Meat technology update

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Risk profiles and risk assessments

HACCP teams know the importance of hazard analysis. Risk profiling, risk analysis, risk assessment and risk management are terms with which HACCP teams should also become familiar. This update describes what is meant by risk profiling and risk assessment and illustrates how the outputs are used for assessing food handling strategies and policies. Risk profiling and assessment are relatively new techniques which are becoming more widely used as software tools are developed. They do not have immediate application for HACCP teams, but some of the information that goes into a risk profile or risk assessment could be useful in hazard analysis.

The main tool for controlling food safety in the Australian Meat Industry is HACCP. Its use assists in identifying and controlling food safety hazards in separate parts of food supply chains. HACCP teams focus on their own operations, and other techniques are used to take a wider view of hazards across a food supply chain and to examine the risk of food safety hazards to people. Techniques such as risk profiling and risk assessment involve more detailed examination of risk across the food chain, than is appropriate in the scope of a HACCP plan.

Risk profiling and risk assessments are new concepts in food safety. These concepts are evolving and are currently used by regulators to set policy. In the future they may have influence over how HACCP plans are developed.

The number of published risk profiles and risk assessments is increasing, partly because the software tools that can quickly calculate risk over a wide range of circumstances are becoming more readily available. While a HACCP team would not conduct a risk profile or risk assessment, there may be useful information in published risk profiles and risk assessments that could be used in developing HACCP plans. This newsletter summarises the outputs of examples of risk profiles and risk assessments.

Risk profile

Meat & Livestock Australia has recently conducted risk profiling of a wide range of biological and chemical hazards across the red meat industry. One of the main outcomes of the risk profiling is a risk rating for a range of hazard and meat product pairings, such as enterohaemorrhagic *E. coli* (EHEC) in hamburgers, *Salmonella* in kebabs and *Listeria monocytogenes* in processed meats. The risk ratings are numerical values assigned to the risk of the hazard making people ill when the nominated meat product is eaten.

Risk profiling involves systematic collection of information in order to describe a food safety problem and its context. The MLA risk profiles, therefore, contain considerable background information on the different hazards associated with meat products. The risk ratings assigned to specific hazard:product pairs help to set priorities for research, or further risk assessment of food safety issues.

The risk profile included examination of public health records. This confirmed the recognised food safety hazards associated with the consumption of red meat. The review of meat-borne outbreaks of food poisoning from 1990 to 2002 highlighted that *Salmonella spp*. and EHEC were, and are, the hazards of concern in red meat processing. These hazards accounted for all the reported cases of food-borne illness associated with red meat where inadequacies in the manufacturing process were considered to be the primary cause. This supports the decision made by HACCP teams that the major hazards in fresh red meat processing are *Salmonella* and EHECs. A wider range of hazards were involved in reported cases of food-borne illness associated with red meat in the food service sector. *Clostridium perfringens* was the most common cause of outbreaks of food poisoning arising from red meat products prepared in the food service sector.

The examination of cases of food poisoning showed what hazard:product pairings are most likely to cause food-borne illness. For example, based on available surveillance data, infections from EHEC are relatively rare at around 0.2 cases per 100,000 population. As a result of the examination of cases of food poisoning associated with red meat, a series of hazard:product pairings was identified for further examination and risk rating, to assess the relative significance of the hazard:product pairs.

Risk rating

A spreadsheet tool called 'Risk Ranger v 2' was used to conduct risk ratings. Risk Ranger uses qualitative statements combined with quantitative data about severity and exposure to assign a numerical assessment of risk from 0 to 100 to hazard:product pairings. A rating of 0 means no risk. A rating of 100 means every member of the population would eat the nominated food containing a lethal dose of the hazard every day.

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The risk from pathogens such as *Listeria monocytogenes*, *Salmonella* spp. and *Staphylococcus aureus* on meat products such as steaks and chops was considered to be low because the site of microbial concern is on the surface and the terminal cooking step is enough to eliminate hazards. Similarly, the risk from EHECs in hamburgers was rated as very low in circumstances where the hamburgers are well cooked.

For comminuted meat products in other scenarios, the risk rating was higher because it was considered that the products might not be sufficiently cooked. For example the risk rating for *Salmonella* in kebabs was 40. From this risk rating it is predicted that, in Australia, there could be 250 cases of salmonellosis per year—from eating kebabs. In the case of kebabs, it was considered that in periods of high demand at retail outlets, there might not be enough time to heat the product sufficiently to kill *Salmonella*.

Other examples of hazard:product pairs with medium risk ratings were *Salmonella* and EHEC in uncooked fermented meat.

A rating derived from Risk Ranger is particularly useful in risk profiles when the rating is used to assess different production methods or consumption patterns. The Risk Ranger tool can quickly provide assessments of the consequences of different methods of handling food. Risk ratings were reassessed to look at the effect on risk of different food handling scenarios and different levels of population susceptibility. Several scenarios were reassessed and some of these reassessments are summarised in Table 1.

One example of the altered risk scenario was what happens if hamburgers are undercooked.

In the case of the hazard:product pairing of EHEC in hamburgers, if hamburgers are undercooked such that the hazard is reduced by 90% the Risk Ranger rating increased from 0 to 36. The rating of 36 is a medium risk and means there is a prediction that 6 Australians per year would succumb to an EHEC illness.

The risk rating of kebabs also increased when the scenario included the possibility that meat carved from the skewer could be cross-contaminated by *Salmonella* in the drip tray

It is obvious that undercooked hamburgers are more of a risk to the population than well-cooked hamburgers, and that contamination of kebab meat in the drip tray increases risk. The advantage of assessing these scenarios semi-quantitatively is that the relative change in risk as a result of changes in process control, which equates to a predicted number of illnesses, can be obtained.

Risk Analysis

Risk analysis is a more formalized approach to looking at food safety risks than risk profiling.

Food safety hazards are subjected to risk analysis for the purpose of setting food safety policy. Risk analysis is a process that helps in making policy decisions about the relative safety of different foods; what resources should be allocated to different food safety risks; and what foods can be safely imported into Australia.

Risk analysis is particularly important in the context of setting restrictions or conditions on the importation of foods. World Trade Organisation rules prevent countries from imposing sanitary and phytosanitary conditions on trade unless the conditions are based on recognised standards or the importing country has conducted a risk analysis and the risk analysis justifies imposition of conditions that are different from international standards.

There are three activities involved in risk analysis. They are:

- Risk assessment
- Risk management
- Risk communication.

Risk assessment is a rigorous scientific exercise. The assessments may be qualitative or quantitative. A quantitative risk assessment aims to make a numerical estimate of the risk of people being exposed to and affected by a microbiological hazard.

Risk assessment and HACCP

Risk assessment should not be confused with the hazard analysis or hazard evaluation that a HACCP team will conduct as part of developing a HACCP plan, but there are some similarities in the processes. The team may be able to use the outputs of risk assessments to help conduct hazard evaluations, and determine what might be an acceptable level of a hazard.

Risk assessment process

As mentioned above, risk assessment is one component of the process of risk analysis. There are four stages in a risk assessment. They are

Table 1: Risk ratings of hazard:product pairings for scenarios with reduced process controls

Hazard	Product scenario	Risk Ranger semi-quantitative risk rating	Product scenario with reduced process control	Risk Ranger semi-quantitative risk rating
Clostridium perfringens	Meals provided to slightly susceptible consumers (i.e. in aged care) by caterers with HACCP plans	46	Meals provided to the general public by institutional caterers who have not implemented an effective HACCP plan	54
Salmonella	Kebabs produced in normal production	40	Kebabs when cooked meat can be contaminated in the drip tray	58
EHEC	Salami consumed by susceptible population when 0.01% the raw meat is contaminated by EHEC at a level of 0.1/g	33	Salami consumed by susceptible population when 0.01% of the raw meat is contaminated by EHEC at a level of 10/g	44
EHEC	Fully cooked hamburgers	0	Undercooked hamburger	36

- Hazard identification
- Exposure assessment
- Hazard characterisation
- Risk characterisation.

Hazard identification

Hazard identification is a process of collecting evidence of a link between a food product and an adverse health outcome. The evidence might include data on disease outbreaks from which cause and effect may be established. Other types of evidence come from challenge tests where food production and distribution systems are challenged by introducing hazards into the system on an experimental basis. An example of this is the study of the survival of pathogens in the production of salami. Predictive microbiology can also contribute to hazard identification by providing information of the potential growth of microbes under defined conditions.

Exposure assessment

Exposure assessment is intended to assess the risk of a person coming into contact with the hazard in question. The assessment is based on the frequency of a person consuming a food containing the hazard, how much of the food will be consumed, and the prevalence and concentration of the hazard in the food. The assessment will take into account available information about microbial behaviour. This may include information on the prevalence and concentration of microbes in herds; and post-slaughter factors such as contamination during slaughter, conditions under which the food is transported and stored, shelf-life, and cooking or preparation methods. Possible temperature abuse will also be taken into account. These factors influence the concentration of the hazard in the food at the time of consumption. The assessment will examine how changes in these handling conditions may affect the risk of people being exposed to the hazard. If the information available for the exposure assessment is of sufficient quality and quantity, a quantitative assessment can be done and the outcome of the assessment is a mathematical risk of exposure.

Hazard characterisation

The step of hazard characterisation considers the likelihood of people becoming ill when they are exposed to a particular hazard. To do this, it is necessary to know what response is expected from different sectors of the community when individuals are exposed to hazards at different levels and frequencies. Human feeding trials have been carried out to determine the response to doses of microbial hazards, but these trials are conducted on healthy adults. People who are at most risk are the very young, elderly and immuno-compromised and the dose response of these susceptible populations is difficult to determine. Information on the dose response of these people to the particular hazard is sometimes available from studies of microbiological data and the demographics of people involved in food poisoning outbreaks. Mostly it is not available and a very conservative estimate has to be made. For bacteria such as *E. coli* O157:H7, *Listeria monocytogenes* and *Salmonella* spp, the decision will be taken that if they are present at all, some groups of people will be at risk.

Risk characterisation

Risk characterisation brings together the information from the hazard identification, exposure assessment and hazard characterisation to produce a statement of risk i.e. the likelihood and severity of a food poisoning event.

Using risk assessment in HACCP

Risk assessments include the type of information that could be useful in developing HACCP plans; however, the number of published risk assessments is limited. One risk assessment relevant to the meat industry is a Canadian study of the risk from *E. coli* O157:H7 in ground-beef hamburgers. This risk assessment applies to beef trimmings produced at integrated abattoirs and boning rooms, and ground at a retail outlets. It is not necessarily relevant to Australian production systems, but it illustrates how risk assessment can point to improved control in HACCP plans. Also, the risk assessment relates to the prevalence of *E. coli* O157:H7 in the mid-1990s, and the results of the assessment should be updated as the apparent prevalence changes due to improved detection techniques.

In the assessment scenario, the hamburgers were prepared and cooked at home. Using this scenario it was estimated that the average probability of illness from a hamburger meal is 1 in 510,000 adults. The probability of mortality was estimated to be 1 in 19 million for the very young. These probabilities do not apply to hamburgers served outside the home where methods of processing, distribution and cooking are different.

The risk assessment brings together information on the prevalence and consequences of *E. coli* O157:H7. More importantly, the risk assessment determines the effect of various interventions on the risk of people becoming ill. In the Canadian risk assessment, the most important factors in predicting the risk of people becoming ill were (in order of importance in the model):

- the concentration of *E. coli* O157:H7 in the faeces of the cattle from which the meat was derived;
- the host susceptibility (i.e. the predisposition for an individual to become ill);
- the carcase contamination factor (i.e. the dilution from the concentration of *E. coli* O157:H7 in cattle faeces to the concentration on the carcase surface);
- cooking method;
- retail storage temperature;
- reduction due to decontamination;
- growth during processing;
- retail storage time.

These factors (and others) are combined to create a process risk model (PRM). This is similar to the Risk Ranger approach, but allows for more inputs than Risk Ranger. In the PRM, values for the different factors can be adjusted to determine the effect on risk. In the hamburger example, the values used in the PRM were adjusted in response to three strategies that could be introduced through a HACCP process.

In the original PRM, the retail storage temperature of the ground beef was entered as variable between 4 and 15°C (the variation was based on observations of the temperature of ground beef in retail displays). If most retailers stored the product at less than 8°C (and in the worst case the maximum temperature was 13°C), the risk of illness would be reduced by 80%.

The second adjustment was to change the concentration of *E. coli* O157:H7 shed in faeces in response to changing feeding practices. In the initial assessment the concentration in faeces was a distribution in which 10% of animals shed more than 4 $\log_{10}$ cfu per gram of faeces. In the adjusted model it was assumed that a change in animal feeding would virtually eliminate animals shedding more then 4 $\log_{10}$ cfu per gram. When the PRM was run with this adjustment the risk of illness was reduced by 46%.

The third strategy of educating consumers about cooking hamburgers was expected to have limited success. In the original PRM, the values used—that 3% of people prefer rare hamburgers and 16.1% prefer medium rare—came from a consumer survey. The PRM was adjusted assuming that an education campaign could change consumer preference so that 2% preferred rare hamburgers and 10% preferred medium rare. When the PRM was run with this adjustment, the risk of illness was reduced by 16%.

This risk assessment illustrates how strategies to reduce the risk of people contracting food-borne illness can be quantified. The risk characterisation (i.e. the statement of the actual risk of people becoming ill) may not be useful to HACCP teams because it may apply to a specific set of circumstances that are not the same as encountered by the HACCP team. However, the change in risk when risk reduction strategies are assessed can be valuable in deciding what interventions should be included in HACCP plans.

Further Reading

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The risk rating tool 'Risk Ranger' is available from the website: http://www.foodsafetycentre.com.au/riskranger.htm

Contact us for additional information

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