12 projects to tackle most common food poisoning bacteria

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12 projects, bringing together researchers from across disciplines, will study Campylobacter in the food chain, from field to plate. Together, the projects cover a comprehensive range of questions about Campylobacter, which is the leading cause of food poisoning in the UK.

The projects (see notes for details), funded through a joint call for proposals managed by BBSRC, the Food Standards Agency and Defra, will use a total of over £4M funding to find out more about the organism that causes over 300,000 cases of food poisoning a year in England and Wales, and how best to control it.

Science Minister David Willetts said "Tackling the causes of food poisoning is vital for our health and will give the public greater confidence in the British poultry industry, as well as helping to guarantee future food security. These projects will ensure this important task is underpinned by leading edge, robust science, with a coordinated approach between Government agencies and the research community."

The most common source of *Campylobacter* infection in humans is poultry meat - either through consumption of undercooked product or through cross contamination in the kitchen environment. Whilst good hygiene and thorough cooking can effectively prevent infection, there are still a high number of cases in the UK and the cost to the economy is estimated at up to £600 million per annum.

These projects will also contribute to future food security in the UK. Having an appropriate quantity of food to eat is important, but that food must also be sustainable, safe and nutritious. Tackling food poisoning bacteria can improve food safety and also reduce wastage and losses via fewer quality control failures and increased shelf life. BBSRC, Defra and FSA are all partners in the Global FoodSecurity programme and these projects are funded as part of a wider cross-government research and innovation strategy on *Campylobacter*.

The poultry industry in the UK is worth £4Bn at the retail level and employs 35,000 people. This science will serve to underpin strength in this industry in the UK and also globally where it is estimated to be worth over £85Bn. This not least because the UK hosts the world's two leading poultry breeding companies, which supply more than 80% of the global supply of breeding stocks.

There are three main areas covered by the funded projects:

- When does infection begin in poultry, what are the common points of contamination, and are there stages in the process where control measures are likely to be most effective?
- How can biocontrol of *Campylobacter* on farms and during processing make a difference? What are the best approaches to biocontrol?
- What is it about the biology of the bacteria, the bird, and the interaction between them that compounds the problem?

  Campylobacter infection or contamination can potentially occur at any point during poultry production and food processing. The aims of this group of projects include identification of the key sources of the initial infection on farms; the common points of contamination; and 'weak spots' in the pipeline of infection where there is a high chance of eliminating bacteria from the food chain.

  Some of the projects look at the potential to control *Campylobacter* infection on farms. By developing and/or testing new and existing biocontrol methods they hope to provide advice for new policy and practice.

  Birds are able to tolerate a relatively large population of *Campylobacter* in their gut without ill effect, whereas humans can become ill after ingesting only a few bacteria. This raises questions as to why the birds don't become ill and what factors could reduce the burden of bacteria in their gut. This

leads to another aim of these projects, which is to investigate the factors that affect colonisation of the poultry gut, retention of bacteria inside the gut, and whether diet can reduce the incidence or level of infection.

The research teams will combine many disciplines to take a holistic approach to the questions raised - microbiology, genomics, mathematics, computing, genetics, epidemiology, and more.

Professor Douglas Kell, Chief Executive, BBSRC said "*Campylobacter* raises some unique questions about food security, human health, and animal welfare. We need good science to underpin changes to policy and practice throughout the food chain that can address these problems whilst supporting a strong farming industry and healthy UK economy. These projects are well placed to make significant advances to this end."

Andrew Wadge, Chief Scientist at the Food Standards Agency said "Improving public health by tackling *Campylobacter* is a key priority for the Food Standards Agency. The levels found on raw chicken are too high in the UK and we are working with industry to reduce them significantly. To help us we need to know more about *Campylobacter*. The research we are carrying out with

the BBSRC and Defra will help us increase our knowledge and better protect consumers."

Peter Bradnock, Chief Executive of the British Poultry Council and chair of the Joint industry/government *Campylobacter* Working Group, welcomed the new round of research.

"*Campylobacter* is very different from other food-borne bacteria. This work is vital to better inform the controls already in place and interventions being trialled on farms and across the production chain. Poultry companies are fully engaged with the researchers and are collaborating on these projects to find more effective interventions against this most difficult organism"

ENDS

Projects

1. Efficacy, practicality, and costs of using currently available intervention methods to reduce *Campylobacter* contamination in slaughterhouses Dr Dean Burfoot, Campden BRI Funded by FSA This project aims to provide evidence on the efficacy, practicality, and costs of using existing (allowable) intervention methods to reduce *Campylobacter* contamination levels on UK chicken carcasses in slaughterhouses. The interventions

planned to be tested include: electrolysed water, steam, hot water, UV light, and electro-oxidation. Preliminary testing will be carried out and if successful application tunnels installed on production lines. *Campylobacter* reductions achieved using each intervention will be measured after treatment and during subsequent storage. The most successful methods will be tested over longer periods by the industry. Data from the project will inform processors and enable them to decide on the best interventions to meet their needs.

2. Efficacy, practicality, and costs of using lactic acid solutions, ozonated water, or ozonated carbon dioxide pellets to reduce *Campylobacter* contamination in slaughterhouses Dr Dean Burfoot, Campden BRI Funded by FSA This project aims to provide rigorous evidence on the efficacy, practicality, and costs of using intervention methods that are not currently allowed in the EU to reduce*Campylobacter* contamination on UK poultry in slaughterhouses. The interventions planned to be tested include electrostatic spraying of buffered lactic acid solutions, conventional spraying of ozonated water, and application of ozonated carbon dioxide pellets. Preliminary testing will be carried out at Campden BRI process facilities. Application tunnels will be then be

designed and installed on production lines at poultry processors. Campylobacter reductions achieved using each intervention will be measured after treatment and after subsequent storage. Data will inform the FSA and enable suppliers of the interventions and processors to investigate approval for use in the EU of any successful treatment.

3. Protective effect of increased n3 polyunsaturated fatty acid in feed on *Campylobacter* spp. colonisation of broiler chickens Dr Tristan Cogan, University of Bristol Funded by Defra Addition of polyunsaturated fatty acids (PUFAs) to the diet of chickens has been investigated as a means of improving health and welfare and is used to produce PUFA-enriched eggs. The n6 PUFAs, found in soybean and sunflower oil, and the n3 PUFAs, α-linolenic acid (ALA, in flaxseed oil), eicosapentaenoic acid and docosahexaenoic acid (EPA and DHA; in salmon and mixed fish oils), are the major sources of PUFAs in the diet. Broiler chicken diets are typically high in n6 and low in n3 PUFAs. Preliminary studies indicate that n3 can reduce *Campylobacter* colonisation and reduce inflammation in broilers. The objective of the proposed work is to determine the optimal n3 polyunsaturated fatty acid (PUFA) content required in feed to

control *Campylobacter* infection in broiler hens. The outcome of the project is to develop a broiler diet tailored to *Campylobacter* control that can be produced by industry.

4. Predictive modelling to optimise phage intervention against *Campylobacter* in poultry Professor Ian Connerton, University of Nottingham Funded by BBSRC This project investigates the use of bacteriophage - a naturally occurring virus that kills specific bacteria - as a sustainable form of biocontrol against *Campylobacter*. The aim is to prevent *Campylobacter* from colonizing and contaminating poultry and poultry meat. Bacteriophage are quite specific and so will only affect *Campylobacter* and not other, 'friendly' bacteria. They are also very common in the environment, which means that humans encounter them on a daily basis, including on fresh produce. The team will use laboratory work and computer modelling to build a comprehensive understanding of how*Campylobacter* and bacteriophage interact in poultry from farm to supermarket shelf.
5. Interventions effects on *Campylobacter* populations in poultry and poultry meat Professor Ian Connerton, University of Nottingham Funded by BBSRC and FSA This project will survey*Campylobacter* present

throughout the production pipeline. The team will sample all stages of broiler chicken production from farm to retail in order to record the levels of contamination and types of *Campylobacter* present. This will enable development of a mathematical model that can be used to assess the effects of implementing multiple interventions and how useful these might be in reducing human exposure to the bacteria.

6. Integrating microbiology and modelling to determine the source of *Campylobacter* infection in the broiler house and develop interventions Dr Ken Forbes, University of Aberdeen Dr Nick Sparks, Scottish Agricultural College Funded by BBSRC and FSA To gain a better understanding of the relative importance of potential sources of *Campylobacter* in broiler chickens, this team will use a modelling approach. If some strains of the bacteria, and certain sources of infection, are more important than others it will be possible to identify the most effective control measures to keep broiler houses free of Campylobacter and so reduce the likelihood that the bacteria enter the food chain.
7. Production systems, bird welfare and endemic disease affect the susceptibility of chickens to *Campylobacter* Professor Tom Humphrey, University

of Liverpool Funded by BBSRC and FSA Focussing on chickens reared intensively in housed systems - representing around 90% of the UK market - this team will collaborate with the three biggest poultry producers in the UK and all the major food retailers to look at farm-based control options that will
reduce *Campylobacter* infection in chickens. They will carry out longitudinal studies on flocks reared under different systems to determine when birds first become infected and how does this relate to other changes in bird health and welfare. They will also determine whether the spread of *Campylobacter* from the intestine to edible tissues, such as liver, occurs on the farm and if there is a link to poor welfare or endemic disease.

8. *Campylobacter* phase variation and its impact on immunity and vaccine development Dr Michael Jones, University of Nottingham Dr Christopher Bayliss, University of Leicester Funded by BBSRC and FSA The aim of this project is to aid the development of effective vaccines to protect both animals and humans against infections by *Campylobacter*. Natural infections of the chicken with *Campylobacter* induce the production of antibodies to surface components on the bacteria. However these antibodies do not clear or prevent further

infection. This suggests that the bacteria can somehow avoid clearance due to the chicken's adaptive immune system. This project will investigate a phenomenon of 'phase-variation', which is widespread in bacteria and allows them to change the form of their surface components so as to avoid clearance by antibodies. The team will identify the frequency of these switches in bacteria in chickens. They will look at the occurrence of the switches both when natural immune responses occur and also following vaccination.

9. Dynamics of susceptibity and transmission of *Campylobacter* jejuni in chickens Professor Duncan Maskell, University of Cambridge Funded by BBSRC and FSA A new approach whereby transmission of and susceptibility to *Campylobacter* can be measured together during a controlled challenge experiment will enable this team to design more efficient experiments to assess interventions. They will also investigate the within and between host competition between different strains of the bacteria, to test whether chickens naturally clear *Campylobacter* from their intestines after the normal age of slaughter (30-40 days in broiler production). This epidemiological framework will set the ground work for linking population evolution and

transmission through next-generation genome sequencing. Ultimately a better understanding of the basic colonisation biology of *Campylobacter* will aid the development of future control strategies.

10. Modelling *Campylobacter* survival and spread through poultry processing: a population genomics approach Dr Samuel Sheppard, University of Oxford Funded by BBSRC and FSA This team will sequence the genomes of *Campylobacter* strains that appear at key stages through poultry processing and human disease. This will allow them to link traits such as survival through a particular stage of processing with genotype. Ultimately the aim is to develop a model to simulate i) how the relative abundance of strains change through processing, ii) factors that are responsible for the survival of particular strains, and iii) the points in processing where it is most likely that *Campylobacter* can be eradicated.
11. Assessment of the efficacy of on-farm biosecurity measures for controlling *Campylobacter* Dr Nick Sparks, Scottish Agricultural College Funded by Defra This study is designed to explore a range of biosecurity procedures (hygiene barriers, fly-screens, and drinking water treatments) identified as having the ability to reduce the prevalence of Campylobacter in chicken flocks. The

interventions will be tested on commercial farms in a sequential manner and the most successful interventions will be combined for a final study.

12. Deciphering the molecular basis of environmental persistence in *Campylobacter* using a systems approach Professor Richard Titball, University of Exeter Funded by BBSRC This project focuses on understanding how some *Campylobacter* cells resist killing by antibacterial chemicals and heat stresses which are currently used to control carcass contamination. By understanding the metabolic networks that allow these bacteria to survive, it will be possible to develop more effective methods to eliminate bacteria from the food chain.

About the UK Research and Innovation Strategy for *Campylobacter*

In 2010, the UK's main public funders of food safety research published a co-ordinated strategy to investigate the food poisoning bacteria *Campylobacter*. This was the first time these organisations have agreed to a common set of objectives to tackle the problem.

BBSRC, Defra, the Food Standards Agency (FSA), the Northern Ireland Department for Agriculture and Rural Development and the Scottish Government all support the strategy.

The strategy includes:

- Research to understand current infection incidences, current food and farming practices and potential intervention strategies
- Studies of the biology of *Campylobacter* and the animal hosts
- The development of new tools and diagnostic techniques (for example, feasibility of developing a rapid on-farm test for *Campylobacter*)

A number of different delivery mechanisms, coordinated by all the funders, will be used to implement this strategy.

The strategy is available to download here: www.bbsrc.ac.uk/web/FILES/Publications/100717_campylobacter_strategy.pdf (PDF 751KB).

About Global Food Security

Global Food Security is a multi-agency programme bringing together the research interests of the Research Councils, Executive Agencies and Government Departments.

Through Global Food Security the partners are working together to support research to meet the challenge of providing the world's growing population with a sustainable, and secure supply of safe, nutritious and affordable high quality food from less land and with lower inputs.

Partner and sponsor organisations are:

- Research Councils UK - comprising of:

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- Economic and Social Research Council
- Engineering and Physical Sciences Research Council
- Medical Research Council
- Natural Environment Research Council Department for Business
- Innovation and Skills Department for Environment
- Food and Rural Affairs
- Department for International Development
- Food Standards Agency
- Government Office for Science
- Scottish Government
- Technology Strategy Board
- Welsh Assembly Government

For more information about the food security challenge and Global Food Security visit: www.foodsecurity.ac.uk.

About Defra

Defra funds applied research to ensure all policy-decisions are based on sound scientific evidence. Further information can be found on the Defra website at: www.defra.gov.uk.

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BBSRC invests in world-class bioscience research and training on behalf of the UK public. Our aim is to further scientific

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