PhD Project Advertisement

Project title:
Repurposing artificial sweeteners as infection and contamination control agents.
Project number: FBS2024-040-McCarthy-bq

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Project description:

Artificial sweeteners are a group of compounds that have a significantly higher sweetening power than sucrose but have little to no calorific contribution. Because of these properties, artificial sweeteners have become mainstays in the human diet with many companies offering "Zero" or "Sugar Free" alternatives to typically high sugar products. While there have been extensive studies investigating the impact of these sweeteners on the human body (Carocho *et al.*, 2017), there have been relatively few studies looking at the impact of these compounds on the bacteria in the human body. However, these is emerging evidence that artificial sweeteners can significantly alter the gut and oral microbiome and that these changes can have an impact on human health (Suez *et al.*, 2022). A recent study by the McCarthy lab has demonstrated that a number of these artificial sweeteners possess antimicrobial properties with the highly popular sweetener acesulfame K (ace-K) in particular, being able to inhibit bacterial movement, their ability to acquire antibiotic resistance genes from the environment and their ability to grow (De Dios *et al.*, 2023). In this project we want to repurpose this sweetener as an infection and contamination control agent.

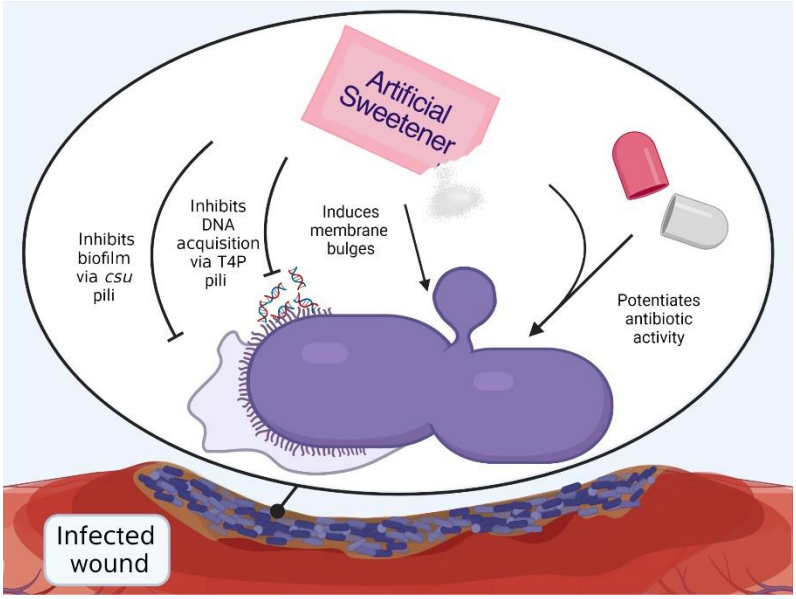

Figure 1: Antimicrobial Ace-K: A schematic breakdown of the various antimicrobial properties of the artificial sweetener ace-K. Specifically it can inhibit motility, biofilm formation, potentiate antibiotic activity and induce bulges in the cell membrane

Bacterial infection is a major challenge to the agrifood sector with wound infections such as digital dermatitis (a wound infection of the hoof which leads to lameness) having a major impact of livestock welfare and presenting a significant economic challenge (Palmer & O'Connell., 2015). Digital dermatitis is highly prevalent particularly in dairy farms with 70-95% of herds showing signs of digital dermatitis. The treatment of such wound infections in livestock presents a number of challenges such as the restricted contact time between the site of infection and the treatment, and the formation of bacterial communities called biofilms within the wounds. Biofilms are communities of bacteria encased in polysaccharide matrix, by growing in biofilms, bacteria are between 10-1,000 more resistant to antibiotic therapy and chemical disinfection (Maslova *et al.*, 2021). The increasing restrictions on the use of antibiotics in agriculture also complicates the treatment landscape (Manyi- Loh *et al.*, 2018).

Bacterial contamination in food processing is a major cause of foodborne illness, food spoilage and production pipeline shuts downs. This contamination is particularly problematic and difficult to eradicate when bacteria adopt the biofilm mode of growth. These biofilms can form within key parts of the food processing infrastructure leading to costly plant shuts downs and damaging decontamination procedures (Galie *et al.,* 2018)

In this project we will explore the ability of the artificial sweetener, ace-K , to treat livestock associated wound infections and assess its ability to act a surface decontamination agent. We will address this through three distinct but interlinked objectives.

1) ***Determine the ace-K spectrum of antimicrobial activity (BUL):*** In this objective we will investigate which foodborne pathogens are susceptible to the antimicrobial activity of ace-K and at what concentrations. We will also explore the basic physiological consequences of ace-K exposure to these pathogens using live cell imaging. To determine if ace-K can influence the transmission of antibiotic resistance genes within livestock, we will use simulated porcine gut microbiota model and an *ex vivo* skin microbiota model to study horizontal gene transfer.
2) ***Investigate the ability of artificial sweeteners to treat wound infections in livestock (BUL &QUB):*** Ace-K has been shown to be effective at preventing biofilm formation and disrupting established biofilms. This proposal will explore its ability to treat and prevent wound infections in livestock using ace-K wash solutions and ace-K loaded hydrogel wound dressings in an *ex vivo* porcine wound model.
3) ***Determine the capacity of artificial sweeteners to decontaminate contaminate surfaces (BUL &QUB):*** We will use 3D printed replica models of food processing pipelines and surfaces to assess the ability of ace-K loaded wash solutions to prevent surface contamination or to cause biofilms on contaminated surfaces or model pipelines.

Ace-K is a compound consumed by millions of people around the world on a daily basis and its ability to prevent pathogen growth has only recently been recognised. This project will build on this finding by generating new insights into the fundamental biology of how ace-K kills foodborne pathogens and assessing its capacity be used as an infection and contamination control agent. Repurposing this food additive as a biocontrol agent could offer viable therapeutic and decontamination solutions to a variety of stakeholders in the agrifood sector.

Training opportunities:

The prospective student will gain experience and training in a wide range of molecular biology and microbiological methods. This will include live cell imaging and within host horizontal gene transfer assays. They will also gene experience in pharmaceutical formulation and wound therapy development as well as in ex vivo porcine wound assays to determine treatment efficacy. The student will also gain experience in computer aided design, 3D printing and in the use of flow cell biofilm assays. The student will also play a central role in communicating project goals and progress with stakeholders.

Student profile:

This project would be suitable for students with a strong interest in antibiotic resistance and biofilms with a BSc honours degree at upper second-class level (or equivalent) in Microbiology/Biomedical Sciences 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 2023/24 this is £20,622 (including London allowance) 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.

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

References:

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