Public Health and Safety of Poultry Meat in Australia

Explanatory Summary of the Scientific Assessment
Acknowledgements

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This Explanatory Summary provides an overview of the Scientific Assessment of the Public Health and Safety of Poultry Meat in Australia undertaken by Food Standards Australia New Zealand (FSANZ).

The document aims to provide poultry industry personnel, State and Territory regulators and consumers with a concise plain-English summary of the background, approach and main findings of the full scientific assessment.

In order to gain an in-depth understanding of the scientific assessment, it is recommended that you read the full document which is available on the FSANZ website.
Explanatory Summary of the Scientific Assessment

Food Standards Australia New Zealand (FSANZ) has conducted a scientific assessment of the risks to public health and safety from consumption of poultry meat in Australia. The main findings are:

- Risks associated with chemical hazards in poultry meat are low;
- Campylobacter and Salmonella are the principal pathogens of concern found on poultry meat;
- On-farm contamination by Salmonella is mainly due to contaminated feed and water, environmental sources and transmission from contaminated eggs;
- Important on-farm risk factors for Campylobacter are the age of the birds and environmental factors;
- The presence and amount of Salmonella on a chicken after processing largely determine the likelihood of salmonellosis;
- Inadequate hand washing and food handling practices determine the likelihood of human illness from Campylobacter; and
- Adequate cooking is the main means of minimising the risk to human health from both pathogens.
Australian consumers enjoy a high level of food safety. However, each year as many as one-in-four Australians will contract foodborne illness – that is, food poisoning – from something they have eaten. To address the problem, the governments of Australia have decided to look at food safety along entire food chains, from paddock to plate, and to put management systems in place to reduce hazards.

FSANZ is the government agency responsible for conducting scientific assessments of the risk to public health and safety for a number of primary industries. We are currently developing a Primary Production and Processing Standard for the poultry meat industry.

This Explanatory Summary describes the findings of our scientific assessment and the approaches and methodologies that we used. You should read this Explanatory Summary in conjunction with the full scientific assessment report, Scientific Assessment of the Public Health and Safety of Poultry Meat in Australia, which can be found on the FSANZ website at: http://www.foodstandards.gov.au/_srcfiles/P282_Poultry%20_%20DAR%20Attach3.pdf.
2. Scope of the scientific assessment

We have undertaken an assessment of the public health and safety risks posed by microbiological and chemical hazards in poultry meat in Australia. In this work we adhere to the principles and guidelines of the Codex Alimentarius Commission – the international agency that advises national food regulators on best practice.

We have sought to determine the extent of the food safety risks associated with the consumption of poultry meat and poultry meat products, and to identify the factors along the poultry meat supply chain that may have the greatest impact on public health and safety.

In our assessment, we considered all avian (bird) species sold for human consumption in Australia, including chickens, ducks, turkeys, game birds (e.g. squab, quail) plus wild caught birds (e.g. mutton-birds) where the carcass is dressed and processed in a registered processing establishment. We did not include ratites such as emu and ostrich.

We divided the poultry meat supply chain into four main stages: primary production, primary processing, retail and consumer preparation. Primary production includes the activities around the on-farm production of birds and transport to the slaughter facility. Primary processing encompasses slaughtering, processing and value adding of the poultry meat. Retail includes wholesale activities in addition to the sale of poultry through restaurants, take-away food outlets, butcher shops and supermarkets. Consumer preparation incorporates food handling, storage, hygiene and cooking.

Our assessment covered all stages of the poultry meat supply chain from the importation of fertilised eggs through to consumption.
Because very little information was available on hazards associated with non-chicken poultry species, we concentrated on an assessment of chicken meat. In the absence of definitive data, we assumed that the hazards of concern to poultry species other than chicken are similar to those of chicken. In any event, chicken meat represents the vast proportion of poultry meat consumed in Australia.

During the scientific assessment, we accessed a wide range of sources of information including:

- government surveys;
- industry data;
- epidemiological data;
- domestic and international scientific literature; and
- the National Nutrition Survey for Australian consumption data.

Where possible, we made use of published international scientific assessments and, where necessary, modified them to account for Australian conditions and practices.

**Chemical hazards**

Figure 1 shows a paddock-to-plate flowchart identifying potential chemical inputs into poultry meat products. The flowchart is divided into two stages: primary production and further processing stages.
Figure 1. Chemical inputs into poultry meat products

Chemical inputs represented by a red arrow are those that are ‘intentionally added’ to food and have undergone a pre-market assessment and approval prior to use in food products.

Inputs represented by the green arrow are contaminants (‘unintentionally present’) in food. Contaminants are ubiquitous and are regulated in such a way as to ensure levels of these chemicals are as low as reasonably possible. Chemicals that may migrate into food from contact with packaging are shown as a grey arrow.

Microbiological hazards

Our approach undertaken during the scientific assessment was influenced by access to relevant and reliable data at each stage of the poultry meat supply chain. Hence, primary production and primary processing were evaluated qualitatively due to a scarcity of quantitative data and information on pathogens.

We quantitatively modelled stages after primary processing to assess the risk from Salmonella spp. and Campylobacter spp. using an approach based on existing Food and Agriculture Organization of the United Nations and World Health Organization (FAO/WHO) models¹.


4. Scientific assessment results

Chemical hazards

The origins of potential chemical risks that may be introduced into poultry meat products vary. Exposure to chemicals during the primary production occurs through the ingestion of feed and water, as a result of veterinary treatment, and through environmental sources such as air, soil, or from housing materials. Further along the processing chain, chemical inputs may include food additives and processing aids, and chemicals that migrate from packaging materials.

Our assessment found little evidence of public health risks associated with chemical hazards in Australian poultry meat. The results indicate that the current regulatory measures in the Australia New Zealand Food Standards Code adequately protect public health and safety with respect to chemical hazards in poultry meat products in Australia.

Microbiological hazards

A range of microbiological hazards may be introduced to poultry during the primary production stage. These include bacterial pathogens introduced through contaminated feed and water, and also via the environment. The microbiological agents considered for poultry meat included Salmonella spp., Campylobacter spp., pathogenic Escherichia coli, Staphylococcus aureus, Clostridium perfringens, and Listeria monocytogenes.

We determined that the risk associated with pathogenic E. coli, S. aureus, C. perfringens and L. monocytogenes is low. These pathogens are primarily a concern after primary processing, especially from post-processing contamination and through temperature abuse of ready-to-eat poultry products.
We found that the principal microbiological pathogens of concern on poultry meat are Campylobacter spp. and Salmonella spp. These two organisms are the leading cause of human intestinal infection in developed countries, including Australia, and have frequently been isolated from raw poultry meat and implicated in foodborne illness. These organisms become associated with poultry during primary production and their prevalence and/or levels may be amplified during primary processing and at all stages up to consumption.

We also looked at the main risk factors during primary production, primary processing and consumer preparation and handling of poultry meat:

(a) Primary production (on-farm)

There are a number of pathways by which poultry can become contaminated with Salmonella or Campylobacter on-farm. Some are more important for one organism than for the other.

Contamination of poultry by Salmonella on-farm can usually be traced to three main factors: (1) contaminated feed; (2) environmental sources (includes contaminated litter, insects, personnel etc); and/or (3) vertical transmission to chickens from contaminated eggs.

For Campylobacter, infection in chickens is mainly a result of horizontal contamination i.e. transmission of the pathogen from infected birds to other birds within the same flock. Sources of horizontal transmission include contaminated water, contaminated litter, insects, rodents, wild birds and by farm workers from their boots. The age of the birds is also a risk factor for Campylobacter infection, with older birds being more likely to be infected.

Biosecurity is an important issue for managing contamination by Campylobacter and Salmonella. Biosecurity describes management practices which, when followed, reduce the potential for the introduction and/or spread of disease-causing organisms onto and between poultry production sites. In general, biosecurity programs consist of controlling the introduction of stock, litter and feed; controlling access to sheds; treating the water supply; excluding wild birds and other animals; adopting general hygiene practices; providing buffer zones to prevent airborne transmission and training of staff.
Figure 2 summarises the main risk factors associated with on-farm transmission of Salmonella and Campylobacter.

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Increasing Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biosecurity</td>
<td></td>
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<tr>
<td>Vertical transmission from breeder flocks</td>
<td></td>
</tr>
<tr>
<td>Positive chicks</td>
<td></td>
</tr>
<tr>
<td>Previously positive flocks</td>
<td></td>
</tr>
<tr>
<td>Litter/Insects</td>
<td></td>
</tr>
<tr>
<td>Contaminated Feed</td>
<td></td>
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<tr>
<td>Age of birds</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Campylobacter</th>
<th>Salmonella</th>
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</table>

**Figure 2.** The main risk factors associated with on-farm transmission of Salmonella and Campylobacter.

Good hygienic practices and good agricultural practices are necessary prerequisites for the management of Salmonella and Campylobacter on-farm.

**(b) Primary processing**

Contamination of poultry meat depends mostly on the status of the birds prior to processing and hygienic operations during processing.

Although some variation exists in the processing of different poultry species, the major steps are similar and are illustrated in Figure 3.
Contamination of poultry meat in the processing plant by Salmonella and Campylobacter arises from two main sources. Processing of infected birds may lead to contamination of the carcass through contact with faecal material and/or rupture of the gut during evisceration. Alternatively, carcasses may become contaminated as a result of cross-contamination from other contaminated birds or the environment in the processing plant. In general, most studies show the prevalence of Salmonella to be higher at the end of processing than at the start. In contrast, the general trend is for prevalence and levels of Campylobacter contamination to fall during poultry processing.

Figure 4 provides a summary of the effect of each of the processing stages on the level of Salmonella and Campylobacter contamination. Individual plants or companies may perform these tasks differently and to different levels of hygiene.
### Effect on contamination by *Salmonella* and *Campylobacter*

<table>
<thead>
<tr>
<th>Process stage</th>
<th>Reduce</th>
<th>Minimal</th>
<th>Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stun/Kill</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Scald - Low temperature</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Scald - High temperature</td>
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<td></td>
<td></td>
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<tr>
<td>De-feathering</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Washing</td>
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<td></td>
<td></td>
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<tr>
<td>Evisceration</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Washing</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Chilling – immersion</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Chilling – air</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Portioning</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Campylobacter</td>
<td><img src="#" alt="Green" /></td>
<td><img src="#" alt="Green" /></td>
<td><img src="#" alt="Red" /></td>
</tr>
<tr>
<td>Salmonella</td>
<td><img src="#" alt="Red" /></td>
<td><img src="#" alt="Red" /></td>
<td><img src="#" alt="Red" /></td>
</tr>
</tbody>
</table>

*Figure 4.* Effect on contamination by *Salmonella* and *Campylobacter* at each processing stage.

### (c) Consumer handling and preparation

We quantified the risk of foodborne illness from the consumption of both *Salmonella* and *Campylobacter* contaminated chicken by mathematical modelling. The modelling took into consideration the complex food chain from the end of primary processing through to the time of consumption, including transport, retail storage, storage at home, handling in the home, cooking and consumption (see Figure 5).

We sourced information and data to run the mathematical model from Australian poultry industry statistics, studies by FAO/WHO and international literature. We included data on time and temperature in the model at each stage, as well as predictive growth models for *Salmonella* and *Campylobacter*. Rather than using fixed values for each input in the mathematical model, we defined some values using probability distributions to take into account uncertainty and variability.
Sensitivity analysis for Salmonella and Campylobacter

We used a sensitivity analysis to identify those steps in the mathematical model that have the greatest impact on the final output (i.e. the predicted probability of illness). The results of a sensitivity analysis are presented as a tornado graph. Figure 6 represents the sensitivity analysis for the probability of salmonellosis from the consumption of poultry meat and Figure 7 is for the probability of campylobacteriosis.

Figure 5. Stages of the poultry meat supply chain included in the quantitative model to estimate the likelihood of illness (pink shaded text lists key variables)

Figure 6. Sensitivity analysis for input variables used to model the probability of salmonellosis from the consumption of poultry meat.
The size of the bars in each of the figures represents the magnitude of the change in the probability of illness with changes in the input variable. Bars to the right indicate that an increase in the variable results in an increased probability of illness, while bars to the left indicate that an increase in the variable results in a decreased probability of illness.

Therefore, Figure 6 demonstrates that the initial prevalence and concentration of Salmonella on the chicken carcass at the end of processing are the two most significant factors that may increase the probability of salmonellosis i.e. an increase in prevalence will increase the probability of illness. While adequate cooking of the meat is the most significant step to decrease the probability of salmonellosis i.e. an increase in the level of adequate cooking will significantly decrease the probability of illness.

For Campylobacter (Figure 7), inadequate hand washing is the most significant factor that may increase the probability of campylobacteriosis, and adequate cooking of the meat is the most significant step to decrease the probability of campylobacteriosis.

**Figure 7.** Sensitivity analysis for input variables used to model the probability of campylobacteriosis from the consumption of chicken.
Uncertainty and variability

We have accounted for uncertainty and variability in the scientific assessment through the use of mathematical models. Uncertainty reflects what we don’t know about a system or process, while variability is a measure of the natural variability inherent in all systems. However, we may not have identified all the important factors and therefore not all uncertainty and variability may have been captured. The effect of uncertainty and variability is to make the estimate of the number of cases of disease less sure.

The level of pathogens on carcasses at the end of processing had a significant influence on the final probability of predicted number of illness. However levels are highly variable.

Uncertainty can be minimised by gathering more data. From a modelling point of view, uncertainty in the level of pathogen contamination can be reduced by gathering quantitative data at the end of processing and at various stages throughout processing and the transport, retail and food preparation chain.

The behaviour of consumers and food preparers in the kitchen is an example of variability. The variability can only be reduced through the changes in food storage and preparation practices i.e. educating consumers and food preparers about better practices may result in fewer failures in the kitchen and therefore reduce the amount of variability.

Clearly in the current model there are a large number of variables that have associated uncertainty and variability. The challenge is to gather further data on those variables that affect the final risk the most e.g. food preparation in domestic and commercial kitchens.
While a range of chemical and microbiological hazards may contaminate poultry meat, we can confirm that the main hazards are microbiological, specifically *Salmonella* and *Campylobacter*.

We believe contamination of poultry by *Salmonella* and *Campylobacter* on-farm is multifactorial, and can find no information on the relative importance of one factor compared with another. Despite difficulties in obtaining through-chain data, the assessment qualitatively identified factors on-farm and during primary processing which may affect the prevalence and levels of *Salmonella* spp. and *Campylobacter* spp. on the finished carcass.

We found on-farm biosecurity factors and inputs such as feed and water impact on the introduction of these pathogens into flocks. Measures on-farm which reduce prevalence of contamination will aid in reducing the potential risk of foodborne illness.

We believe specific steps during primary processing, such as de-feathering, evisceration and immersion chilling, when poorly controlled adversely impact on the contamination of the final carcass.

Quantitative risk modelling of steps after primary processing showed the impact of temperature control, freezing, cross-contamination and cooking on risk estimates. In addition, we found measures to reduce prevalence and levels of *Salmonella* and *Campylobacter* on carcasses reduced the estimated number of cases of human illness.

Our scientific assessment determined that, provided poultry meat is adequately cooked and cross-contamination is minimised, the public health and safety risk posed by poultry meat is low.