PhD Project Advertisement

Project title: Crop protection: protecting farmed insects from pathogens using predatory bacteria.
Project No: FBS2024-003-Whitworth-aq

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Project description:

Background:

Interest in farming edible insects (e.g. locusts, mealworms and crickets) as sustainable food supplies of the future is rapidly increasing. The estimated global market value of edible insects is currently 3.2 billion USD per annum and expected to reach 17 billion USD per annum by 2032. However, insects are prone to microbial infections, with fungal diseases able to spread quickly through populations of cultivated insects. Consequently, there is an imminent need for safe and sustainable methods to control the pathogens of food insects (entomopathogens). Due to the infancy of the insect-production industry, there are currently no estimates of the economic impact of entomopathogens on edible insect production, however it is acknowledged that "diseases of insects are a bottleneck for every type and scale of rearing system".

Myxobacteria are microbial predators which can kill and consume a broad range of bacterial and fungal prey organisms. Their wide prey range is due to their mechanism of predation – the untargeted secretion of broad spectrum digestive enzymes, protein toxins and antimicrobial peptides. This makes myxobacteria ideal candidates for use as biological control agents, as they could potentially protect insect crops by consuming the fungal pathogens of those insects. Indeed, we have preliminary data showing that myxobacteria can provide complete protection to populations of the edible insect Schistocerca gregaria (African desert locust) from otherwise fatal infection by the entomopathogen Metarhizium robertsii.

The purpose of this project is to investigate the use of myxobacteria as biological control agents for the protection of insect crops from a range of entomopathogens.

Hypothesis:

The broad range of prey consumed by myxobacterial predators allows them to protect crop insects from a wide range of entomopathogens, increasing crop yields without adversely impacting their nutritive value.

To test this hypothesis we will characterise the ability of different myxobacterial species to prey upon entomopathogens and protect crop insects from disease, assess the impact of myxobacteria/pathogen on the nutritional value of insect crops, and investigate methods for optimising administration of myxobacteria with a view to industrial application.

Objectives:

1- Characterising myxobacterial predation of entomopathogens. More than 750 species of fungi are pathogenic to insects. It is therefore important to identify myxobacterial strains/species which have the greatest possible breadth of predatory activity. We will therefore use a variety of in vitro assays to quantify the predatory activity of myxobacteria (from our pre-existing culture collection) against a diverse panel of entomopathogenic fungi.

2 - Isolation of novel predators with optimised activity against entomopathogens. We have preliminary evidence that the natural microbial biota of insects includes predatory bacteria, which are likely to be evolutionarily optimised predators of

entomopathogens. We will therefore isolate insect-resident predators using a variety of methods. The resulting isolates will be thoroughly characterised, e.g. via phylogenetic analysis, physiological assays and genome sequencing.

3 – Crop protection assays. To test the effectiveness of myxobacteria in a crop protection context, we will rear populations of insects and challenge sub-populations with a range of different pathogens. Selected myxobacteria from objectives 1 and 2 will be applied to infected insects, and their effectiveness in preventing disease assessed. We will also test the effectiveness of different application regimes. For instance, investigating different mechanisms of applying myxobacteria (e.g. as spores or cells, via sprays or coated onto carriers), and the impact of application timing/regularity (e.g. pre or post infection with entomopathogen).

4 – Assessing the impact of myxobacteria and entomopathogens on nutrient use efficiency. The nutritive value of different insect crops (e.g. protein, minerals) will be evaluated with/without myxobacteria and/or entomopathogens. We will also assess in vitro their effect on fermentation in the digestive tract using both monogastric and ruminant models.

Training opportunities:

This studentship lies at the interface between zoology, microbiology, and food science, and has been designed to gently introduce the student to an ever-expanding range of methods. The project team will provide full training in modern methods of numerous microbiology techniques, insect husbandry, experimental design, data analysis and other 'core' research skills. Training will also be provided by the supervisors in methods for assessing nutrient use efficiency and nutritive value of insects, plus in vitro models of digestive fermentation. The applicability of these skills to problems across the life, agricultural, and food sciences, make them 'generically' cross-disciplinary. The project includes funded research visits to Queen's University Belfast during the PhD, attendance at summer school and funding to present research findings at national and international scientific conferences.

Student profile:

The project would be suitable for students with interests in cross-disciplinary research, involving fundamental and applied research in microbial physiology, insect production and food science. We are open to applicants from diverse academic backgrounds in a biological, or otherwise relevant science, and with a clear interest in developing the expertise required to fulfil this exciting research program. The ability and motivation to learn new skills quickly would be highly advantageous.

Stipend (Salary):

FoodBioSystems DTP students receive an annual tax free stipend (salary) that is paid in instalments throughout the year. For 2023/24 this is £18,622 and it will increase slightly each year at rate set by UKRI.

Equality Diversity and Inclusion:

The FoodBioSystems DTP is committed to equality, diversity and inclusion (EDI), to building a doctoral researcher(DR) and staff body that reflects the diversity of society, and to encourage applications from under-represented and disadvantaged groups. Our actions to promote diversity and inclusion are detailed on the FoodBioSystems DTP website.

In accordance with UKRI guidelines, our studentships are offered on a part time basis in addition to full time registration. The minimum registration is 50% FT and the studentship end date will be extended to reflect the part-time registration.

References:

Livingstone PG, Morphew RM, Whitworth DE (2017). Myxobacteria Are Able to Prey Broadly upon Clinically-Relevant Pathogens, Exhibiting a Prey Range Which Cannot Be Explained by Phylogeny. Frontiers in Microbiology. 8:1593. doi: 10.3389/fmicb.2017.01593.

For up to date information on funding eligibility, studentship rates and part time registration, please visit the FoodBioSystems website.