Implementing a Food Safety Intervention Strategy

When planning an intervention, the most important variables to consider are the method, stage and time of application, equipment design and maintenance, pressure and nozzle type, temperature, chemicals, and duration of application.

It is important to identify whether or not a chemical is to be used because non-chemical interventions have some distinct advantages such as:

- The cost of chemicals and the hazards associated with chemical storage, transportation and handling are eliminated.
- Operating costs are reduced by eliminating the need to mix or meter chemicals into water flow.
- Regulatory authorities (particularly in the EU) have significant restrictions on the use of chemicals for fresh meat.

The information contained in this review is of a general nature, and when considering a new intervention, it is important to consult AQIS or the relevant State authority before implementation.

Validation and verification

If any of the intervention technologies are to be used as a pathogen control CCP in a hazard analysis and critical control point (HACCP) system, validation of control will be required. There are two approaches to validate the efficacy of interventions; either using carcass or carcass parts with natural contamination (total microbial flora which may include *E. coli* and *Salmonella*) or specifically inoculated with a known quantity of bacteria (e.g., *E. coli* strains).

If naturally contaminated carcasses are used, it can be quite difficult to measure the true influence on food safety of the intervention treatment. This is because of the infrequent presence of pathogens (e.g., *E. coli* O157:H7). This means that it would be necessary to treat and test many hundreds, perhaps thousands of carcasses or carcass parts in order to achieve a measurable effect. Therefore, inoculating the carcass or carcass parts is the preferred option for validation. This can be done either under laboratory conditions using the pathogenic bacteria of choice, or if it is done in the processing environment, it must be conducted under controlled conditions, using the appropriate bacterial inoculum. Advice should be sought from the relevant controlling authority (i.e., AQIS) and an independent laboratory.

Unfortunately, no single microorganism can realistically demonstrate the effectiveness of an intervention treatment for the reduction of all pathogens that may be present, so it is appropriate to choose a combination of indicator organisms. These indicator organisms should have similar characteristics to the target pathogen. The following microbial characteristics are desirable and suggested by the Institute of Food Technologists Expert panel (IFT, 2000):

- Non-pathogenic;
- Behaviour similar to target microorganisms when exposed to processing parameters (e.g., pH stability, temperature sensitivity, oxygen tolerance);
- Stable and consistent growth characteristics;
- Easily prepared to yield high-density populations;
- Once prepared, population is constant until utilised;
- Easily enumerated using rapid, sensitive, inexpensive detection systems;
- Easily differentiated from other microflora.

CSIRO Food and Nutritional Sciences have used such an inoculum in intervention studies for carcasses, studies of carcass chilling procedures and for challenge testing in uncooked fermented meat products. The inoculum contains a cocktail of *E. coli* strains that contain no known virulence markers for pathogenic *E. coli* (i.e., are considered to be non-harmful). These generic strains are used as surrogates for *E. coli* O157:H7 and *Salmonella.* Other researchers have also suggested a cocktail of indicator strains (Marshall *et al*., 2005) for pathogen-specific testing. They isolated a range of bacterial indicators from beef cattle (including *E. coli*, *Enterobacter*, *Serratia* and *Providencia*) and found that *E. coli* had the greatest potential to represent *E. coli* O157:H7 and that a cocktail of the strains should be used.

Cost analysis

There are many potential benefits of intervention technologies such as a more consistent microbial standard of product; better management and clearer worker responsibilities; reduced cost through insurance premiums; stable and even expanded markets (domestic or export) following increased levels of trust by key customers. The financial cost of food safety interventions is difficult to calculate because there are many ancillary costs, which will influence the feasibility of a particular intervention in a particular establishment such as:

- Does the plant operation need to be modified (production lines, laboratory tests, sanitation/plant clean-up, waste management etc.)?
- Is capital investment required for construction of new buildings or modification of premises to accommodate the new equipment or work station?
- Is there an existing space available to accommodate any equipment required?
- Are there licensing agreements that need to be put in place?
- Do worker management/education programs need to be implemented for the new technology?

Therefore, each food safety intervention will have to be assessed on a plant-by-plant basis. For some of the food safety technologies described herein, indicative costs have been estimated, particularly for commercially available technologies. Installation of a wash cabinet can cost A$500,000 to A$1 million, and chemical costs may be 50¢ to A$2.00 per carcass. Treatments, which involve manual application, such as trimming or steam vacuuming, also involve the cost of the labourer. For most of the emerging technologies, it is very difficult to provide a costing, particularly where multiple technologies may be used in combination within a process. Many packing plants in the US employ multiple interventions. Such system may include a pre-evisceration lactic acid wash, steam vacuuming and trimming, and a final hot water treatment or steam pasteurisation. Given this scenario, the estimated cost (for a plant killing around 70 head per hour) of a combination of water wash, lactic acid spray and hot water is around A$1.50 per carcass; that of water, steam pasteurisation and lactic acid at A$2.00; and steam vacuuming, lactic acid and hot water at A$2.50 per carcass. This does not include the capital cost of setting up each food safety technology.

Efficacy/microbial reductions

The main driver for companies implementing some of these food safety technologies is the assurance of a further microbial reduction on their products. In the case of processors, this is a reduction in *E. coli* and *Salmonella*, and for further processors, this is more often targeted towards post-processing microbial contamination from spoilage microorganisms and pathogens such as *Listeria monocytogenes*. Consideration should be given, however, to the long-term consequences of some food safety technologies and their effect on the microbial ecology of meat environments. For example, is there increased survival of pathogens during refrigerated storage because of a potentially altered natural flora – particularly do we risk increasing virulence of pathogens or resistance to other treatments such as heat?

Laboratory studies often show better reductions in microbial count than commercial trials for a number of reasons. Firstly, research studies often use artificially contaminated product, so the initial level of bacteria present are high. As numbers decrease, it becomes more and more difficult to remove the remaining organisms. Secondly, the inherent variability in the product will affect the outcome of any treatments: whether the surface is predominantly fat or lean, or if the shape of the product is such that parts of the product are not exposed to the treatment. Thirdly, in a commercial situation, the product may undergo a number of processes after the intervention, which can themselves result in increases or decreases in microbial load. It is also important to realise that as bacterial counts are expressed as logarithms, a 90% reduction equates to 1 log, a 99% reduction to 2 log, and a 99.9% reduction to 3 log.

Objections to the use of intervention technologies

There are two main schools of thought with regard to control of food safety during meat production, normally referred to as “Non-intervention HACCP” and “Intervention HACCP”.

Non-intervention HACCP relies on inspection at the end of the line to identify contamination and then removes it. It is really a monitoring activity, and carcass hygiene is controlled by strict adherence to GMP, and proactive measures to prevent contamination occurring. There is the system in place in the EU.

Intervention HACCP uses strategically positioned interventions to reduce levels of microbial contamination. These interventions may be applied at any positions on the production line, and more than one may be used. Such system is used in the US.

Defenders of the non-intervention system object to interventions on a number of issues such as:

- Washing may not remove the contamination – it just moves it to another part of the carcass
- High pressure washing may drive bacteria into the deeper parts of the carcass, where it is not exposed to heat treatment during traditional cooking
- The bacteria that are not removed may just become dormant, and can recover and grow later in the chain
- Use of chemicals may kill off the bacteria that are sensitive to the chemical, but resistant bacteria will survive and become dominant
- Using interventions encourages unhygienic practices on the line, and poor adherence to GMP, as the workers believe that the intervention will clean the carcass for them

This last point is a major obstacle to acceptance of intervention HACCP by a number of regulatory authorities, but advocates of the intervention system agree that good adherence to GMP is an important pre-requisite to any HACCP system, intervention-based or not. The intervention system gives a further level of control over the non-intervention system, which is required, because even with the best processing practices, a degree of contamination is inevitable.