Tackling antimicrobial resistance in dairy production: using microfluidics and smartphone technology to monitor resistance genes alongside functional antibiotic sensitivity testing

Lead Supervisor: Dr Al Edwards, University of Reading, School of Chemistry, Food and Pharmacy
Email: a.d.edwards@reading.ac.uk

Co-Supervisors:
Professor Roberto La Ragione, University of Surrey, Department of Pathology and Infectious Diseases, School of Veterinary Medicine
Dr Partha Ray, University of Reading, School of Agriculture

Project Description:
PROBLEM - Dairy farming is a socially and economically important sector of agriculture, and also illustrates the importance of a 'one health' approach that addresses both human and animal health. Antibiotics are used extensively to treat important infections in agriculture, including mastitis – a bacterial infection of the udder – which can infect 1 in 5 cows every year even in modern farms with extensive infection control measures. Mastitis not only causes animal suffering, but significantly reduces milk production. Antimicrobial resistance (AMR) is common in bacterial mastitis making it harder to treat. Agricultural antibiotic use (including treating mastitis in dairy farming) contributes to the rise and spread of AMR, which is a major global public health risk, as bacterial infections become ever-harder to treat. It has become clear that industrial antibiotic use (e.g. in dairy production) is one driver for a rise in 'superbugs' spreading across the world, which are resistant to multiple antibiotics. A major route of AMR from farm to human is through food production- in the case of dairy, through milk and cheese products. As well as becoming a serious threat to human health and public safety, treatment of our animals – not just dairy cattle but also companion animals – becomes ever-harder as antibiotics become less effective. Preliminary research by our groups suggests that not only is AMR common in mastitis, but antibiotic resistance can be detected in a range of dairy foods. A 'one health' approach, where food producing animal and human health are addressed hand-in-hand, is now vital to tackle the global threat of AMR.

SOLUTION - Conventional AMR tests (e.g. using agar plates) are very slow and can only be conducted in labs. As a result, vets must administer antibiotics without knowing which antibiotic will effectively treat an infection or what AMR genes are present. This project combines several cutting edge tools for the first time, to create powerful yet simple new methods for faster AMR testing outside a laboratory. At Reading, we have focused on functional cellular assays that measure bacterial growth or killing when combined with antibiotics, using low-cost microcapillary devices read by smartphone cameras. At Surrey, the latest DNA techniques including isothermal amplification and whole genome sequence analysis, has made it possible to both rapidly detect specific AMR genes, and survey genomes of resistant organisms. Crucially, we will develop methods that combine these complementary technologies to both detect AMR genes, and measure functional antibiotic sensitivity; by combining these tools we will be able to gain unique insights into rise and spread of AMR. Ultimately, if we can rapidly test for antibiotic resistance on the farm, we can make sure that animals with mastitis are treated with safe and effective medication.
TOOLS and TECHNOLOGY - Microfluidics, the science of miniaturization, allows laboratory analysis to be taken outside the lab and can give more rapid results than conventional bioanalytical methods. At the same time, global demand for high quality smartphone cameras has made high performance digital imaging portable and affordable. Our research teams at Reading and Surrey have developed rapid and portable testing technology for both functional bacterial assays including antibiotic sensitivity measurement, and genetic detection for example

for AMR genes. This PhD project will focus on combining these analytical tools to allow us to track both genetic and phenotypic AMR, and then applying the technology developed to tackling the problem of AMR in dairy production and dairy food manufacture.

TEAM - This project brings together three complementary research groups: the leading veterinary and 'one health' microbiology team at Surrey ; CEDAR- the University of Reading's excellent centre for dairy research established >25 years ago within the School of Agriculture; brought together by the Biomedical Technology Laboratory within the School of Chemistry, Food and Pharmacy. This will allow the student access to state-of-the-art microbiology and microbial genetics facility at Surrey, in addition to the 600-cow commercial farm plus bioengineering facilities at Reading.

References:

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