PhD Project Advertisement

Project title: Feed for Net Zero: Understanding the structure function relationships in forages driving rumen feed degradation

Project No: FBS2023-29-Kingston-Smith-aq

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Project description:

Forage grasses are the main source of nutrition for ruminant livestock in the UK, contributing to the supply of nutrient-dense foods like meat and milk. However, livestock production is responsible for significant greenhouse gas emissions (GHG). Methane release is linked to efficiency of rumen digestion of the "fibre" part in the feed. In this project, the student will investigate the effect of relevant environmental stresses on the cell wall characteristics of the forage grasses and the production of GHGs. This information is essential to help deliver Net Zero grassland-based food systems.

Context and Background

Ruminants are a vital part of the human food supply chain, delivering highly nutritious products (milk and meat) from land that produces food inedible by humans. However, while the evolution of the rumen and its microbial community enables fermentation of fibrous feed, a by-product is emission of methane. The quality and digestibility of the forage grasses has a direct effect on methane emissions. It is known that livestock-based methane emissions decrease with increased digestibility and nutritional value of forage grasses.

Future climate scenarios predict increasingly erratic and extreme weather patterns in the UK with grasslands more frequently exposed to stressful environmental conditions. Cell walls, representing ~70% of a plant dry weight, adapt their composition and structure in response to external challenges to maintain cell integrity. However, we have surprisingly little understanding of the compositional and structural cell wall changes as a result of different environmental conditions and how these changes in turn affect the colonization patterns in the rumen. In this context, it is important to understand the effect of the forage feed on microbial community composition and the functional roles of the microbiota at the various stages of digestion. A metagenomics approach linked to plant biochemistry and genetics will be used to explore these relationships. By understanding more about how the rumen microbiota interact with the structural carbohydrates in the forage feed it will be possible to use plant breeding to develop forages with optimal composition for digestion and minimal environmental impact.

Aim and Objectives

Our hypothesis is that environmental stress will alter the cell wall composition and structure, impacting on forage quality and nutritive value, which leads to changes in GHG emissions (methane) of forages. Understanding the interaction between relevant environmental stresses, cell wall characteristics and GHGs is essential to help deliver Net Zero grassland-based food systems

1) The student will establish the effect of relevant environmental stresses on cell wall quality of forage grasses. Three leading forage grass varieties will be grown under controlled environment conditions and exposed to a range of defined and relevant environmental stresses: drought, heat, wind, and flooding. Following plant phenotyping, biomass samples will be used to detect treatment induced changes in cell wall composition (lignin, cellulose, hemicellulose).
2) The student will determine if stress induced changes in cell wall properties impact the in vitro digestibility of forage grasses. Biomass samples of each of the forage grasses exposed to the different environmental stresses will be exposed to a rumen fluid inoculum and total gas production, CO_2 and methane measured. Samples of the rumen inoculum will also be used for FTIR analysis to explore differences in metabolite production.

3) The student will establish microbiome and colonisation profiles. Samples from in vitro incubation of grasses and rumen microbiota will be subject to metagenomics and metatranscriptomic analysis to establish the taxonomy profile during colonisation of the plant material and the related transcriptomic profiles within and between microbial communities in response to changes in the plant carbohydrate structure.

Training opportunities:

This multidisciplinary project will provide the opportunity for the student to integrate the disciplines of crop science, cell wall biochemistry, microbiology and bioinformatics. The student will have the opportunity to spend 6 months during the PhD at Queen's University Belfast to receive training in programming and cutting edge bioinformatic analyses of microbiome data

Student profile:

We are looking for a student that shows a keen interest in pursuing this multidisciplinary PhD project that will provide the candidate with training and skills in a range of varied techniques. This project would be suitable for students with a degree in biology, chemistry, agriculture, food science or a closely related subject.

Stipend (Salary):

FoodBioSystems DTP students receive an annual tax free stipend (salary) that is paid in instalments throughout the year. For 2022/23 this will be £17,668 and this will increase slightly each year at rate set by UKRI.
For up to date information on funding eligibility, studentship rates and part time registration, please visit the FoodBioSystems website.

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.

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