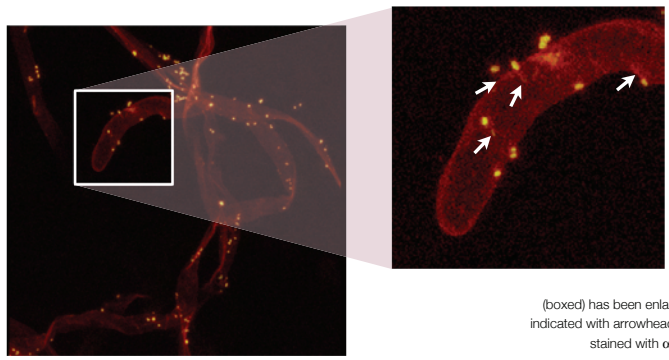

Figure 3. Confocal micrograph showing apparent flagella-mediated adherence of *S. Typhimurium* to tomato seedling root hairs. One of the hairs (boxed) has been enlarged and the flagella indicated with arrowheads. The bacteria are stained with α-LPS and α-flagella.

Conclusions

These data support the role of factors that mediate specific interactions with host plants, which substantiates the notion that human pathogenic enterobacteria actively interact with plant hosts.

Future work will expand on these findings to determine the host receptors. In the longer term, such information could be used to find interventions that prevent bacterial adherence and thus reduce the carriage of harmful bacteria in fresh produce.

References

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