FSA Project M01019:

Physical methods readily adapted to existing commercial lines for reducing pathogens, particularly campylobacters, on raw poultry

Duration

1st October 2001 - 31st October 2005

Project Partners:

Division of Food Animal Science (DFAS), University of Bristol

Food Refrigeration and Process Engineering Research Centre (FRPERC), University of Bristol

Silsoe Research Institute

Background

The overall aim of this project was to develop physical methods that could be readily adapted to existing poultry processing lines in order to reduce numbers of pathogenic microbes, especially campylobacter and salmonella, on the carcasses. To meet this aim studies were carried out to:

1. Investigate the organisms of most interest, including campylobacters and Enterobacteriaceae, and their uniformity of distribution on the carcass and between carcasses
2. Quantify the effect of the following on numbers of campylobacter and other organisms on poultry:
    - rate and magnitude of surface drying in combination with chilling
    - rapid high temperature surface drying
    - application of steam at 100°C for times up to 12 s
    - hot water
    - freezing
3. Quantify the effect of the best combination of 2.1 to 2.5 on the reduction in numbers of campylobacters and other organisms on poultry
4. Rank the optimum system produced by 2.1 to 2.5 in terms of pathogen reduction, cost and ease of application, poultry quality and yield
5. Develop the highest ranking system and demonstrate and verify its potential at poultry plant(s)
6. Widely disseminate results

Research Summary

Distribution of microbes on poultry carcasses

Microbes in total, and Enterobacteriaceae and campylobacters in particular were evenly distributed all over the carcasses, including the body cavity, with slightly higher numbers on the neck flap. Campylobacter were not always detected, and numbers of campylobacters were usually lower than numbers of Enterobacteriaceae. It was therefore decided that for the laboratory-scale experiments carcasses should be inoculated with a mixture of Campylobacter jejuni and Escherichia coli.

Effect of drying and chilling on C. jejuni and E. coli

Investigations with inoculated chicken skin in a small bench- top rig showed no significant reductions in numbers of the two test strains. A small commercial scale refrigeration unit in combination with a purpose-built cabinet was used with inoculated freshly-processed chicken carcasses. Chilling and surface freezing were found to have similar effects, and reduced numbers of C. jejuni and E. coli by about 0.5 log cycles

Effect of rapid high temperature surface drying on C jejuni and E.coli

The “BUGDEATH” rig previously built for an EU project, which produces repeatable and known heating and cooling time temperature cycles on the surface of a range of foods was used with inoculated chicken breast skin. Dry ‘heating’ even at 30 C or 40 C caused a marked reduction of both inoculated bacteria on chicken skin (about 3 log cycles reduction in numbers after holding samples at 30 or 40°C for 15 min). Whereas this might be plausible for C. jejuni, known to be sensitive to drying, the similar response of the E. coli test strain was puzzling. Comparisons of weight loss of skin with and without inoculum indicated that the explanation might be that the high velocity air movement was responsible for removing some of the inoculum. This would also account for the rapid reduction in numbers during the first part of the treatments at all temperatures, and the fact that substantial reductions in numbers after the first 5 min of treatment were only observed at 50’C and 60’C. However, studies carried out using lux gene technology as part of the BUGDEATH had shown that this did not occur. This method of decontamination was not further investigated because of the lack of availability of a large rig capable of taking portions or whole carcasses

Quantifying the effect of steam application at 100°C for times up to 12 s on the reduction in numbers of campylobacter and other organisms

Experiments were conducted with inoculated carcasses in the laboratory in a steam cabinet. The optimum treatment with atmospheric steam for maximum effect on C. jejuni and E. coli, least skin shrinkage and change of colour, was concluded to be 12 s. This resulted in reductions of 2.6 and 2.3 log 10 cfu cm -2, respectively, in comparison with untreated controls. Experiments with uninoculated chicken portions in a commercial continuous steam system, which can produce temperatures up to 110°C achieved reductions in aerobic plate counts of up to 3 log cycles.

Quantifying the effect of hot water on the reduction in numbers of campylobacter and other organisms on poultry carcasses.

A pilot hot water immersion vessel was designed and constructed. Immersion treatment was tested on inoculated whole carcasses at 70°C for 40 s, 75°C for 30 s and 80°C for 20 s. The treatment at 80°C for 20 s produced a reduction of over 1 log cycle in numbers of both C. jejuni and E. coli

Quantifying the effect of crust freezing on numbers of campylobacters and other organisms on poultry carcasses

A chamber delivering high velocity air at -30°C was used to rapidly freeze inoculated chicken skin. This resulted in reductions in numbers of the two test bacteria in the region of 1 log cycle. It was decided to discontinue using this equipment, and move on to investigate the Air Products AIM (accelerated in line maturation) rig in combination trials, as this rig was already designed for use on the processing line, and also froze the surface of carcasses ('crust freezing').

Combination trials

Inoculated carcasses were treated with either atmospheric steam (10 s) or hot water (80°C for 20 s) followed by crust freezing using the Air Products AIM rig. This showed that following a thermal decontamination treatment by a rapid chilling stage, particularly one that crust freezes, is an effective method of reducing numbers of bacteria on the surface of a carcass. The most effective treatment in respect to both test strains was a 10 s steam treatment followed by crust freezing. This reduced numbers of cfu cm -2 of both C. jejuni and E. coli K12 by over 3 log cycles. However since this treatment caused some damage to the appearance of the carcasses, the optimum treatment was considered to be a 20 s hot water treatment at 80°C followed by crust freezing, which produced a similar reduction in numbers of C. jejuni and E. coli.

Best methods of poultry decontamination

Steam or hot water either alone, or in combination with crust freezing, were considered to represent the best processes in terms of pathogen reduction, cost and ease of application, as well as optimum poultry quality and yield, but there was no clear advantage of one treatment over another. Hence, it was decided that all three processes would be further investigated in industrial trials

Some Publications from this Project

Physical methods, readily adapted to existing commercial processing plants, for reducing numbers of campylobacters, on raw poultry.

Corry J.E., James C., O'Neill D., Yaman H., Kendall A., Howell M. (2003). Proceedings of the 12th international Workshop on Campylobacter, Helicobacter and Related Organisms, Aarhus, Denmark. International Journal of Medical Microbiology 293, suppl. no. 35: 32 (abstract no D22). [FRPERC Bibio ref: 771]

Thermal decontamination of food.

James S. J. & James C. (2003). Proceedings of the Institute of Refrigeration 100: 1-12 . [FRPERC Bibio ref: 783]

A new chilling technique for processing chicken.

Kennedy C. & Miller J. (2004) Food Science and Technology 18: 30 - 33

James C. (2005) Dealing with decontamination. New Food 4: 59-62. [FRPERC Bibio ref: 816]

Surface pasteurisation of chicken carcasses using hot water.

Corry J. E. L., James S. J., Purnell G., Pinto C. S., Chochois Y., Howell M. and James C. (2007) Journal of Food Engineering 79: 913-919 [FRPERC Biblio Ref: 864]

Decontamination of poultry carcasses using steam or hot water in combination with rapid cooling, chilling or freezing of carcass surfaces.

James, C., James, S.J., Hannay, N., Purnell, G., Barbedo- Pinto, C.S., Yaman, H., Araujo, M., Gonzalez, M. L., Calvo, J., Howell, M. & Corry, J.E.L. 2007. International Journal of Food Microbiology. 114(2), 195-203. doi: http://dx.doi.org/10.1016/j.ijfoodmicro.2006.09.019.. [FRPERC Biblio Ref: 875]

On-line physical methods for decontaminating raw poultry meat.

James C. (2005) Chapter 17, pp393-413. Food safety control in the poultry industry, edited by Mead, G. Woodhead Publishing Ltd. ISBN 1 85573 954 2 . [FRPERC Bibio ref: 807]

Carcass decontamination.

James C. (2005) Food hygiene monitoring and control, Spring Scientific Meeting of the Veterinary Public Health Association, Saturday 23rd April 2005, Cumbernauld, Scotland . [FRPERC Bibio ref: 791]

The Food Standards Agency meat hygiene research programme.

Howell M. (2005) Food hygiene monitoring and control, Spring Scientific Meeting of the Veterinary Public Health Association, Saturday 23rd April 2005, Cumbernauld, Scotland

Surface pasteurisation of chicken carcasses using hot water or steam at atmospheric pressure in order to reduce levels of Campylobacter spp. and other bacteria.

James C., Purnell G., Hannay N., James S. J., Allen V. M., Barbedo-Pinto C., Howell M. & Corry J. E. L. (2005) Proceedings of 13th International Workshop on Campylobacter, Helicobacter and Related Organisms (CHRO 2005), Gold Coast, Queensland, Australia, 4-8th September, 2005 . [FRPERC Bibio ref: 839]

Reduction of campylobacters on poultry using steam or hot water heat treatments and subsequent chilling.

Purnell G., Corry J. E. L and James C. (2006) "Harnessing and exploiting global opportunities" 52nd International Congress of Meat Science and Technology, Dublin, Ireland, 13th-18th August, p333-334, ISBN-10: 90-8686-010-9. [FRPERC Biblio Ref: 851]

Development and evaluation of a pilot scale atmospheric steam treatment cabinet.

Purnell G., James S., Corry J. E. L. and James C. (2006) "Harnessing and exploiting global opportunities". 52nd International Congress of Meat Science and Technology, Dublin, Ireland, 13th-18th August, p599-600, ISBN-10: 90-8686-010-9 [FRPERC Biblio Ref: 852]

Physical intervention methods for reducing pathogens on raw poultry.

James C., Corry J. E. L., Purnell G. and James S. J. (2006) Symposium on food processing and technology, 17th International Congress of Chemical and Process Engineering CHISA 2006, Prague, Czech Republic, 27-31 August 2006. Summaries 5: Systems and Technology, K1.06, p1551-1552. CD-Rom of Full Texts, paper 1426 . [FRPERC Bibio ref: 840]

Development of an atmospheric steam surface pasteurisation unit.

Purnell G., Foster A. and James C. (2006) Symposium on food processing and technology, 17th International Congress of Chemical and Process Engineering CHISA 2006, Prague, Czech Republic, 27-31 August 2006. CD-Rom of Full Texts, paper 1413. [FRPERC Bibio ref: 847]

Microbial studies of carcass hygiene issues.

Purnell, G., James, S., Wilkin, C-A., Fisher, A., Corry, J., Howell, M., Brown, T. & James, C. 2007. In Proceedings; 2007 CIGR International Symposium on Food and Agricultural Products: Processing and Innovations. Naples, Italy. 24-26 September. [FRPERC Biblio Ref: 921]

Contacts

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