# Appendix IX.4: Generic HACCP Plan for Slaughter, Dressing, Portioning and Deboning of Chicken (Broilers)

***This generic HACCP plan is intended to serve as guide to assist poultry processing premises in the development of their own HACCP plans. It is very important that individual premises customise their HACCP plan to their specific product, process and premises.***

## 1. Supporting Systems

***Prior to starting the HACCP plan, the HACCP team should ensure that all relevant supporting systems (also known as prerequisite programmes, good hygienic practices) are documented and that they are in compliance with regulatory requirements and/or specifications for good manufacturing practice (GMP). The Poultry Industry Processing Standard 5 (PIPS 5) and Meat Industry Standards provide guidance on relevant supporting systems.***

The following is a list of recommended supporting systems:

- sanitary design;
- potable water and ice quality;
- sanitation and cleanup procedures for edible areas and food contact surfaces
- (pre-operational and operational);
- personal hygiene (protective clothing requirements, personal equipment and use of amenities);
- training;
- hygienic processing (processing techniques and procedures, dropped meat, maintenance of product temperatures);
- food contact materials (specifications, handling and storage);
- repairs and maintenance of equipment;
- control of chemicals;
- vermin control;
- waste disposal;
- refrigeration management;
- handling and disposition of detained and non-conforming products.
- programmes and/or contract specifications agreed with producers covering on-farm and pre-slaughter practices (e.g. Whole Flock Health Scheme, chemical residue monitoring programme, specifications for transport and handling including cleaning of crates and vehicles, feed withdrawal periods, vendor declarations)

## 2. Scope of HACCP Plan

**HACCP application:** Food safety

**Product:** Whole chicken, chicken portions and edible offal (i.e. giblets)

**Process:** Slaughter, dressing, cooling, portioning, deboning (excluding mechanically deboned meat), processing of edible offal and packing of products from receipt of live birds to dispatch of chilled and frozen products.

# 3. Product Description and Intended Use

## Form 1: Product description and intended use

| | | |
|---|---|---|
| **1.** | **Product name(s)** | Raw whole chicken<br>Raw chicken portions (bone-in and deboned)<br>Edible offal (giblets) |
| **2.** | **Important product characteristics** | Product meeting company and regulatory specifications for microbiological and sensory quality, foreign objects, temperature and packaging. |
| **3.** | **How is it to be used:**<br>**a. By a further processor or retailer**<br><br>**b. By the consumer.** | a. Further processing into manufactured products, retail products, food service items<br><br>b. Cooked |
| **4.** | **Intended consumer** | General public |
| **5.** | **Packaging** | Company/regulatory specification |
| **6.** | **Shelf life and storage requirements** | Company/regulatory specification |
| **7.** | **Where it will be sold**<br>**a. Local market**<br>**b. Export market** | List countries, if applicable |
| **8.** | **Labelling instructions** | Company/regulatory specification |
| **9.** | **Special distribution controls required** | Refrigerated distribution as per company/regulatory specification for each type of product. |

# 4. Initial Food Safety Objectives

*(To be confirmed after hazard analysis and CCP determination. See Section 8 for confirmed objectives).*

To minimise microbiological hazards in the product to levels not exceeding specified targets.

To ensure that chemical residues in the product do not exceed specified targets as monitored by the MAF Broiler Chemical Residue Monitoring Programme.

To minimise the presence of foreign material on products to levels not exceeding specified targets.

# 5. Process Flow Diagram

### Form 2: Raw materials / other inputs

| **Product names:** Whole chicken, chicken portions, edible offal | |
|---|---|
| **Raw material/other inputs** | **Description/specification** |
| Raw material - live birds | Sourced from producers that comply with a whole flock health scheme. |
| Permitted bactericidal agent (e.g. chlorine[1]) | As per company specifications |
| Other inputs[2] - food contact packaging materials | Suitable for use as food contact materials |

1. Chlorinated water as used in this HACCP plan refers to water with added chlorine at levels higher than that present in tap water or municipal water.

2. These inputs and possible hazards must be addressed by a supporting system (i.e prerequisite programme, good hygienic practices), or be specifically considered during hazard identification in this HACCP plan.

## Form 3a: Process flow diagram

**Process:** Slaughter and dressing of chicken (broilers)

| Inputs | Process steps | Edible outputs |
|---|---|---|
| Live birds ▸ | 1. Receipt of live birds ▾ | |
| | 2. Hanging ▾ | |
| | 3. Stunning ▾ | |
| | 4. Killing ▾ | |
| | 5. Bleeding ▾ | |
| | 6. Scalding ▾ | |
| | 7. Defeathering ▾ | |
| Water with bactericidal agent[1] ▸ | 8. Washing[1] ▾ | |
| | 9. Head pulling ▾ | ▸ Head [2] |
| | 10. Hock cutting ▾ | ▸ Feet [2] |
| | 11. Venting ▾ | |
| | 12. Evisceration ▾ | ▸ Edible offal (liver, gizzard, heart) **(To Form 3b)** |
| Water with bactericidal agent[1] ▸ | 13. Washing[1] ▾ | |
| | 14. Crop removal ▾ | |
| | 15. Neck cracking/cutting of neck flap ▾ | ▸ Necks [2] |
| Water with bactericidal agent[1] ▸ | 16. Washing (inside/outside wash) ▾ | |
| Water with bactericidal agent[1]/ice ▸ | 17. Immersion chilling or combination Chilling[3] ▾ | |
| | 18. Rehanging[4] ▾ | |
| | 19. Conveying to secondary processing area ▾ | |
| | 20. Portioning ▸ ▾ | |
| | ▾ 21a. Storage[5] ▾ | |
| | ▾ 21b. Deboning [5] ▾ | |
| Packaging materials ▸ | 22. Packaging ◂ ▾ | |
| | 23. Chilling/freezing ▾ | |
| | 24. Storage ▾ | |
| | 25. Dispatch | ▸ Packed whole chicken, chicken portions |

1. The number and location of washing steps in the process and the use of permitted bactericidal agents (e.g. chlorine) will vary from premises to premises. Individual premises should consider the impact of any washing step during hazard analysis.

2. Premises that collect heads, feet and necks as edible products must do a hazard analysis for these products and establish control measures to address any identified hazards. These products will not be considered further in this generic plan.

3. Combination chilling consists of immersion chilling followed by holding in a freezer or chiller to complete the chilling process prior to secondary processing.

4. Rehanging often involves grading (sending defective product to cut-up so that the quality defects can be removed).

5. Process option.

## Form 3b: Process flow diagram

**Process: Processing of edible offal**

| **Inputs** | **Process steps** | **Edible outputs** |
|---|---|---|
| Edible offal (from evisceration step) ▸ | 1. Separation of liver/heart and gizzard ▾ ▾ | |
| | Liver /heart ▾ Gizzard ▾ | |
| | 2. Peeling of gizzard ▾ ▾ | |
| Water with bactericidal agent[1] ▸ | 3. Washing or immersion chilling ▾ | |
| | 4. Weighing and packing ▾ ▾ | |
| | 5. Chilling ▾ 6. Freezing ▾ | |
| | 7. Storage ◂ ▾ | |
| | 8. Dispatch | ▸ Packed chilled/frozen edible offal |

1. The use of a permitted bactericidal agent (e.g. chlorine) varies from premises to premises.

# 6. Job Descriptions

Job descriptions or instructions should be documented and confirmed for each step in the process.

Form 4 is an example of a job description format.

**Form 4: Example of a job description format**

| **Job description** |
| --- |
| **Process step no:** |
| **Summary list of food safety responsibilities of operator:***(confirm after HACCP plan completed)*<br><br>**Reference:** |

# 7. Hazard Analysis and CCP Determination

***The hazards and CCPs identified by individual premises may differ from those identified in this generic plan due to variations in a number of factors such as: adequacy of whole flock health scheme, products, processing procedures and parameters, equipment, premises design, and effectiveness of supporting systems. Thus, it is very important that individual premises customise their hazard analysis.***

## 7.1 Raw material hazard identification

### Form 5a: Hazard identification for live birds

| Raw material components | Biological hazard [1,2] | Chemical hazard | Physical hazard |
|---|---|---|---|
| Carcass excluding internal organs | B1 - Microbiological hazards associated with contamination from feathers and skin, e.g. *Salmonella* spp., *Campylobacter jejuni*, *Clostridium* spp. | C1 - Chemical residues, e.g. anthelmintics, antibiotics, heavy metals, environmental contaminants | None |
| Gastrointestinal tract (GIT) | B2 - Microbiological hazards associated with contamination from the GIT, e.g. *Salmonella* spp., *Campylobacter jejuni*, *Clostridium* spp., *Listeria monocytogenes* | None | None |
| Internal organs excluding GIT | None [1,3] | C1 - Chemical residues, e.g. anthelmintics, antibiotics, heavy metals, environmental contaminants | None |

1. Live birds affected with systemic bacterial infection or septicaemia generally exhibit obvious clinical signs of the disease. Diseased birds are likely to be culled while still on the farm.

2. At present, there is insufficient information on *Salmonella*, *C. jejuni* and *L. monocytogenes* on raw poultry to serve as basis for establishing food safety objectives for raw poultry. The implementation of the National Microbiological Database (NMD) programme for broilers is expected to provide information for establishing microbiological targets for *Salmonella*. However, for *C. jejuni* and *L. monocytogenes*, it is unlikely that adequate information will be available in the near future due to uncertainties in microbiological methodology and controls.

3. Localised pathological abnormalities may occur sporadically in internal organs of chicken. There are, currently, no national data available on the pathology of broilers in New Zealand. Anecdotal evidence from industry suggests that pathological abnormalities are rarely observed on internal organs of broilers grown under a whole flock health scheme. An inspection system and disease and defects surveys are currently being developed by MAF and industry which will provide information on the levels of pathology on carcasses and offal.

## 7.2 Hazard analysis and CCP determination (raw material, other inputs and process steps)

***Hazard analysis may result in changes to the initial food safety objectives set in Section 4. See Section 8 for confirmed objectives.***

### Form 5b: Hazard analysis and CCP determination (raw material, other inputs and process steps) for whole chicken and chicken portions.

| Process step | Inputs | | | | Process step hazards and potential impact of process step on existing hazards | Q1. Could the hazard be present in or on the product[1] at unacceptable levels[2] at this step? If yes, answer Q2 and Q3. | | Q2. Is there a control measure at this step that would prevent unacceptable levels of the hazard or reduce/eliminate the hazard to acceptable levels? If yes, this step is a CCP. If no, not a CCP. | Q3. Is there a control measure available at a previous step? If yes, retrospectively assign the previous step as a CCP. | CCP No. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Raw material | | Other inputs | | | | | | | |
| | Component | Hazards | Component | Hazards | | Yes/No | Justification | | | |
| 1. Receipt of live birds | Carcass/head/ feet/feathers | B1. Enteric pathogens | | | | Yes | External surface of birds is likely to be contaminated with unacceptable levels of microorganisms. Refer to Annex, Sections 2 and 5. | No | No | |
| | | C1. Chemical residues | | | | No[3] | | | | |
| | GIT | B2. Enteric pathogens | | | | No | | | | |
| | Internal organs | C1. Chemical residues | | | | No[3] | | | | |
| 2. Hanging | Carcass/head/ feet/feathers | B1. Enteric pathogens | | | | Yes | External surface of birds is likely to be contaminated with unacceptable levels of microorganisms. | No | No | |

| Process step | Inputs | | | | Process step hazards and potential impact of process step on existing hazards | Q1. Could the hazard be present in or on the product[1] at unacceptable levels[2] at this step? If yes, answer Q2 and Q3. | | Q2. Is there a control measure at this step that would prevent unacceptable levels of the hazard or reduce/eliminate the hazard to acceptable levels? If yes, this step is a CCP. If no, not a CCP. | Q3. Is there a control measure available at a previous step? If yes, retrospectively assign the previous step as a CCP. | CCP No. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Raw material | | Other inputs | | | | | | | |
| | Component | Hazards | Component | Hazards | | Yes/No | Justification | | | |
| | | C1. Chemical residues | | | | No | | | | |
| | GIT | B2. Enteric pathogens | | | | No | | | | |
| | Internal organs | C1. Chemical residues | | | | No | | | | |
| 3. Stunning | Carcass/head/ feet/feathers | B1. Enteric pathogens | | | | Yes | External surface of birds is likely to be contaminated with unacceptable levels of microorganisms. | No | No | |
| | | C1. Chemical residues | | | | No | | | | |
| | GIT | B2. Enteric pathogens | | | | No | | | | |
| | Internal organs | C1. Chemical residues | | | | No | | | | |
| 4. Killing | Carcass/head/ feet/feathers | B1. Enteric pathogens | | | | Yes | External surface of birds is likely to be contaminated with unacceptable levels microorganisms. | No | No | |
| | | | | | Contamination of the cut area | No | | | | |

| Process step | Inputs | | | | Process step hazards and potential impact of process step on existing hazards | Q1. Could the hazard be present in or on the product[1] at unacceptable levels[2] at this step? If yes, answer Q2 and Q3. | | Q2. Is there a control measure at this step that would prevent unacceptable levels of the hazard or reduce/eliminate the hazard to acceptable levels? If yes, this step is a CCP. If no, not a CCP. | Q3. Is there a control measure available at a previous step? If yes, retrospectively assign the previous step as a CCP. | CCP No. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Raw material | | Other inputs | | | | | | | |
| | Component | Hazards | Component | Hazards | | Yes/No | Justification | | | |
| | | C1. Chemical residues | | | | No | | | | |
| | GIT | B2. Enteric pathogens | | | | No | | | | |
| | Internal organs | C1. Chemical residues | | | | No | | | | |
| 5. Bleeding | Carcass/head/ feet/feathers | B1. Enteric pathogens | | | | Yes | External surface of birds is likely to be contaminated with unacceptable levels of microorganisms. | No | No | |
| | | C1. Chemical residues | | | | No | | | | |
| | GIT | B2. Enteric pathogens | | | | No | | | | |
| | Edible offal | C1. Chemical residues | | | | No | | | | |
| 6. Scalding | Carcass/head/ feet/feathers | B1. Enteric pathogens | | | | Yes | External surface of birds is likely to be contaminated with unacceptable levels of microorganisms. | No | No | |
| | | | | | Cross-contamination from scald water | No | | | | |

| Process step | Inputs | | | | Process step hazards and potential impact of process step on existing hazards | Q1. Could the hazard be present in or on the product[1] at unacceptable levels[2] at this step? If yes, answer Q2 and Q3. | | Q2. Is there a control measure at this step that would prevent unacceptable levels of the hazard or reduce/eliminate the hazard to acceptable levels? If yes, this step is a CCP. If no, not a CCP. | Q3. Is there a control measure available at a previous step? If yes, retrospectively assign the previous step as a CCP. | CCP No. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Raw material | | Other inputs | | | | | | | |
| | Component | Hazards | Component | Hazards | | Yes/No | Justification | | | |
| | | C1. Chemical residues | | | | No | | | | |
| | GIT | B2. Enteric pathogens | | | | No | | | | |
| | Edible offal | C1. Chemical residues | | | | No | | | | |
| | | | | | Contamination from scald water | No | | | | |
| 7. Defeathering | Carcass/head/ feet/feathers | B1. Enteric pathogens | | | | Yes | External surface of birds is likely to be contaminated with unacceptable levels of microorganisms. | No | No | |
| | | | | | Cross-contamination | Yes | Potential increase in incidence of pathogens on carcasses.<br><br>Refer to Annex, Section 5.2. | No | No | |
| | | C1. Chemical residues | | | | No | | | | |
| | GIT | B2. Enteric pathogens \ | | | | No | | | | |
| | Internal organs | C1. Chemical residues | | | | No | | | | |

| Process step | Inputs | | | | Process step hazards and potential impact of process step on existing hazards | Q1. Could the hazard be present in or on the product[1] at unacceptable levels[2] at this step? If yes, answer Q2 and Q3. | | Q2. Is there a control measure at this step that would prevent unacceptable levels of the hazard or reduce/eliminate the hazard to acceptable levels? If yes, this step is a CCP. If no, not a CCP. | Q3. Is there a control measure available at a previous step? If yes, retrospectively assign the previous step as a CCP. | CCP No. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Raw material | | Other inputs | | | | | | | |
| | Component | Hazards | Component | Hazards | | Yes/No | Justification | | | |
| 8. Washing | Carcass/head/ feet | B1. Enteric pathogens | | | | Yes | External surface of carcasses is likely to be contaminated with unacceptable levels of microorganisms. | Yes - effective washing will reduce microbiological contamination from previous step (part of system CCP1). Refer to Annex, Section 5.5. | No | 1a |
| | | C1. Chemical residues | | | | No | | | | |
| | GIT | B2. Enteric pathogens | | | | No | | | | |
| | Internal organs | C1. Chemical residues | | | | No | | | | |
| 9. Head pulling | Carcass/head/ feet | B1. Enteric pathogens | | | | Yes | External surface of carcasses is likely to be contaminated with unacceptable levels of microorganisms. | No | No | |
| | | C1. Chemical residues | | | | No | | | | |
| | GIT | B2. Enteric pathogens | | | | No | | | | |
| | Internal organs | C1. Chemical residues | | | | No | | | | |

| Process step | Inputs | | | | Process step hazards and potential impact of process step on existing hazards | Q1. Could the hazard be present in or on the product[1] at unacceptable levels[2] at this step? If yes, answer Q2 and Q3. | | Q2. Is there a control measure at this step that would prevent unacceptable levels of the hazard or reduce/eliminate the hazard to acceptable levels? If yes, this step is a CCP. If no, not a CCP. | Q3. Is there a control measure available at a previous step? If yes, retrospectively assign the previous step as a CCP. | CCP No. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Raw material | | Other inputs | | | | | | | |
| | Component | Hazards | Component | Hazards | | Yes/No | Justification | | | |
| 10. Hock cutting | Carcass/feet | B1. Enteric pathogens | | | | Yes | External surface of carcasses is likely to be contaminated with unacceptable levels of microorganisms. | No | No | |
| | | C1. Chemical residues | | | | No | | | | |
| | GIT | B2. Enteric pathogens | | | | No | | | | |
| | Internal organs | C1. Chemical residues | | | | No | | | | |
| 11. Venting | Carcass | B1. Enteric pathogens | | | | Yes | External surface of carcasses is likely to be contaminated with unacceptable levels of microorganisms. | No | No | |
| | | C1. Chemical residues | | | | No | | | | |

| Process step | Inputs | | | | Process step hazards and potential impact of process step on existing hazards | Q1. Could the hazard be present in or on the product[1] at unacceptable levels[2] at this step? If yes, answer Q2 and Q3. | | Q2. Is there a control measure at this step that would prevent unacceptable levels of the hazard or reduce/eliminate the hazard to acceptable levels? If yes, this step is a CCP. If no, not a CCP. | Q3. Is there a control measure available at a previous step? If yes, retrospectively assign the previous step as a CCP. | CCP No. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Raw material | | Other inputs | | | | | | | |
| | Component | Hazards | Component | Hazards | | Yes/No | Justification | | | |
| | GIT | B2. Enteric pathogens | | | Contamination from the GIT | Yes | Faecal contamination due to gut breakage is likely to result in an unacceptable increase in the incidence and levels of pathogens on carcasses and edible offal.<br><br>Refer to Annex, Section 5.3. | No | No | |
| | Internal organs | C1. Chemical residues | | | | No | | | | |
| 12. Evisceration | Carcass | B1/B2[4]. Enteric pathogens | | | | Yes | Carcasses are likely to be contaminated with unacceptable levels of microorganisms. | No | No | |
| | | C1. Chemical residues | | | | No | | | | |
| | GIT | B2. Enteric pathogens | | | Contamination from the GIT | Yes | Faecal contamination due to gut breakage is likely to result in an unacceptable increase in the incidence and levels of pathogens on carcasses and edible offal<br><br>Refer to Annex, Section 5.3. | No | No | |

| Process step | Inputs | | | | Process step hazards and potential impact of process step on existing hazards | Q1. Could the hazard be present in or on the product[1] at unacceptable levels[2] at this step? If yes, answer Q2 and Q3. | | Q2. Is there a control measure at this step that would prevent unacceptable levels of the hazard or reduce/eliminate the hazard to acceptable levels? If yes, this step is a CCP. If no, not a CCP. | Q3. Is there a control measure available at a previous step? If yes, retrospectively assign the previous step as a CCP. | CCP No. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Raw material | | Other inputs | | | | | | | |
| | Component | Hazards | Component | Hazards | | Yes/No | Justification | | | |
| | Edible offal **(Continued in Form 5c)** | B2. Enteric pathogens from GIT | | | Contamination from the GIT | Yes | Faecal contamination due to gut breakage is likely to result in an unacceptable increase in the incidence and levels of pathogens. | No | No | |
| | | C1. Chemical residues | | | | No | | | | |
| 13. Washing | Carcass | B1/B2. Enteric pathogens | | | | Yes | Carcasses are likely to be contaminated with unacceptable levels of microorganisms. | Yes - effective washing will reduce microbiological contamination from previous steps (part of system CCP1). Refer to Annex, Section 5.5. | No | 1b |
| | | C1. Chemical residues | | | | No | | | | |
| | GIT (crop) | B2. Enteric pathogens | | | | No | | | | |
| 14. Crop removal | Carcass | B1/B2. Enteric pathogens | | | | Yes | Carcasses are likely to be contaminated with unacceptable levels of microorganisms. Refer to Annex, Sections 2 and 5. | No | No | |

| Process step | Inputs | | | | Process step hazards and potential impact of process step on existing hazards | Q1. Could the hazard be present in or on the product[1] at unacceptable levels[2] at this step? If yes, answer Q2 and Q3. | | Q2. Is there a control measure at this step that would prevent unacceptable levels of the hazard or reduce/eliminate the hazard to acceptable levels? If yes, this step is a CCP. If no, not a CCP. | Q3. Is there a control measure available at a previous step? If yes, retrospectively assign the previous step as a CCP. | CCP No. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Raw material | | Other inputs | | | | | | | |
| | Component | Hazards | Component | Hazards | | Yes/No | Justification | | | |
| | | C1. Chemical residues | | | | No | | | | |
| | GIT (crop) | B2. Enteric pathogens | | | Contamination from the crop | Yes | Contamination due to crop breakage is likely to result in an unacceptable increase in the incidence and levels of pathogens on carcasses and edible offal.<br><br>Refer to Annex, Section 5.4. | No | No | |
| 15. Neck cracking/ cutting of neck flap | Carcass | B1/B2. Enteric pathogens | | | | Yes | Carcasses are likely to be contaminated with unacceptable levels of microorganisms. | No | No | |
| | | C1. Chemical residues | | | | No | | | | |
| 16. Washing (inside/outside wash) | Carcass | B1/B2. Enteric pathogens | | | | Yes | Carcasses are likely to be contaminated with unacceptable levels of microorganisms. | Yes - effective inside/outside washing will reduce microbiological contamination from previous steps (part of systemCCP1).<br><br>Refer to Annex, Section 5.5. | No | 1c |

| Process step | Inputs | | | | Process step hazards and potential impact of process step on existing hazards | Q1. Could the hazard be present in or on the product[1] at unacceptable levels[2] at this step? If yes, answer Q2 and Q3. | | Q2. Is there a control measure at this step that would prevent unacceptable levels of the hazard or reduce/eliminate the hazard to acceptable levels? If yes, this step is a CCP. If no, not a CCP. | Q3. Is there a control measure available at a previous step? If yes, retrospectively assign the previous step as a CCP. | CCP No. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Raw material | | Other inputs | | | | | | | |
| | Component | Hazards | Component | Hazards | | Yes/No | Justification | | | |
| | | C1. Chemical residues | | | | No | | | | |
| 17. Immersion chilling/ combination chilling | Carcass | B1/B2. Enteric pathogens | | | | Yes | Carcasses are likely to be contaminated with unacceptable levels of microorganisms. | Yes - effective chilling and use fo a permitted bactericidal agent can reduce overall microbiological counts on carcasses<br><br>Refer to Annex, Section 5.6. | Yes - washing at previous steps particularly at step 16 | 2 |
| | | | | | Cross-contamination | Yes | Immersion chilling can result in an unacceptable increase in the incidence of pathogens on carcasses.<br><br>Refer to Annex, Section 5.5. | Yes - effective chilling and use of a permitted bactericidal agent (e.g. chlorine) can minimise cross-contamination<br><br>Refer to Annex, Section 5.6. | Yes - washing at previous steps particularly at step 16 | 2 |
| | | C1. Chemical residues | | | | No | | | | |
| 18. Rehanging | Carcass | B1/B2. Enteric pathogens from skin, feathers, GIT | | | | No | | | | |
| | | C1. Chemical residues | | | | No | | | | |

| Process step | Inputs | | | | Process step hazards and potential impact of process step on existing hazards | Q1. Could the hazard be present in or on the product[1] at unacceptable levels[2] at this step? If yes, answer Q2 and Q3. | | Q2. Is there a control measure at this step that would prevent unacceptable levels of the hazard or reduce/eliminate the hazard to acceptable levels? If yes, this step is a CCP. If no, not a CCP. | Q3. Is there a control measure available at a previous step? If yes, retrospectively assign the previous step as a CCP. | CCP No. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Raw material | | Other inputs | | | | | | | |
| | Component | Hazards | Component | Hazards | | Yes/No | Justification | | | |
| 19. Conveying to secondary processing area | Carcass | B1/B2. Enteric pathogens from skin, feathers, GIT | | | | No | | | | |
| | | C1. Chemical residues | | | | No | | | | |
| 20. Portioning | Carcass | B1/B2. Enteric pathogens | | | | No | | | | |
| | | | | | Cross-contamination | No | | | | |
| | | | | | Growth of microorganisms | No | | | | |
| | | C1. Chemical residues | | | | No | | | | |
| 21a. Storage | Portions | B1/B2. Enteric pathogens | | | | No | | | | |
| | | | | | Growth of microorganisms | No | | | | |
| | | C1. Chemical residues | | | | No | | | | |
| 21b. Deboning | Portions | B1/B2. Enteric pathogens | | | | No | | | | |
| | | | | | Cross-contamination | No | | | | |
| | | | | | Growth of microorganisms | No | | | | |

| Process step | Inputs | | | | Process step hazards and potential impact of process step on existing hazards | Q1. Could the hazard be present in or on the product[1] at unacceptable levels[2] at this step? If yes, answer Q2 and Q3. | | Q2. Is there a control measure at this step that would prevent unacceptable levels of the hazard or reduce/eliminate the hazard to acceptable levels? If yes, this step is a CCP. If no, not a CCP. | Q3. Is there a control measure available at a previous step? If yes, retrospectively assign the previous step as a CCP. | CCP No. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Raw material | | Other inputs | | | | | | | |
| | Component | Hazards | Component | Hazards | | Yes/No | Justification | | | |
| | | C1. Chemical residues | | | | No | | | | |
| | | | | | P1. Bone | No for manual boning | | | | |
| | | | | | | Yes for auto-matic boning | Reported incidences of noncompliance. Refer to Annex, Section 5.7. | Correct machine settings. | No | 3 |
| 22. Packaging | Whole carcass/ portions/ deboned meat | B1/B2. Enteric pathogens | | | | No | | | | |
| | | | | | Cross-contamination | No | | | | |
| | | C1. Chemical residues | | | | No | | | | |
| 23. Chilling/ freezing | Whole carcass/ portions/ deboned meat | B1/B2. Enteric pathogens from skin, feathers, GIT | | | | No | | | | |
| | | | | | Growth of microorganisms for chilled products | No | | | | |
| | | C1. Chemical residues | | | | No | | | | |

| Process step | Inputs | | | | Process step hazards and potential impact of process step on existing hazards | Q1. Could the hazard be present in or on the product[1] at unacceptable levels[2] at this step? If yes, answer Q2 and Q3. | | Q2. Is there a control measure at this step that would prevent unacceptable levels of the hazard or reduce/eliminate the hazard to acceptable levels? If yes, this step is a CCP. If no, not a CCP. | Q3. Is there a control measure available at a previous step? If yes, retrospectively assign the previous step as a CCP. | CCP No. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Raw material | | Other inputs | | | | | | | |
| | Component | Hazards | Component | Hazards | | Yes/No | Justification | | | |
| 24. Frozen/chilled storage | Whole carcass/ portions/ deboned meat | B1/B2. Enteric pathogens from skin, feathers, GIT | | | | No | | | | |
| | | | | | Growth of microorganisms for chilled products | No | | | | |
| | | C1. Chemical residues | | | | No | | | | |
| 25. Dispatch | Whole carcass/ portions/ deboned meat | B1/B2. Enteric pathogens from skin, feathers, GIT | | | | No | | | | |
| | | C1. Chemical residues | | | | No | | | | |

1. Product is defined as the edible component of final product.

2. Unacceptable - as demonstrated by data (scientific literature, applied research or on-site experience) associated with achieving the FSOs established for the process. In the determination of unacceptability, hazards should be considered in terms of:
   - level;
   - frequency;
   - transfer and redistribution;
   - severity of effect on consumer.

3. Most control measures for addressing potential hazards associated with chemical residues are applied in the livestock production system under a Whole Flock Health Scheme. New Zealand MAF maintains a Broiler Chemical Residue Monitoring Programme that monitors the residue status of birds slaughtered for human consumption.

4. B1 and B2 have been combined because the hazards of concern, which initially come from the surface of the carcass and the GIT, are the same type of microorganisms and are now found on the same raw material component (i.e. the carcass). In addition, the source of the contamination cannot be differentiated at this stage of the process and at succeeding steps.

# Form 5c: Hazard analysis and CCP determination (raw material, other inputs and process steps) for processing of edible offal.

| Process step | Inputs | | | | Process step hazards and potential impact of process step on existing hazards | Q1. Could the hazard be present in or on the product[1] at unacceptable levels[2] at this step? If yes, answer Q2 and Q3. | | Q2. Is there a control measure at this step that would prevent unacceptable levels of the hazard? If yes, this step is a CCP. If no, not a CCP. | Q3. Is there a control measure available at a previous step? If yes, retrospectively assign the previous step as a CCP. | CCP No. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Raw material | | Other inputs | | | | | | | |
| | Component | Hazards | Component | Hazards | | Yes/No | Justification | | | |
| 1. Separation of liver/heart and gizzard<br><br>**(From evisceration step in Form 5b)** | Edible offal | B2. Enteric pathogens from GIT | | | | Yes | Faecal contamination from the evisceration steps is likely to result in unacceptable levels of microorganisms.<br><br>Refer to Annex, Section 2.2. | No | No | |
| | | C1. Chemical residues | | | | No | | | | |
| 2. Peeling of gizzard | | B2. Enteric pathogens from GIT | | | | Yes | Faecal contamination from the evisceration steps is likely to result in unacceptable levels of microorganisms. | No | No | |
| | | C1. Chemical residues | | | | No | | | | |
| 3. Washing or immersion chilling | Edible offal | B2. Enteric pathogens from GIT | | | | Yes | Edible offal are likely to be contaminated with unacceptable levels of microorganisms.<br><br>Refer to Annex, Sections 2 and 5.6. | Yes - effective chilling and use of permitted bactericidal agent (e.g. chlorine) can reduce overall microbiological counts[3]<br>Refer to Annex, Section 5.6. | | 4 |

| Process step | Inputs | | | | Process step hazards and potential impact of process step on existing hazards | Q1. Could the hazard be present in or on the product[1] at unacceptable levels[2] at this step? If yes, answer Q2 and Q3. | | Q2. Is there a control measure at this step that would prevent unacceptable levels of the hazard? If yes, this step is a CCP. If no, not a CCP. | Q3. Is there a control measure available at a previous step? If yes, retrospectively assign the previous step as a CCP. | CCP No. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Raw material | | Other inputs | | | | | | | |
| | Component | Hazards | Component | Hazards | | Yes/No | Justification | | | |
| | | | | | Cross-contamination from chiller water | Yes | Immersion chilling can result in an unacceptable increase in the incidence of pathogens.<br><br>Refer to Annex, Section 5.6. | Yes - effective chilling and use of permitted bactericidal agent (e.g.chlorine) can minimise cross-contamination Refer to Annex, Section 5.6. | | 4 |
| | | C1. Chemical residues | | | | No | | | | |
| 4. Weighing and packing | Edible offal | B2. Enteric pathogens from GIT | | | | No | | | | |
| | | C1. Chemical residues | | | | No | | | | |
| 5. Chilling | Edible offal | B2. Enteric pathogens from GIT | | | | No | | | | |
| | | | | | Growth of microorganisms | No | | | | |
| | | C1. Chemical residues | | | | No | | | | |
| 5. Freezing | Edible offal | B2. Enteric pathogens from GIT | | | | No | | | | |
| | | C1. Chemical residues | | | | No | | | | |

| Process step | Inputs | | | | Process step hazards and potential impact of process step on existing hazards | Q1. Could the hazard be present in or on the product[1] at unacceptable levels[2] at this step? If yes, answer Q2 and Q3. | | Q2. Is there a control measure at this step that would prevent unacceptable levels of the hazard? If yes, this step is a CCP. If no, not a CCP. | Q3. Is there a control measure available at a previous step? If yes, retrospectively assign the previous step as a CCP. | CCP No. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Raw material | | Other inputs | | | | | | | |
| | Component | Hazards | Component | Hazards | | Yes/No | Justification | | | |
| 6. Storage | Edible offal | B2. Enteric pathogens from GIT | | | | No | | | | |
| | | | | | Growth of microorganisms | No | | | | |
| | | C1. Chemical residues | | | | No | | | | |
| 7. Dispatch | Edible offal | B2. Enteric pathogens from GIT | | | | No | | | | |
| | | C1. Chemical residues | | | | No | | | | |

1. Product is defined as the edible component of final product.

2. Unacceptable - as demonstrated by data (scientific literature, applied research or on-site experience) associated with achieving the FSOs established for the process. In the determination of unacceptability, hazards should be considered in terms of:
   - level;
   - frequency;
   - transfer and redistribution;
   - severity of effect on consumer.

3. Washing without the use of a permitted bactericidal agent (e.g. chlorine) may not be an adequate control measure for reducing microbiological levels and minimising cross-contamination to acceptable levels. Premises should take this into consideration during hazard analysis.

# 8. Confirmed Food Safety Objectives

**FSO1**: To minimise microbiological hazards in the product to levels not exceeding specified targets.

**FSO2**: To ensure that chemical residues in the product do not exceed specified targets as monitored by the MAF Broiler Chemical Residue Monitoring Programme.

**FSO3**: To minimise the presence of bone in automatically deboned products to levels not exceeding specified targets.

# 9. Completion of the HACCP Plan

Full documentation is required for the remaining elements of the HACCP plan:

- critical limit setting;
- monitoring procedures;
- corrective action procedures;
- verification procedures including validation;
- documentation and record keeping procedures.

Refer to Sections 9 to 13 of the *Template for Establishing a HACCP Plan for Further Processing of Meat and Meat Products* for detailed requirements.

# 10. Verification of the HACCP Plan

## 10.1 Validation of the HACCP plan

Validation of the HACCP plan involves the initial confirmation that the HACCP plan is complete and will achieve identified food safety objectives (FSOs). CCPs should be evaluated to ensure that the control measure applied at that particular process step, will achieve or contribute to the achievement of the relevant FSO. Some FSOs may be partially or wholly dependent on supporting systems (i.e. prerequisite programmes) rather than the HACCP plan itself.

An example of how this generic HACCP plan may be validated is given below:

**FSO1: To minimise microbiological hazards in the product to levels not exceeding specified targets.**

This FSO is expected to be achieved by providing adequate control measures at the washing steps (CCP1a, 1b & 1c) and at immersion chilling (CCP2 for carcasses and CCP4 for edible offal) together with effective prerequisite programmes (e.g. cleaning and sanitation, hygienic processing, refrigeration management).

The use of microbiological observations is appropriate for evaluating the adequacy of the process to achieve FSO1. Microbiological data may be obtained from relevant published scientific literature, in-house historical data, and/or by gathering new data.

Scientific evidence from published literature may be used to justify the effectiveness of a control measure applied at a specific step or steps. The use of published information will be a sufficient basis for validation only if it can clearly be shown that the conditions or variables considered in the scientific study are applicable to those existing in the process being validated. However, microbiological testing of products as an on-going verification activity may still be required.

Premises that have previously collected microbiological data may use this historical information for evaluating the CCPs in relation to the achievement of the FSO. Historical data may be used provided there has been no change in the product and process from the time the data were collected, sampling and the analytical tests are based on standardised methods and the amount of data available is adequate for validation.

When published scientific information or historical data is not available or is inadequate, microbiological validation will involve the collection of new data from the time that the HACCP plan is implemented. The following are factors which should be considered when developing an appropriate design for microbiological validation in the absence of benchmark or historical data:

| | |
|---|---|
| Sample size: | Number determined by statistical techniques. |
| Sample time frame: | Random selection of samples taken over a specified processing period. |
| Methodology: | Samples to be taken and tested as per current NMD protocol (*this is presently being developed by a PISC/MAF working group)* |

NMD data will provide information on microbiological levels that are achievable for carcasses after slaughter and dressing. Individual premises are expected to assesss their own NMD results when setting microbiological targets within the framework of national guidelines, taking into consideration on-farm practices and seasonal factors.

Supporting systems (i.e. prerequisite programmes) should be validated as complying with good hygienic practice.

**FSO2**: **To ensure that chemical residues in the product do not exceed specified targets as monitored by the MAF Broiler Chemical Residue Monitoring Programme.**

FSO2 is expected to be achieved by ensuring that live birds are sourced from producers that comply with the whole flock health scheme which has been considered in this plan as a supporting system. Compliance with the scheme, as it relates to chemical residues, is verified under the MAF Broiler Chemical Residue Monitoring Programme.

**FSO3**: **To minimise the presence of bone in automatically deboned products to levels not exceeding specified targets.**

FSO3 is expected to be addressed at CCP3 (deboning). Visual inspection of deboned products for the presence of bone may be used to evaluate the adequacy of procedures at this process step to control the hazard. Guidance on establishing sampling regimes for validation using visual observation may be obtained from publications on statistical process control.

## 10.2 Ongoing verification

Ongoing verification activities confirm whether the HACCP plan is operating effectively and according to documented procedures. Examples of these activities are internal and extrinsic audits, HACCP review, and product testing programmes.

## 10.3 Revalidation

A revalidation of the HACCP plan is required whenever changes are made (e.g. changes to premises, product, process, intended use of the product) that could have a significant impact on hazards and their controls, or when process failure that may compromise product safety occurs.

# Form 6: HACCP plan summary spreadsheet for slaughter and dressing of chicken (broilers)

| Process step | Hazard ID | CCP no. | Critical limits | Monitoring procedures/tools (consider who, what, when and how) | Corrective actions[1] | Verification procedures[2] | HACCP records[3] |
|---|---|---|---|---|---|---|---|
| 8, 13 & 16. Washing steps | B1/B2. Enteric pathogens | 1a, b, c | Specified washing parameters that will achieve or contribute to the achievement of specified microbiological targets for carcasses, i.e.<br>• complete carcass coverage by showers<br>• water pressure adequate to remove visible extraneous material<br>• specified concentration of bactericidal agent (e.g. chlorine), if used | Person responsible to check and record washing parameters at specified frequency[4], i.e.<br>• check carcass coverage<br>• check presence of extraneous material on predetermined number of washed carcasses<br>• measure concentration of bactericidal agent, if used | Correct washing parameters.<br>Increase frequency of monitoring.<br>Review adequacy of operational and/or monitoring procedures. | FSO validation<br>Product testing (e.g. microbiological)<br>Water testing<br>Calibration of measuring equipment<br>Internal audit<br>Extrinsic audit (e.g. regulator, client)<br>Client feedback<br>HACCP review | Validation records<br>Daily monitoring records<br>Corrective action reports<br>Analytical test reports<br>Calibration records<br>Internal audit reports<br>Extrinsic audit reports<br>Client feedback records<br>HACCP review records |
| 17. Immersion chilling | B1/B2. Enteric pathogens | 2 | Specified chilling parameters that will achieve specified microbiological targets for carcasses, i.e.<br>• minimum water flow rates (e.g. as per recommendation in PIPS 50<br>• water temperature<br>• exit temperature of carcass<br>• concentration of bactericidal agent (e.g. chlorine) in overflow water, if used<br>• maximum carcass loading of tanks | Person responsible to check and record chilling parameters at specified frequency[4], , i.e.<br>• check or measure water flow rates<br>• check or measure water temperature<br>• measure deep muscle temperature of a predetermined number of chilled carcasses<br>• measure concentration of bactericidal agent in over flow water, if used<br>• check carcass loading of tanks | Correct chilling parameters.<br>Reduce temperature of products to acceptable level (e.g. blast chill or ice)<br>Increase frequency of monitoring.<br>Review adequacy of operational and/or monitoring procedures. | FSO validation<br>Product testing (e.g. microbiological)<br>Water testing<br>Calibration of measuring equipment<br>Internal audit<br>Extrinsic audit (e.g. regulator, client)<br>Client feedback<br>HACCP review | Validation records<br>Daily monitoring records<br>Corrective action reports<br>Analytical test reports<br>Calibration records<br>Internal audit reports<br>Extrinsic audit reports<br>Client feedback records<br>HACCP review records |

| Process step | Hazard ID | CCP no. | Critical limits | Monitoring procedures/tools (consider who, what, when and how) | Corrective actions[1] | Verification procedures[2] | HACCP records[3] |
|---|---|---|---|---|---|---|---|
| 20b. Deboning | Bone in automatically deboned products | 3 | Limits for presence of bone to be specified by the operator. (Refer to Annex, Section 5.7 for guidance.) | Person responsible to inspect predetermined sample size of deboned products at specified frequency | Adjust deboning machine.<br>Rework noncompliant products.<br>Increase monitoring of deboning process.<br>Retrain personnel | FSO validation<br>Product testing for presence of bone<br>Internal audit<br>Extrinsic audit (e.g. regulator, client)<br>Customer complaints<br>HACCP review | Validation records<br>Daily monitoring records Corrective action reports<br>Internal audit reports<br>Extrinsic audit reports<br>Customer complaints file<br>HACCP review records |

1. Corrective actions should reflect an escalating response when ongoing noncompliance occurs. Corrective actions must take three components into consideration when a critical limit is exceeded. These are: quick restoration of control; disposition of affected product, if applicable; and prevention of recurrence of the problem.

2. Verification procedures apply to all aspects of the HACCP plan.

3 HACCP records apply to all aspects of the HACCP plan. Refer to IS8 Section 4 regarding requirements for documentation and record keeping.

4. Monitoring frequencies should be set so that time periods between monitoring result in minimal amount of product being affected when critical limits are not met during this period.

## Form 7: HACCP plan summary spreadsheet for processing of chicken edible offal

| Process step | Hazard ID | CCP no. | Critical limits | Monitoring procedures/tools (consider who, what, when and how) | Corrective actions[1] | Verification procedures[2] | HACCP records[3] |
|---|---|---|---|---|---|---|---|
| 3. Immersion chilling | B1/B2. Enteric pathogens | 4 | Specified chilling parameters that will achieve specified microbiological targets for edible offal, i.e.<br>• minimum water flow rates<br>• water temperature<br>• exit temperature of edible offal<br>• time to reach specified temperature from evisceration<br>• concentration of bactericidal agent (e.g. chlorine) in water, if used | Person responsible to check and record chilling parameters at specified frequency[4], i.e.<br>• check or measure water flow rates<br>• check or measure water temperature<br>• measure temperature of a predetermined number of offal<br>• check time to reach specified temperature<br>• measure concentration of bactericidal agent in water, if used | Correct chilling parameters.<br><br>Reduce temperature of products to acceptable level (e.g. blast chill or ice)<br><br>Increase frequency of monitoring.<br><br>Review adequacy of operational and/or monitoring procedures. | FSO validation<br><br>Product testing (e.g. microbiological)<br><br>Water testing<br><br>Calibration of measuring equipment<br><br>Internal audit<br><br>Extrinsic audit (e.g. regulator, client)<br><br>Client feedback<br><br>HACCP review | Validation records<br><br>Daily monitoring records<br>Corrective action reports<br><br>Analytical test reports<br><br>Calibration records<br><br>Internal audit reports<br><br>Extrinsic audit reports<br><br>Client feedback records<br><br>HACCP review records |

1. Corrective actions should reflect an escalating response when ongoing noncompliance occurs. Corrective actions must take three components into consideration when a critical limit is exceeded. These are: quick restoration of control, disposition of affected product, and prevention of recurrence of the problem.

2. Verification procedures apply to all aspects of the HACCP plan.

3. HACCP records apply to all aspects of the HACCP plan.

4. Monitoring frequencies should be set so that time periods between monitoring result in minimal amount of products being affected when critical limits are not met during this period.

# Annex to Appendix IX.4: Background Information to the Generic HACCP Plan for Slaughter, Dressing, Portioning and Deboning of Chicken (Broilers)

## SUMMARY

The New Zealand poultry industry currently supplies all of the domestic chicken requirements of the country, with negligible amounts of products being exported. The size of poultry processing operations ranges from large fully integrated companies to small family-run processing premises. At present, three major processing companies produce over 90% of chicken sold in the New Zealand market, with the rest produced by about 15 smaller processors.

An attempt has been made to include in this generic plan those food safety hazards and processes that are of relevance to both large and small processors. However, due to the wide variation in systems and parameters used in commercial poultry processing it has not been possible to consider all of these aspects in one generic plan. Thus, it is very important that individual premises customise their HACCP plan to their specific product, process and premises.

The scope of this generic plan is limited to slaughter and dressing of chicken, from the receipt of live birds to dispatch of finished products. However, a complete food safety assurance programme for chicken processing should include on-farm and pre-slaughter practices since major hazards associated with chicken consumption, such as *Salmonella* and *Campylobacter*, are strongly linked to these aspects of the operation.

Literature reviews and hazard analysis indicate that microbiological contamination on chicken carcasses during processing mainly occurs during scalding, defeathering, and evisceration. There is also potential for cross-contamination to occur during immersion chilling. Controls for minimising contamination at the scalding, defeathering and evisceration steps are presently achieved in New Zealand premises mainly through the observance of good hygienic practices. There is general agreement from industry representatives that there is very little that can be done, at present, to further reduce contamination at these steps without a change in equipment. Changing to new equipment can be a very costly exercise and is viewed by industry as a long term solution which may address some or all of the contamination issues. There is an opportunity to reduce microbiological levels on carcasses during processing by using effective multiple washing steps and immersion chilling.

Poultry processing operations cannot eliminate pathogenic bacteria. However, research and/or

observations indicate that observance of good hygienic practices (i.e. supporting systems) and the following procedures can reduce the bacterial load (including pathogens) and/or prevent their proliferation on raw chicken carcasses:

- adequate feed withdrawal;
- effective spray washing with water containing permitted bactericidal agent (e.g. chlorine) immediately after contamination steps;
- effective chilling (i.e. rapid chilling, optimum washing effect and minimised cross-contamination)
- maintenance of low carcass temperatures.

## 1. Foodborne Illness Associated with Chicken

Numerous cases and outbreaks of foodborne illness worldwide have been attributed to the consumption of chicken products (Bremner and Johnston, 1996). Outbreaks involving large numbers of people are usually due to *Salmonella*, *Clostridium perfringens* and *Staphylococcus aureus* (ICMSF, 1998). In the United States, during the period of 1988-1992, chicken products accounted for around 3-4.5% of outbreaks and 1-8.5% of cases reported for which the food vehicle was identified (Bean *et al*., 1997). The primary bacterial agent for the outbreaks was *Salmonella* (72%). *Campylobacter* may be a more common cause of human diarrhoeal disease than *Salmonella*, although it is rarely associated with outbreaks (NACMCF, 1997; ICMSF, 1998). Improper storage or holding temperature and inadequate cooking were the contributing factors most often reported for chicken-related outbreaks (Bean and Griffin, 1990).

Undercooked chicken has also been identified as a possible vehicle of *Listeria monocytogenes* infection in the United States based on a case-control study conducted in conjunction with an active surveillance programme in several states. Two cases of listeriosis in England and one case in the United States have also been positively linked to consumption of poultry products (Ryser and Marth, 1991). Two of the foods involved in the cases were precooked (cooked-and-chilled chicken; turkey frankfurters). The source of infection for the other case was identified as chicken nuggets of the "fast food" kind which was thought to be most likely undercooked.

In New Zealand, there is very limited published information on cases or outbreaks of foodborne illness for which food vehicles have been identified. Although there is little information directly implicating chicken consumption with foodborne illness, the results of a New Zealand survey on poultry quality and a case control study on campylobacteriosis show a strong and consistent association of the disease with the consumption of poultry, specifically chicken (Ikram *et al*., 1994; Eberhart-Phillips *et al*., 1995). Factors identified as being associated with increased risk include: eating raw or undercooked chicken, barbecued chicken, and chicken prepared outside of the home, including at restaurants or takeaway establishments. However, chicken that is thoroughly cooked appears to convey little or no risk of disease.

# 2. Biological Hazards

Live birds affected with systemic bacterial infection or septicaemia generally exhibit obvious clinical signs of the disease. Severely infected birds are likely to be culled while still on the farm as part of the whole flock health scheme. Localised pathological abnormalities may occur sporadically in chicken. There are, currently, no national data available on the pathology of broilers in New Zealand. However, anecdotal evidence from industry suggests that pathological abnormalities are rarely observed on broilers grown under a whole flock health scheme. An inspection system and disease and defects surveys are currently being developed by MAF and industry which will provide information on the levels of pathology on carcasses and offal.

A review of literature suggest that pathology in birds and associated disease is probably of minor importance compared with enteric pathogens such as *Salmonella* and *Campylobacter*.

The two important zoonotic bacteria commonly implicated in foodborne illness associated with poultry meat are *Salmonella* and *Campylobacter* (Bremner and Johnston, 1996). In order to control the incidence of these organisms on poultry meat, measures must be taken at a number of stages of production and processing. *Salmonella* and *Campylobacter* vary considerably in their epidemiology, such that different control measures are appropriate for each. Generally, both organisms are carried in the intestines of poultry without causing clinical disease.

## 2.1 Meat

### *Salmonella* spp.

*Salmonella* species have long been associated with poultry products. Commercial poultry flocks are prone to infection with S*almonella*, especially during the early weeks of life. The presence of *Salmonella* in the gut, on the skin and the feathers causes contamination of carcasses during subsequent slaughter and processing.

Prevalence of *Salmonella* in New Zealand broiler flocks has been observed to be around 10-15% positive flocks on an annual basis (Diprose pers.comm., 1999). Care must be taken in interpreting this information due to the numerous factors affecting prevalence (e.g. flock, on-farm practices, feed, transport and handling) which results in a great variability in prevalence levels obtained.

A New Zealand survey on poultry quality found that 16% of 159 raw poultry samples tested were contaminated with *Salmonella* spp. (Campbell and Gilbert, 1995). The pathogen was found in both fresh and frozen raw samples. This level of contamination is consistent with previous New Zealand surveys. Fraser *et al*. (1991) found a 12.5 to 15% annual contamination rate A recent survey conducted by the Consumers' Insitute detected *Salmonella* spp. in 17 out of 50 whole raw chickens bought from supermarkets and butchers in Christchurch and Auckland (Consumers' Institute, 1999). Care must also be taken in interpreting this result as reflecting the national flock due to the limitations of the sampling protocol followed.

Carcass contamination levels in New Zealand appear to be lower than that in the UK (45 to 80%) (Bremner and Johnston, 1996) and the US (35%) (USDA as cited by Lillard, 1989a). However, recent reports claim that the contamination level in the US has decreased from approximately 20% prior to mandatory HACCP implementation (USDA FSIS, 1996a) to approximately 10.9% after one year of HACCP implementation (Beers, 1999).

The results of the New Zealand survey also show that *Salmonella* was not detected in any of 1330 ready-to-eat poultry products, confirming the effectiveness of proper cooking in destroying *Salmonella* in food products (Campbell and Gilbert, 1995).

***Campylobacter jejuni***

The incidence of *Campylobacter jejuni* in broilers has been reported to range from 83% (Grant *et al*., 1980) to 88% (USDA FSIS, 1996a) in the United States, and 14% (Simmons and Gibbs, 1977) to 91% (Ribiero, 1978) in the United Kingdom. An Australian study showed that three of four flocks examined carried *C. jejuni* with an isolation rate of 52 to 100% in the positive flocks (Shanker *et al*., 1982). The variations may be due to differences in sample size, isolation methodology, or variation in flocks from different localities, or all of these factors. The prevalence of *C. jejuni* in New Zealand flocks is presently unknown.

*C. jejuni* has been isolated from raw poultry products worldwide, often at prevalence rates exceeding 50% (Wempe *et al*., 1983; Berndtson *et al*., 1992; NACMCF, 1997). The level of *C. jejuni* are generally higher than other enteric bacteria, and on occasion can be present at levels as high as $10^5$ to $10^6$ cfu/carcass (Shanker *et al*., 1982; Gill and Harris, 1984).

A microbiological survey of 159 raw poultry samples collected at random from New Zealand poultry processors, found that 82 samples (52%) were positive for *Campylobacter* (Campbell and Gilbert, 1995). This rate is slightly lower that those earlier reported by Gill and Harris (1984) who detected *C. jejuni* in 68% of chilled carcasses from retail outlets in New Zealand. A recent survey conducted by the Consumers' Insitute detected *Campylobacter* in 27 out of 50 whole raw chickens bought from supermarkets and butchers in Christchurch and Auckland (Consumers' Institute, 1999). Care must be taken in interpreting this result as reflecting the national flock due to the limitations of the sampling protocol followed.

Despite the fact that raw poultry have been frequently found to be contaminated with *Campylobacter*, only one sample (0.07%) of ready-to-eat poultry products tested positive for the organism in the New Zealand survey (Campbell and Gilbert, 1995). This is as expected because *Campylobacter* is killed at normal cooking temperatures. Contamination of cooked products could be a result of undercooking, but is more likely to be due to cross-contamination between cooked and raw products or contaminated contact surfaces, or direct contamination by an infected food handler.

*C. jejuni* on poultry carcasses appear to be highly susceptible to freezing. Investigations suggest that commercial freezing substantially reduces *Campylobacter* contamination of chickens (Gill and Harris, 1984; Hassell, 1994). A study on broiler carcasses obtained from 21 retail outlets in New Zealand showed that *C. jejuni* was isolated in 68% of chilled carcasses and only 16% of

frozen carcasses, maximum numbers being $10^5$ and $10^3$ cfu/carcass, respectively (Gill and Harris,1984). A more recent survey of poultry in the New Zealand retail market did not detect any positive isolates from frozen poultry (Campbell and Gilbert, 1995).

### *Clostridium perfringens*

*Clostridium perfringens* is a spore-forming anaerobe that commonly inhabits the lower intestinal tract of both chickens and humans (NACMCF, 1997). Low levels of the microorganism are typically found on the surface of a large percentage of broilers and other poultry (Lillard, 1971). Its spores are more resistant than vegetative cells and are unaffected by the processes associated with poultry slaughter, such as scalding. *C. perfringens* has been found in high frequencies (31-77%) on different parts of the carcass (i.e. feet , feathers, caecum, vent area, and neck skin ) and the scald tank (Lillard, 1971). Prevalence of the organism in broiler carcasses in the United States has been reported to be approximately 43% (USDA FSIS, 1996a). The prevalence of *C. perfringens* in New Zealand flocks is presently unknown.

Because *C. perfringens* gastroenteritis is only associated with consumption of high levels of vegetative cells ($\geq 10^6$ cfu/g), raw poultry would require substantial temperature abuse (> 15°C) to result in spore germination and outgrowth. *C. perfringen* outbreaks have been commonly associated with improper cooling, improper hot holding, inadequate reheating of cooked products (Bryan, 1980; Bean *et al*., 1997), but not temperature abuse of raw chicken (NACMCF, 1997). A US survey of cooked products found 2.6% of 118 samples positive for *C. perfringens* (Lillard, 1971).

### *Staphylococcus aureus*

*Staphylococcus aureus* is part of the microflora of chickens, commonly associated with bruised or infected tissue, nasal passages, skin surfaces, and arthritic joints (Mead and Dodd, 1990; NACMCF, 1997). Low levels of *S. aureus* are commonly found on the surface of poultry and throughout poultry processing premises (Thompson *et al*., 1980; Noterman *et al*., 1982; Mead and Dodd, 1990). Typically, these are poultry-associated strains which can be differentiated from human isolates (Gibbs *et al*., 1978a,b). Poultry strains do not seem to be important in the aetiology of poultry product-associated staphylococcal intoxications and may be considered as unimportant in terms of food safety (Isigidi *et al*., 1992). Instead, most staphylococcal outbreaks appear to be related to contamination of cooked products by infected food handlers followed by improper holding temperatures (Bryan, 1980).

Prevalence of *S. aureus* in broiler carcasses in the United States was found to be 64% based on a nationwide baseline survey (USDA FSIS, 1996a). The survey did not identify whether the isolates were poultry-associated strains or human strains.

A New Zealand survey found *S. aureus* to be present in 3.6% of 48 ready-to-eat poultry product samples tested with 7 samples (0.5%) found to contain excessive numbers (Campbell and Gilbert, 1995).

### *Listeria monocytogenes*

Several studies indicate that that *Listeria monocytogenes* infrequently enters the processing plant on live broilers (Genigeorgis *et al*. 1989; Hudson and Mead, 1989; Bolder *et al*., 1991a; Cox *et al*., 1997). The slaughter and processing environments appear to be the primary source for *L. monocytogenes* (Hudson and Mead, 1989; Bolder et al., 1991a) though it is likely that the original source of the microorganism is contamination of the equipment or environment with faeces or ingesta (Hudson and Mead, 1989). The organism appears to take up residence in the plant, leading to cross-contamination during processing.

Hudson and Mead (1989) did not detect *L. monocytogenes* on neck skin from freshly killed birds (i.e. before scalding) or the caeca during evisceration, but the organism was isolated from 50% of carcasses prior to packaging. Similarly, Bolder *et al*. (1991a) did not detect the organism from 120 samples of caecal contents but found low levels of the organism on skin samples after chilling. Genigeorgis *et al*. (1989) did not isolate the organism from feathers of the broilers at arrival at the slaughterplant. They reported that the prevalence of *L. monocytogenes* increased from 10 to 36.4% and then to 45.5% as the chicken carcasses and parts moved through hanging after chilling, cutting, and then packaging, respectively. A more recent study (Cox *et al*., 1997) confirmed the findings of earlier investigations. *L. monocytogenes* was found on only 1 of 115 whole bird rinses and none of the 115 caeca were contaminated upon entering the processing plant. After processing, 27 of 105 carcasses (25.7%) were found to be positive for *L. monocytogenes*.

A high prevalence of *L. monocytogenes* has been found in poultry slaughter plants, not only on the product, but also both on the tools and the workers (Genigeorgis *et al*.,1989). Hudson and Mead (1989) observed that the processing equipment that was consistently contaminated with *L. monocytogenes* was the automatic venting machine. They suggested that the frequent contamination of the venting machine was likely due to the presence of *Listeria* in the gut content of some birds, having originated from contaminated feed (Skovgaard and Morgen, 1988).

The results of these studies indicate that the common occurrence of *Listeria* on finished carcasses could be directly attributable to contamination of processing equipment and the inevitable problem of cross-contamination.

*L. monocytogenes* is a common contaminant of poultry products worldwide, with isolation rates from raw carcasses ranging from 15 to 60% (Bailey *et al*., 1989; Genigeorgis *et al*., 1989; Hudson and Mead, 1989; Varabioff, 1990, Ryser and Marth, 1991, Rocourt and Cossart, 1997). However, the populations of *L. monocytogenes* present in raw or processed meat products are usually low, with 80 to 90% of samples containing < 10 to 100 CFU/g (Rocourt and Cossart, 1997). For example, the organism was recovered from 15% of the 1297 broiler carcasses analysed (samples collected at the drip line after chilling) in a US baseline survey (USDA FSIS, 1996a). The organism was detected in very low numbers with all positive samples having < 100 mpn/$cm^2$ and 99% < 10 mpn/$cm^2$. Currently, there are no data available on the prevalence of *L. monocytogenes* on raw poultry products processed in New Zealand.

Bolder *et al*. (1991a) concluded from their findings that the level of *L. monocytogenes*

contamination on the skin of broiler carcasses immediately after chilling is very low and will be no direct threat to public heath. They came to a similar conclusion for poultry products held at 4°C (Bolder *et al*., 1991b). There is no evidence that multiplication of *L. monocytogenes* on raw poultry during storage is a factor in human listeriosis (ICMSF, 1998). Case control studies, however, suggest that undercooking raw poultry is involved in human listeriosis among individuals susceptible to listeriosis (Schwartz *et al*., 1988).

### *Escherichia coli* O157:H7

*Escherichia coli* O157:H7 is not commonly associated with chicken products. The organism was not recovered from any of the 1297 broiler carcasses analysed in a US nationwide baseline survey (USDA FSIS, 1996a). Currently, there are no data available on the prevalence of *E. coli* O157:H7 on raw poultry products processed in New Zealand.

### *Yersinia* spp.

*Yersinia pseudotuberculosis* is endemic in wild birds but is rare in New Zealand poultry (Black, 1997).

## 2.2 Edible offal

Localised pathological abnormalities may occur sporadically in internal organs of chicken. There are, currently, no national data available on the pathology of broilers in New Zealand. However, anecdotal evidence from industry suggests that pathological abnormalities are rarely observed on internal organs of broilers grown under a whole flock health scheme.

The different processing operations during slaughter and dressing contaminate the internal organs such that the same pathogens found on chicken carcasses and products are commonly isolated on chicken edible offal. Studies show that edible offal which had been through standard processing, water flumed, and batch ice chilled were found to be positive for *Salmonella* and *S. aureus* (Charoenpong and Chen, 1979; Cox *et al*., 1983). Isolation rates of *C. jejuni* for hearts and livers were reported to be 57% and 69%, respectively (Wempe *et al*., 1983). A later study found higher isolation rates for hearts and livers at 66.7% and 97%, respectively (Genigeorgis *et al*., 1986). A case-control study on campylobacteriosis in New Zealand showed that consumption of chicken liver one or more times a month was associated with the disease (Eberhart-Phillips *et al*., 1995). A US study found *L. monocytogenes* to be present in 33% of packaged livers at the end of the processing line (Genigeorgis *et al*., 1989).

In New Zealand, there is a particular concern in relation to chicken livers, which may contain very high numbers of bacteria, since common cooking practices involve minimal cooking (Hassell, 1994).

## 3. Chemical Hazards

Chemical hazards that could be present in chicken carcasses and edible offal include agricultural chemicals (i.e. pesticides, herbicides, veterinary drugs) and environmental contaminants (i.e. heavy metals, organochlorine compounds). Most control measures for addressing potential hazards associated with chemical residues are applied on-farm under the Whole Flock Health Scheme. New Zealand MAF maintains a Broiler Chemical Residue Monitoring Programme that monitors the residue status of birds slaughtered for human consumption. The results of this monitoring programme are published in *Surveillance*. The monitoring results for the two years that have been completed are summarised below.

In both 1998 and 1999, just over 6,000 analyses for various chemical residues were performed on samples of randomly selected broilers taken from processing plants nationally. No hormonal growth promotants, organophosphates, synthetic pyrethroids, or herbicides were found in either year. No mycotoxins were found in 1998 and this was not tested for in 1999. Residues below the tolerance level were detected for insecticides (2/600 samples in both years), heavy metals (25/25 samples in both years), fungicides (0/960 samples in 1998 and 2/960 samples in 1999), DDT and its metabolites (14/180 samples in 1998 and 57/180 samples in 1999) and nicarbazin (14/60 samples in both years). In 1998 there were also 4 nicarbazin samples over the tolerance level and in 1999 this number had increased to 8 although the levels detected were at approximately half the concentration found the previous year. 1 mercury sample was over the tolerance level in 1999. A traceback found that the mercury problem was due to high mercury levels in some fish meal. Tracebacks on the nicarbazin results found that the problems were mainly due to cross contamination of the broiler feed, or birds having access to starter feed containing nicarbazin during the withdrawal period. Acceptable corrective action was taken by the relevant companies to address these problems (MAF Food Assurance Authority, 1999; MAF Food Assurance Authority, 2000).

## 4. Physical Hazards

Based on a survey of New Zealand poultry processors, foreign objects such as feathers, feed material, human hair, packaging material (e.g. plastic), and metal have been found on raw poultry products at low frequencies and levels. Bone in deboned products is a more common problem. Not all of these foreign objects can be considered as physical hazards because some of them are not related to food safety. Metal and bone pose the biggest food safety concern because they can cause injury such as cuts, broken teeth, choking (Rhodehamel, 1992), and intestinal perforation (Gunn, 1966). Poultry processors should implement a preventive programme for physical contamination and should consider installing a metal detection system, if levels of metal hazards deem it necessary.

# 5. Key Process Steps: Hazards and Potential Impact on Existing Microbiological Hazards

Several reviews have been published about the microbiological aspects of poultry processing (Bailey *et al*., 1987; Bremner and Johnston, 1996; NACMCF, 1997; Bolder, 1998; ICMSF, 1998).

There are three main mechanisms that have been proposed to account for the attachment of bacteria on poultry carcasses (NACMSF, 1997). "Retention" occurs when carcasses come into contact with water containing bacteria. A film of water is retained on the carcass surface. Rinsing carcasses with water having a lower microbial population will reduce the microbial population that is retained on the carcasses. Estimates indicate that bacterial numbers on carcasses can be reduced by 90% through the use of water sprays at several selected points in processing (Thomas *et al*., 1987). "Entrapment" occurs when exposed tissue surfaces (e.g. skin, collagenous connective tissue layers of muscle) absorb water and begin to swell. Swelling exposes deep channels and crevices into which bacteria can penetrate and become entrapped (Thomas and McMeekin, 1980; 1984; Lillard, 1988, 1989b; Benedict *et al*., 1991). Entrapped bacteria cannot be removed by carcass sprays and they would also be protected to some degree from chemicals used for decontamination. With the passage of time, bacteria that are initially retained in the surface film of water may eventually become entrapped (Lillard, 1989b). "Adhesion" occurs when microorganisms adhere to surface tissues. Only certain bacteria are capable of adhesion (e.g. some strains of salmonellae). Adhesion preferentially occurs on the fascia or loose connective tissue that is under the skin and covers muscle. While all three mechanisms likely occur, the relative significance of each is uncertain (Thomas *et al*., 1987). The efficacy of different decontamination methods will be influenced by the proportion of the population which is retained, entrapped or adhered.

Bacteria are firmly attached to carcasses before processing is initiated, i.e. broilers arrive at the premises with aerobic bacteria and *Enterobacteriaceae* firmly attached to the skin (Lillard , 1989a). If incoming flocks are surface contaminated with *Salmonella* before they are processed, it is unlikely that *Salmonella*-free carcasses can be produced because once salmonellae attach to the broiler skin, it is extremely difficult to eliminate or control these microorganisms in the processing premises. Therefore, in order to process a *Salmonella*-free carcass, it seems essential to produce a *Salmonella*-free bird (Lillard, 1989b). The same can probably be said for *Campylobacter*. Although complete elimination of these pathogens on poultry carcasses is unlikely under normal processing conditions, it is possible to minimise cross-contamination in the premises, and therefore *Salmonella* and *Campylobacter* incidence. Processing seems to improve the overall quality of the carcasses with the levels of aerobes and *Enterobacteriaceae* lower at each progressive step in processing from the bleed line to the chiller (Lillard, 1989a;1990; Stals, 1996). However, cross-contamination may still occur (Morris and Wells, 1970; Lillard, 1990).

## 5.1 Scalding

Scalding is a process by which the bird is subjected to moist heat for a short time to facilitate the removal of feathers. Although there are a number of potential means for scalding, most broilers

in New Zealand are processed by immersion scalding using a single or two-stage scalder. Two types of scalding are differentiated based on processing temperatures; soft scalds (≤55°C) and hard scalds (> 55°C). Broilers are primarily hard scalded in New Zealand at temperatures of around 56 to 62°C for up to 3 minutes.

When the birds are immersed in the scalding tank, some of the dirt, faecal material, and other contaminants on the surface of the bird are removed and contaminate the scald water. After an initial increase, bacterial counts of scald water remain relatively constant throughout the processing day (Mulder and Veerkamp, 1974). Bacterial loads of scald water at different temperatures can range from $10^4$ to $10^6$ cfu/ml (Mulder and Dorresteijn, 1977). *C. perfringen* (Lillard,1971), *C. jejuni* (Wempe *et al*., 1983; Genigeorgis *et al*., 1986) and low levels of *S. aureus* can be routinely isolated from scald water, but *Salmonella* is rarely isolated (Bailey *et al*., 1987).

Scalding can serve as a means for cross-contamination. There is opportunity for bacteria to be transferred from one carcass to another via the scald water but it is highly unlikely to result in significant differences in either the nature or degree of contamination of the external surfaces among birds (Bailey *et al*., 1987). Contamination of the skin, in particular, apparently does not increase during immersion scalding. Scalding appears to have little significance relative to the incidence of level of *C. jejuni* contamination on the final carcass (Wempe *et al*., 1983; Genigeorgis *et al*., 1986).

Some investigators report that the major objection to immersion scalding is the possible inspiration of contaminated scald water by the birds, with subsequent contamination of air sacs, lungs, and possibly other internal organs and edible tissues by pathogenic bacteria (Bailey *et al*., 1987; Lillard, 1971). The degree of such contamination is less when slaughter is by the Kosher cut (trachea severed), if birds are electrically stunned, and when bleeding time prior to scalding is 2 minutes or more (Thomson and Kotula, 1959; Tarver and May, 1963a,b). Inspiration of contaminated water by birds is not considered to be a problem in New Zealand premises since most processors electrically stun the birds and bleeding time prior to scalding is generally greater than 2 minutes.

Hard scalding at about 58-60°C and above, followed by mechanical plucking, results in removal of the outer epidermal layer (cuticle) of the bird's skin, whereas scalding at 52-53°C does not (Bailey *et al*., 1987). The cuticle-free and slightly denatured skin of hard-scalded broilers apparently serves as a more suitable substrate for bacterial attachment (Kim *et al*., 1993). Studies have shown that *Salmonella* counts (Kim *et al*., 1993) and *Campylobacter* counts are 1.1 to 1.3 logs higher on carcasses scalded at 60°C than those scalded at 52 or 56°C (Slavik *et al*., 1995).

There is theoretical and experimental evidence that temperatures of about 60°C are more effective in reducing numbers of bacteria in scald water than lower temperatures. However, it has not been clearly established that any difference in bacterial level at this point in the processing line results in a significantly lower incidence of pathogen-contaminated carcasses at the end of the line. The bulk of the evidence suggests that other processes, e.g. defeathering, evisceration, and chilling, are of greater importance than scalding in cross-contamination of

carcasses (Bailey *et al*., 1987).

Counter current scalders and multi-stage scalders generally have a greater impact on reducing levels of microorganisms on the carcass (Bolder, 1998). Multi-tank systems have been shown to reduce both the total aerobic and the enterobacterial counts (Stals, 1996). This is because each time a bird is dipped into the scald water, some 70% of the bacteria attached to the feathers and skin are washed off. This results in lower bacteria numbers both on the bird, and in the scald water, in each successive bath. Typical reductions in a four bath system compared with a conventional scalder are approximately 0.9 log units for the total aerobic count and 1.0 log units for enterobacteria per gram of breast skin (Stals, 1996).

## 5.2 Defeathering

Defeathering has been identified as a major site of cross-contamination for poultry carcasses including pathogens, such as *Campylobacter* and *Salmonella*, and indicator organisms such as *E. coli (*Mulder *et al*., 1978; Wempe *et al*., 1983; NACMCF, 1997). The process removes feathers, dirt and large numbers of bacteria from individual carcasses but creates aerosols that spread bacteria, water and solid matter, contaminating other carcasses and equipment (Tinker *et al*., 1996). In addition to this, carcasses may become contaminated during defeathering with microorganisms which have colonised the machinery such as *Staphylococcus aureus* (Mead and Dodd, 1990; Meat *et al*., 1993). This is associated with the rubber fingers used to remove the feathers, because the microorganism becomes established in cracks in the rubber fingers. Further, the extraction of the feather from the follicle can lead to deep entrapment of bacteria which are difficult if not impossible to remove during later processing steps.

Defeathering can result in a reduction on carcass contamination by 1000-fold (Hinton *et al*., 1996). The extent of cross-contamination is affected, in part, by the distance of the carcass sampled from the inoculated 'seeder' bird and the number of uninoculated carcasses between the two. Mead *et al.* (1975) found that mechanical plucking led to cross-contamination of at least the 200th bird following two carcasses that had been inoculated with the 'marker' organism.

More cross-contamination occurs during scalding and defeathering when lower scalding temperatures (52-54 °C) are used than when a higher scalding temperature (60 °C) is used (Mulder *et al*, 1978).

Recent studies suggest that cross-contamination could be reduced considerably if carcasses were defeathered in separate compartments, possibly on a carousel (Hinton *et al*., 1996). The effect of using chlorinated water on the level of cross-contamination during defeathering is not clear. Hinton *et al*. (1996) noted a reduction in cross-contamination with the use of cold, chlorinated water, however, Mead *et al*. (1975) found that the addition of 20 mg/l chlorine in the spray water had no effect.

Although the defeathering process is generally regarded as a major cause of carcass contamination, it is not usually considered as a critical control point because it is assumed that little can be done to improve the situation. This is likely to be true for New Zealand processors considering existing defeathering systems.

## 5.3 Evisceration

Evisceration can be a major source of faecal contamination on carcasses and edible offal, particularly if the intestines are cut or broken (NACMCF, 1997). This is likely to result in an increase in contamination by mesophilic bacteria, including intestinal pathogens such as *Salmonella*, *Campylobacter*, *Clostridium perfringens,* and *Listeria*.

In New Zealand, evisceration is carried out manually in the small processing premises, whereas large premises use automatic equipment involving several different machines, each dealing with a specific operation. Either approach can result in clean removal of parts, or may lead to extensive gut breakage and the spread of faecal material.

Successful evisceration relies heavily on the accuracy of vent opening and cutting (Bremner and Johnston, 1996). Some of the machinery in current use cause a significant degree of damage to the intestines, because the carcasses vary in size and the equipment is not automatically adjustable. Traditional venting techniques can cause considerable damage to the intestines with incidences of 80-90% being typical (Stals, 1996). Information from New Zealand processors indicate that incidence of gut breakage for mechanical evisceration systems range from 5- 40%. This is largely due to venting machines not being automatically adjustable to accommodate the varying sizes of the birds and partly due to inadequate feed withdrawal. Such high incidence levels of faecal contamination is of major concern to processors but it is claimed that little can be done to improve the situation without changing to new improved machines.

The new evisceration systems are reported to be capable of reducing faecal contamination of both carcasses and organs and hence the spread of foodborne enteric pathogens (Bremner and Johnston, 1996; Stals, 1996). With the new systems, after carefully controlled opening of the abdomen, the viscera is removed and transferred to a separate processing line, which runs parallel to that carrying the carcasses and at the same speed, so that carcasses and organs can be correlated for inspection purposes. In this system, contact between carcasses and exposed viscera is eliminated, while hearts, lungs and livers are removed automatically, without the need for manual handling.

Operator skill is the major factor that influences the levels of gut breakage in smaller processing premises where evisceration is carried out manually. Manual evisceration results in 1- 5% incidence of gut breakage which is largely attributed to operator error and inadequate feed withdrawal.

Inadequate feed withdrawal is an important contributing factor to contamination during evisceration since full crops and intestinal tracts greatly increase the risk of gut breakage. Significantly higher aerobic counts and coliform counts on carcasses are observed when feed is not withdrawn prior to processing (Izat *et al*., 1989). Some investigators recommend that feed be withdrawn eight to twelve hours before the planned slaughter time processing (Rigby and Pettit, 1981; Stals, 1996). A recent study, however, suggests that shorter feed withdrawal periods may be more advantageous in terms of reducing bacteria in the crop and the caeca. Information from New Zealand processors indicate that 1- 5% of birds are presented for slaughter with full

crops.

The faecal contamination of broiler carcasses during evisceration results in an increase in contamination with *Enterobacteriaceae*, including *Salmonella* present (Morris and Wells, 1970; Noterman *et al*., 1980). This increase can be prevented by spray-cleaning carcasses during the various stages of evisceration (Noterman *et al*., 1980). If the carcasses are cleaned only at the end of the evisceration process, the numbers of *Enterobacteriaceae* are not reduced to initial levels and *Salmonella* contamination is less efficiently removed.

The evisceration equipment can be a major source of cross-contamination (Hudson and Mead, 1989). Continuous rinsing of equipment with chlorinated water helps to minimise cross-contamination (NACMCF, 1997).

## 5.4 Crop removal

It is generally thought that *Salmonella* contamination of carcasses during processing originates from bacteria that have colonised the bird's caeca or intestinal tract. However, recent studies indicate that the crop is also a potential source of *Salmonella* (Ramirez *et al*., 1997; Hargis *et al*., 1995) and *Campylobacter* contamination during processing (Byrd *et al*., 1998).

Hargis *et al*. (1995) found higher incidence of *Salmonella*-contaminated crops (52%) compared with the caeca (15%) of commercially processed broilers. They also observed that crops were much more likely to rupture during processing than were caeca, increasing the potential likelihood of carcass contamination. A field trial later conducted by the same authors showed that the incidence of *Salmonella*-positive crops was 36% following an eight hour feed withdrawal period as compared with 19% in samples obtained prior to withdrawal at the broiler house.

Similar results were obtained for *Campylobacter* contamination of the crop (Byrd *et al*., 1998). The total number of *Campylobacter*-positive crops increased significantly from 25% before feed withdrawal to 62.4% after the feed withdrawal period of five to eight hours. Contamination of the caeca after the feed withdrawal period was 3.8%.

The increase in contamination of the crop has been partly attributed to the birds consuming litter and faecal droppings during the withdrawal period (Byrd *et al*., 1998). It has also been suggested that the change in the chemical and microbiological properties of the gut during feed withdrawal contribute to a more suitable environment for the potential survival and subsequent growth of Enterobacteriaceae such as *Salmonella* (Hinton *et al*., 1998). After 6 hours of feed withdrawal, crop pH was observed to increase to 6.6, which is more conducive for growth of pathogenic bacteria. Caeca from broilers held off feed 12 hours instead of 6 hours had over 100 times more pathogenic bacteria (Hinton *et al*., 1998).

Although it appears that extended feed withdrawal times may contribute to an increased number of pathogens in the digestive tract of the birds at time of processing, New Zealand industry representatives still consider it important to impose a feed withdrawal period to reduce the incidence of gut breakage during evisceration. The studies of Hargis *et al*. (1995) and Byrd *et al*. (1998) indicate that more focus is necessary in ensuring the intact removal of the crop

particularly when feed withdrawal of birds is practised.

## 5.5 Washing

In New Zealand, carcasses are spray washed after defeathering and after evisceration. Some premises also have a final inside/outside wash before immersion chilling. Several premises use 20 to 100 ppm chlorinated water for washing.

Spray washing or other forms of rinsing are used to remove organic material and some of the microorganism that may have been acquired during defeathering and evisceration. This step helps reduce bacterial levels on carcasses (Bremner and Johnston, 1996). Immediate spray washing has been demonstrated to be as effective as trimming for removal of faecal contamination acquired during evisceration (Blankenship *et al*., 1975; 1993). The sprays can decrease the aerobic plate count, Enterobacteriaceae and coliforms by 50 to 90% (Sanders and Blackshear, 1971; May 1974; Mulder and Veerkamp, 1974; Thomas *et al*., 1987; CFIA, 1997). The incidence of salmonellae can also be decreased by immediate spray washing (Morris and Wells, 1970; ICMSF, 1998). ). The Canadian standard requires that spray washing of carcasses occur within fifteen seconds after defeathering and after carcass transfer (rehang) in order to reduce the attachment of *Salmonella* and other bacteria to the skin (CFIA, 1999). Frequent multiple sprays from bleeding to chilling are more effective in reducing bacterial levels than a single final wash (Noterman *et al*., 1980; Mulder, 1985).

The cleaning process before immersion chilling also ensures that high numbers of organisms are not introduced into the chill water. A high organic load at the start of chilling reduces the activity of chlorine against bacteria (Mead and Thomas, 1973).
Lower bacterial numbers on carcasses can be achieved when chlorine is added to the spray water (Sanders and Blackshear, 1971). Chlorinated water sprays used to rinse chicken carcasses at the end of the evisceration line do not reduce the number of *Salmonella*-positive carcasses, indicating that *Salmonella* already on the carcass is not accessible to the chlorine (James *et al*., 1992). Studies show that once *Salmonella* becomes firmly attached to the muscle or carcass surface through entrapment or specific binding mechanisms, they resist removal by normal processing methods such as rinsing or washing (Lillard, 1989a; Benedict *et al*., 1991).

Immediate and effective washing after a contamination step provides an opportunity for the reduction of microbiological contaminants on carcasses. Effectiveness of washing is dependent on water volume and pressure, spray patterns and bactericide levels (NACMCF, 1997).

## 5.6 Chilling

PIPS 5 recommends that an internal carcass temperature of 4°C or lower should be reached within 24 hours of dressing. This is achieved in New Zealand premises by immersion chilling or a combination of immersion chilling and “wet” air chilling. “Wet” air chilling involves the chilling of wet birds in containers (i.e. not hanging) using blast air chillers.

### *Immersion chilling of carcasses*

Broilers are cooled by immersion in slush ice or chilled water in continuous mechanically agitated chillers. Immersion chilling generally takes 25 to 50 minutes in New Zealand premises to achieve a carcass temperature of 2 to 7°C. Chlorinated water is commonly used at concentrations of 20 to 90 ppm.

Studies show that properly maintained and operated immersion chillers can reduce the overall bacterial levels on poultry carcasses. However, immersion chilling has been found to be a major area of cross-contamination with *C.jejuni* (Wempe *et al*., 1983), *Salmonella* (Morris and Wells, 1970; Lillard, 1990) and *C. perfringens* (Lillard, 1971).

Important factors that have an influence on microbial counts of immersion chilled poultry are (1) bacterial contamination on carcasses before chilling, (2) the amount of water overflowed and replaced per carcass, (3) the ratio of birds to water in the chiller and (4) and the use of bactericides such as chlorine (Bailey *et al*., 1987). These factors contribute to differences found by various investigators.

The use of chlorine under optimal conditions can facilitate the hygienic operation of commercial water-chilling systems. May (1974) observed that continuous immersion chilling with 18-25 ppm chlorine significantly reduced both total and psychrophilic bacterial counts. Mead and Thomas (1973) found that majority of bacteria present were destroyed by the use of 45 to 50 ppm of total chlorine in conjunction with 5 litres of water per carcass. The use of 25 to 30 ppm of residual chlorine in the chill water gave comparable results when the water usage was increased to 8 litres per carcass. Another study showed that total aerobic counts for chiller water and chilled carcasses were significantly lower when chiller water was treated with chlorine and chlorine dioxide than when chiller water was untreated (Lillard, 1980). Mead *et al*. (1996) also found that the use of chlorine was effective in reducing cross-contamination with an *E.coli* marker organism. Morrison and Fleet (1985) reported that *Salmonella* was eliminated from carcasses with a chlorine concentration of 300-400 ppm .

Although there seems to be general agreement that immersion chilling results in a reduction in total bacterial counts on carcasses, the same effect on *Salmonella* levels on carcasses is not always observed. Several studies show that when bactericides are used in processing water, *Salmonellae* are reduced to nondetectable levels in the water, but only small (< 1 log) or no reductions are obtained on chicken carcasses (Lillard, 1980; Lillard and Thomson, 1983; Lillard *et al*., 1987). This is probably due to bacteria being entrapped in the crevices in the skin formed during water immersion (Lillard, 1988). These entrapped bacteria seem to be protected from outside influences, such as bactericides and other chemicals in solution.

Lillard's studies (Lillard, 1990) show that there is a significant improvement in the microbiological quality of broiler carcass, as determined by aerobic bacteria and *Enterobacteriaceae*, as they advance through the processing line. From the bleed line to the chiller, levels of aerobic bacteria are reduced by 3.3 logs, and *Enterobacteriaceae* by 2.6 logs. However, a significant increase in *Salmonella* incidence for carcasses occurs only after immersion chilling (without chlorine), suggesting that this process is more conducive to cross-

contamination than other processing points. The same author claims that it is possible to reduce *Salmonella* incidence due to cross-contamination in immersion chillers (Lillard, 1980) by the use of 34 ppm chlorine or 5 ppm chlorine dioxide which results in reduced *Salmonellae* in chiller water to non-detectable levels, and in significant reductions (10-13%) in incidence of *Salmonella*. Even at this chlorination level, 1 to 4.5 % of carcasses remained positive for *Salmonella*. These results may be due to salmonellae being firmly attached and/or protected in skin crevices that are, therefore, inaccessible to bactericides.

A USDA study done in Puerto Rico investigated the effect of adding chlorine to chill water (25 ppm in intake water which resulted in residual overflow of 4 to 9 ppm) (James *et al*., 1992). Carcasses were found to have average aerobe plate counts of $\log_{10}$ 3.20 before chilling and 2.51 after chilling; Enterobacteriaceae counts of $\log_{10}$ 2.57 before chilling and 1.75 after chilling; and *E. coli* counts of $\log_{10}$ 2.04 before chilling and 1.20 after chilling. *Salmonella* was found on 43% of the carcasses before chilling and on 46% after chilling (James *et al*., 1992). Without chlorination *Salmonella* prevalence was observed to increase from 48% before chilling to 72% after chilling.

The findings of most studies indicate that there is a potential for cross-contamination to occur during immersion chilling, but with proper equipment, adequate water replacement, temperature control and the use of bactericides it is commercially possible to reduce total bacterial counts on carcasses and reduce cross-contamination of pathogens.

### *Immersion chilling of edible offal*

A US study found that immersion chilling with chlorinated water resulted in reduction of overall microbiological levels and *Salmonella* prevalence on edible offal packs (James *et al*., 1992). For edible offal chilled with no chlorination, mean $\log_{10}$ cfu per pack was found to be 3.72, 2.90, and 1.14 for aerobes, Enterobacteriaceae, and *E. coli*, respectively. Prevalence of *Salmonella*-positive packs was 69%. Packs chilled with chlorination (25 ppm in inlet water), had lower mean $\log_{10}$ cfu per pack at 3.49, 2.57, and 1.06 for aerobes, Enterobacteriaceae, and *E. coli*, respectively. Prevalence of *Salmonella*-positive packs was significantly lower at 12%.

### *Dry air chilling of carcasses*

Spray chilling and dry air chilling (i.e. birds are hanging) have been suggested as alternative methods to immersion chilling to prevent cross-contamination. These methods of chilling poultry carcasses are not currently practised in New Zealand.

Various combinations of time, temperature and humidity are used for air chilling. Dry air chilling dehydrates skin. Although this might be expected to retard microbial growth, this benefit may not be realised due to rehydration of carcass surfaces after packaging (Grey and Mead, 1986). Berner *et al.* (1969) found significantly lower bacteria counts on air-chilled than on water immersion-chilled carcasses immediately after chilling and during storage up to 32 days at -1°C. Other studies, however, show that bacterial numbers on airchilled carcasses are sometimes higher than those on water chilled carcasses (Mead, 1975; Thomson *et al.*, 1975).

### *Country requirements for chilling*

The minimum requirements for chilling recommended or mandated by some countries are summarised below.

| Country Standard | Requirements |
|---|---|
| New Zealand Poultry Industry Processing Standard 5 (PIPS 5, 1998) | Immersion chilling of carcasses:<br>• Water flow should be counter to the flow of carcasses.<br>• Recommended minimum make-up water for different carcass weights are specified.<br>Chilling:<br>• Carcass internal temperature of 4°C should be reached within 24 hours of dressing.<br>• Giblets must be continuously chilled to 4°C or cooler after their removal from the viscera. |
| Australian Standard 4465 (1997) | Immersion chilling of carcasses:<br>• Water flow must be counter to the flow of carcasses<br>• Water temperature must not be more than 4°C<br>• Water must be chlorinated or contain a chemical sanitiser approved for food contact.<br>Chilling:<br>• Whole carcasses shall be chilled to a surface temperature of not more than 7°C within 6 hours of slaughter<br>• Whole carcasses and/or deboned meat must be further reduced to a core temperature of not more than 5°C within 12 hours of slaughter.<br>• Giblets must be chilled to 5°C or below within one hour of their removal from the viscera. |
| EEC Council Directive 92/116/EEC (amendment and update of Directive 71/118/EEC)<br><br>*Available at* http://www.europa.eu.int/eur-lex/en/lif/reg (Under Legislation in Force) | Immersion chilling of carcasses<br>• Water flow must be counter to the flow of carcasses.<br>• Minimum make-up water for different carcass weights are specified.<br>• Water temperature in the tank or tanks measured at the points of entry and exit of the carcasses must not be more than 16°C and 4°C, respectively.<br>• Carcasses must not remain in the first tank for more than half an hour or in the other tank(s) for longer than is strictly necessary. |

| Country Standard | Requirements |
|---|---|
| | Chilling<br>• Carcasses must be chilled to 4°C as soon as possible. |
| Canadian Food Inspection Agency: Meat Hygiene Manual of Procedures (Sections 4.5.3 and 4.10.1)<br><br>*Available at:*<br>http://www.cfia-acia.agr.ca | Immersion chilling of carcasses<br>• Temperature at the warmest section of the chilling system must not exceed 18°C.<br>• Minimum make-up water for different carcass weights are specified.<br>• 20-50 ppm chlorine is suggested to be added to make-up water line such that a total available chlorine residual of 1-5 ppm is maintained in the chiller overflow water.<br>Chilling<br>• All poultry carcasses and portions must be chilled to an internal temperature of 4°C or lower.<br>• Giblets should be chilled to 4°C or lower within two hours after evisceration. |
| US Code of Federal Regulations: Title 9 Part 381.<br><br>*Available at:*<br>http://www.access.gpo.gov/nara/cfr | Immersion chilling of carcasses<br>• Temperature of the chilling media in the warmest part of the chilling system must not exceed 65°F (approx. 18°C).<br>• Minimum make-up water of a half gallon (? L) per carcass.<br><br>Chilling<br>• All poultry carcasses must be chilled immediately after processing so that the internal temperature is reduced to 40 °F (approx. 4°C) or less within specified times for different carcass weights (e.g. 4 hours for carcasses under 1.8 kg).<br>• Giblets must be chilled to 40°F (approx. 4°C) or lower within two hours from the time they are removed from the inedible viscera. |

## 5.7 Portioning and deboning

### *Microorganisms*

The biological hazard associated with portioning and deboning relates to the redistribution of pathogenic bacteria that are present on the incoming carcasses and the transfer of microorganisms from the work environment.

Poultry boning operations have been shown to result in an increase in bacterial numbers (Brant and Guion, 1972; Denton and Gardner, 1981). Cutting boards, boning tables, conveyors, knives, hands and clothing of personnel have all been implicated as vehicles for the transfer of bacteria (May, 1962; Brant and Guion, 1972; Newton *et al*., 1975; 1978; Denton and Gardner, 1981; Holder *et al*., 1996).

Of particular concern is the potential for contamination of products with *Listeria monocytogenes* during portioning and deboning. Hudson and Mead (1989) did not detect *L. monocytogenes* on neck skin from freshly killed birds or the caeca during evisceration, but the organism was isolated from 50% of carcasses prior to packaging. Genigeorgis *et al*. (1989) also reported that the prevalence of *L. monocytogenes* increased from 10 to 36.4% and then to 45.5% as the chicken carcasses and parts moved through hanging after chilling, cutting, and then packaging, respectively. The authors attributed this increase to added handling of the products during the steps.

Transfer and redistribution of bacteria during the portioning and boning operations are expected to be adequately controlled by effective supporting systems (e.g. effective cleaning procedures for equipment, good boning techniques and personnel hygiene). Food contact materials, including knives and gloves, should be washed and sanitised prior to use and at regular intervals during processing.

It is a practice in some premises to hold deboned products in bins while accumulating enough material before transferring to a chiller. Time and temperature conditions should be maintained such that microbiological growth is prevented during this holding period. The minimum growth temperature for *Salmonella* and *E.coli* on meat has been determined to be ≥ 7 °C (Shaw *et al*., 1971; Foster and Mead as cited by Barnes, 1976; Mackey *et al*., 1980; Smith, 1985). Therefore, holding periods should ideally be kept short, and product temperature maintained below 7 °C.

### *Bone*

Higher incidence of bone in deboned products is generally associated with automatic deboning compared with manual deboning. Highly skilled deboners are capable of producing products with minimal levels of bone. Adequate training of deboners, therefore, plays a key role in controlling the levels of bone in manually deboned products.

The level of product inspection for automatically deboned products is largely dictated by customer requirements. It is common practice in New Zealand premises to inspect products and rework those lots that are found to exceed the set limits. In some cases, particularly for

customers with strict requirements, 100% inspection of deboned products is done as an extra step after deboning.

Information from the USDA Food Safety Inspection Service (USDA FSIS, 1996b) indicate that bone particles less than 10 mm are unlikely to pose a food safety hazard. Bone particles from 10 to 20 mm may present a discomfort, but would be a low risk for a food safety hazard, and bone particles greater than 20 mm have the potential to be a food safety hazard and may cause injury to consumers.

## 5.8 Freezing

The extensive research carried out by MIRINZ on microbial growth at sub-freezing temperatures, clearly indicates that meat or meat products stored at product temperatures below -8°C will not support any microbial growth (Winger, 1984). However, if present, some pathogens will survive freezing temperatures.

The different pathogens that could be present on meat and meat products prior to freezing show different sensitivities to freeze damage. Freezing causes damage to *Salmonella*, but it does not guarantee its destruction. *Salmonella* has been detected in products that have been stored frozen for years (ICMSF, 1996). Staphylococci are relatively resistant to freezing temperatures. *E. coli* survives well in frozen food. Vegetative cells of *C. perfringens* are very sensitive to freezing, but its spores are highly resistant to cold. It is therefore important that products are within acceptable microbiological levels prior to freezing.

Campylobacter jejuni is sensitive to freezing. Several studies have shown that *Campylobacter* rapidly become undetectable when poultry or other meat is frozen (Gill and Harris, 1984; Hassell, 1994; Campbell and Gilbert, 1995). A survey of poultry in the New Zealand retail market did not detect any positive isolates from frozen poultry (Campbell and Gilbert, 1995). However, there is now widespread recognition in the scientific community that the methods for detection for *Campylobacter* are inadequate, especially for detection of viable non-culturable cells (e.g. sublethally damaged by refrigeration). Therefore, at this stage, conclusions regarding the epidemiology of *Campylobacter* and possible control measures are questionable.

## 5.9 Cooking

Although the cooking step is outside the scope of this HACCP plan, a brief discussion is given because of the major importance of proper cooking in the destruction of pathogens, such as *Salmonella* and *Campylobacter*, in chicken products.

As discussed in the previous sections, at present, zero tolerance for *Salmonella*, *Campylobacter* and *Listeria monocytogenes* in raw poultry products cannot realistically be achieved. Consequently, implementation of good cooking techniques and good kitchen and personal hygiene during preparation are necessary. The food handler has to use responsible precautions to ensure that the food is properly and safely prepared. The manufacturer also has a role in ensuring that correct food safety information is effectively communicated to users of their products. This may be achieved partly by providing proper handling and cooking instructions on

labels and promotional materials.

The primary method for destroying vegetative pathogens in poultry products is by cooking them to a proper internal temperature. In the United States, regulations require that poultry products be heated to a minimum internal temperature of 160 F (71.1°C) in order for the product to be considered as fully cooked (USDA FSIS Code of Federal Regulations Title 9, Part 381.150). Cooking at this temperature will result in a 7-$\log_{10}$ reduction in *Salmonella*.

The UK Department of Health recommends that to ensure the destruction of *L. monocytogenes*, product must be heated to a minimum of 70°C for 2 min (Gaze *et al*., 1989; UK Department of Health, 1989; Mackey *et al*., 1990).

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