Risk profiles and risk assessments

HACCP teams know the importance of hazard analysis. Risk profiling, risk analysis, risk assessment and risk management are terms 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 HACC 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 HACC 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 HACC 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 HACC 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 enterohaemorrhagie 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 HACC teams that the major hazards in fresh red meat processing are Salmonella and EHEC. 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 v2 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.
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

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

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Product scenario</th>
<th>Risk Ranger semi-quantitative risk rating</th>
<th>Product scenario with reduced process control</th>
<th>Risk Ranger semi-quantitative risk rating</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Clostridium perfringens</em></td>
<td>Meals provided to slightly susceptible consumers (i.e. in aged care) by caterers with HACCP plans</td>
<td>46</td>
<td>Meals provided to the general public by institutional caterers who have not implemented an effective HACCP plan</td>
<td>54</td>
</tr>
<tr>
<td><em>Salmonella</em></td>
<td>Kebabs produced in normal production</td>
<td>40</td>
<td>Kebabs when cooked meat can be contaminated in the drip tray</td>
<td>58</td>
</tr>
<tr>
<td>EHEC</td>
<td>Salami consumed by susceptible population when 0.01% the raw meat is contaminated by EHEC at a level of 0.1/g</td>
<td>33</td>
<td>Salami consumed by susceptible population when 0.01% of the raw meat is contaminated by EHEC at a level of 10/g</td>
<td>44</td>
</tr>
<tr>
<td>EHEC</td>
<td>Fully cooked hamburgers</td>
<td>0</td>
<td>Undercooked hamburger</td>
<td>36</td>
</tr>
</tbody>
</table>
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 carcass contamination factor (i.e. the dilution from the concentration of *E. coli* O157:H7 in cattle faeces to the concentration on the carcass 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 than $4 \log_{10}$ 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


