PROJECTS FUNDED AS PART OF THE RESEARCH AND DEVELOPMENT STRATEGY ON CAMPYLOBACTER

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

Focusing 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 susceptibility 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.