Final Report

Qualitative Risk Assessment to support a policy decision on partially-eviscerated (effilé) poultry production

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1 Executive summary

Partially-eviscerated (also described as effilé, effileé, roped, partly eviscerated, partially drawn, wire drawn or Boston drawn) poultry are produced by removing the intestines from the poultry carcass but leaving the heart, liver, lungs, kidneys, crop, proventriculus and gizzard inside the body cavity (as defined in Regulation (EC) 543/2008). Regulation (EC) 853/2004 allows production of partially-eviscerated poultry, provided it is authorised by the competent authority.

The overall aim of this project was to carry out a risk assessment of partially-eviscerated (effilé) poultry production (poultry with the heart, liver, kidneys, crop, proventriculus and gizzard left inside the body cavity) with a view to considering whether the risks of partially-eviscerated poultry production can be managed to an acceptable level such that the practice could be authorised in the UK.

To achieve this aim the project had four Objectives: Objective 1, an initial risk assessment of the public health implications of allowing partially-eviscerated birds into the food chain together with a review of all relevant and appropriate literature/company information relating to the control of partially-eviscerated poultry production; Objective 2, an industrial survey of current production of partially-eviscerated poultry; Objective 3, a series of short practical evaluations of any processes where further data was required; Objective 4, a full analysis of all the data and findings of Objectives 1 to 3 and the production of the final project report.

The literature review found that documentation on the production of partially-eviscerated poultry was scarce and not comprehensive. However, it highlighted the important points for risk assessment and identified a reason for the development of partial-evisceration processing, i.e. the prevention of “greening” during storage due to the removal of the intestines.

The review of current post-mortem inspection of poultry concluded that of the twenty one conditions that are currently looked for during post-mortem inspection of poultry, the majority of these conditions do not pose a risk to public health. Seven conditions were considered to be of concern to public health (Ascites/oedema, Cellulitis, Contamination, Hepatitis, Pericarditis, Perihepatitis/peritonitis, Respiratory disease (airsacculitis)). It was concluded that only four of those seven conditions (hepatitis, pericarditis, perihepatitis/peritonitis, and respiratory disease (air sacculitis)) may not be identified during post-mortem inspection of partially-eviscerated poultry. Their public health significance was considered to be as indicators of the presence of enteric microbial pathogens rather than any inherent pathology of the conditions. Data on condemnations show that the rates of condemnations for these conditions are very low. In addition, these conditions should be clearly identifiable by the end user of the poultry during preparation of the carcass for cooking. Therefore, in our opinion, it is unlikely that the consumer would ingest such infected viscera.

Four French plants and two UK plants were visited during the industrial survey. Although there was a commonality in the practices employed at all of the plants, differences were found between the plants, particularly in the specific method used to remove the intestines from the carcasses in order to produce the product. Four main methods have been identified that can be used to partially eviscerate poultry, three are manual, one is mechanical. The only UK plant currently producing partially-eviscerated poultry, skinned the whole carcass with its feathers on.

Due to the lack of data on the microbiological quality of partially-eviscerated poultry a series of short targeted experimental evaluations were carried out to: (1) investigate the difference in chilling time between partially-eviscerated and eviscerated broiler carcasses; (2) investigate any difference between the growth of microorganisms on partially-eviscerated and eviscerated broiler carcasses during chilled storage; (3) investigate the growth of microorganisms in the organs of partially-eviscerated broiler carcasses during chilled storage. These studies showed: (1) due to the presence of warm internal organs partially-eviscerated poultry carcasses are warmer than eviscerated carcasses at the start of chilling and the rate of cooling of partially-eviscerated poultry carcasses is slower than that of similar eviscerated carcasses; (2) there was no significant difference between the microbiological quality of partially-eviscerated and eviscerated broiler carcasses after chilling and during chilled storage; (3) ACC, *Pseudomonas*, Enterobacteriaceae, coliform and *Escherichia coli* counts were all shown to be capable of increasing in/on the heart, crop, feet, gizzard, cavity, skin and liver of partially-eviscerated broiler carcasses after chilling and during chilled storage.

A critical review of all available relevant and appropriate literature and data was carried out, supplemented by a survey of current industrial practice and a practical evaluation of processes, to form a risk assessment of the public health implications of allowing partially-eviscerated birds into the food chain. This risk assessment considered:

1. What abnormalities may not be identified in partially-eviscerated poultry production when compared to traditional poultry production;
2. Whether the risk of zoonotic pathogens are any greater for partially-eviscerated poultry production when compared to traditional poultry production;
3. The aetiology of those conditions;
4. The public health implications of those conditions and of allowing partially-eviscerated poultry into the food supply.

Its conclusions, based on the available data, are:

Regarding the first point.

As noted by Löhren (2012), "*most of the abnormalities detected by the post-mortem inspection are more related to quality or animal welfare than veterinary or food safety issues*". The following abnormalities may not be identified in partially-eviscerated poultry and are a current cause of condemnation and are potentially of concern to public health:

1. Hepatitis
2. Pericarditis
3. Perihepatitis/peritonitis
4. Respiratory disease (air sacculitis)

These abnormalities are usually detected by post-mortem inspection of the viscera (specifically the liver in the case of hepatitis and perihepatitis/peritonitis, the heart in the case of pericarditis, and the air sacs in the case of respiratory disease (air sacculitis)). However, their occurrence is very low in comparison with the

prevalence of the main zoonotic pathogens that are associated with poultry meat. Also, their public health significance is as indicators of the presence of enteric microbial pathogens, rather than any inherent pathology of the conditions.

Regarding the second point.

We have found little evidence in the literature to suggest that pathology in birds and associated diseases are of any significant importance compared with enteric pathogens such as *Campylobacter* and *Salmonella* spp. In common with recent reports (EFSA, 2012; Löhren, 2012; Horigan *et al.*, 2013) it can be concluded that main zoonotic pathogenic hazards in partially-eviscerated poultry are:

- *Campylobacter* spp.
- *Salmonella* spp.

Both of these pathogens are recognised as significant risks to public health by the FSA and poultry industry and subject to national control programmes (Campylobacter Risk Management Programme and UK Salmonella National Control Programme (NCP)) to reduce their prevalence in UK poultry flocks. These controls have significantly reduced the prevalence of salmonella in UK flocks in recent years. Birds destined for partially-eviscerated production will be subject to the same controls and benefit from these controls.

These pathogens are associated with faecal contamination and cross-contamination, especially that arising from spillage or rupture of the intestines during removal. Such spillage and rupture often occurs during mechanical evisceration. We have observed that it seldom occurs during the manual or mechanical removal of the intestines in partial-evisceration. In the French plants surveyed, when it does occur such carcasses are diverted and processed as fully eviscerated. Our own studies, carried out as part of this project, show little difference between the general microbiological quality of partially-eviscerated and fully eviscerated poultry.

As noted by Löhren (2012) and the recent EFSA report (2012), neither *Campylobacter* or *Salmonella* spp. can be detected by traditional visual inspection, except by detecting heavily contaminated carcasses. Thus, it may therefore be concluded that detection is no different for partially-eviscerated or traditional production.

Regarding the third point.

Both *Campylobacter* or *Salmonella* spp. are generally associated with faecal contamination deriving from the intestines. In general, most studies and risk assessments have identified the intestines of poultry as a major source of pathogenic hazards, and breakage during evisceration causing faecal contamination as an important risk to public health.

It is clear from the literature that the organs left in the cavity of partly-eviscerated poultry carcasses are likely to harbour *Campylobacter* or *Salmonella* spp., especially the crop and liver. There is no published evidence to suggest that any pathogens present in the organs will diffuse into the muscles of the carcass during storage. No data has been found on the growth or survival of these pathogens in the organs during storage whilst in situ. There is some evidence that the storage life of in situ organs is greater than that of separated organs, this is probably due to the cross-contamination of organs during removal.

The feet have been identified in this project as a potential source of *Campylobacter* or *Salmonella* spp. contamination that is not present with standard fully eviscerated poultry. From our observations the removal of the feet and head (including the crop) from partially-eviscerated poultry could reduce the risk to public health and should be recommended. However, there is some evidence of a growing fashion for restaurants to be cooking and serving feet-on and head-on whole roast chickens.

Regarding the fourth point

Based on the current level of knowledge, the conclusions from this risk assessment are that while there are risks of zoonotic infection to the consumer associated with preparation and consumption of partially-eviscerated (effilé) poultry, these risks are generally no different to those associated with the preparation and consumption of traditionally processed poultry and, assuming a general level of compliance with regulations and basic hygiene practices, are unlikely to be responsible for anything more than sporadic individual infection events in humans. It is our view that the production of partially-eviscerated birds in the UK, subject to the controls outlined in this report, would not result in any significantly increased risk to public health than current poultry processing. However, currently there is a dearth of quantifiable data on which to form a comprehensive risk assessment. Data is currently deficient in the following areas:

1. No studies on the prevalence or concentration of pathogens in partially-eviscerated birds have been identified. The true prevalence of pathogens in birds is likely to be affected by exposure and susceptibility. Furthermore, the effectiveness of detecting the true prevalence will depend on detection methods, sample sizes and sensitivity and specificity of the sampling methods used. Prevalence and concentration of pathogens in the live bird can be assumed to be the same as conventionally processed poultry, however there is no data on the prevalence or concentration of pathogens in partially-eviscerated carcasses. In addition, there is very little data on the prevalence and concentration of pathogens in species other than chicken.
2. The prevalence and concentration of *Clostridium perfringens* in hepatitic livers, and an assessment of the risk of handling and consumption of hepatitic livers to public health.
3. The number of birds following each distribution pathway.
4. The frequency of consumption of partially-eviscerated poultry in and outside the home. Since little partially-eviscerated poultry is produced or supplied to the UK, it is difficult to gauge the current, or future, level of consumption of partially-eviscerated poultry in the UK. It is important to have a good idea of the current number of consumers as a significant increase in consumers could lead to a significant increase in risk.
5. The probability/level of cross-contamination during processing – while there is evidence to suggest the potential for cross-contamination to be a factor during processing, there are little data to accurately assess the level of the associated risk (e.g. how many bacteria are transferred in a cross-contamination event).
6. The survival/growth behaviour of pathogens in partially-eviscerated carcasses from production to consumption. The duration of storage could significantly

affect the pathogen concentration both in and on the carcass depending on the temperature.

7. The risk of cross-contamination during the combined skinning and partial-evisceration of feathered carcasses. In addition, the survival/growth behaviour of pathogens on skin-off and skin-off-partially-eviscerated carcasses from production to consumption.
8. The risk of cross-contamination during the removal of organs from partially-eviscerated poultry, whether performed by the retailer, catering establishment or consumer.

Of these eight points we would recommend that priority should be given to addressing points 1, 7 and 8 in order to support an FSA policy decision on partial eviscerated poultry production in the UK.

Contents

2 Introduction

Partially-eviscerated[1] (also described as effilé, effileé, roped, partly eviscerated, partially drawn, wire drawn or Boston drawn) poultry are produced by removing the intestines from the poultry carcass but leaving the heart, liver, lungs, kidneys, crop, proventriculus and gizzard inside the body cavity.

This form of processing is traditional in France, and there is evidence of it being used in the past in the USA, where the process was described as “Boston” or “wire” drawing (Pennington *et al*., 1911). Regulation (EC) 853/2004 allows production of effilé poultry, provided it is authorised by the competent authority. The UK has little current experience of the production of partially-eviscerated poultry. A few UK plants have been trialling this method of production, and a single plant has been found that is currently producing skinless partially-eviscerated broiler carcasses in the UK. There is some similarity between partially-eviscerated poultry and New York Dressed poultry (NYD) or delayed eviscerated poultry. All traditionally keep the head intact so are killed and bleed using the same method and are scalded and plucked. However with NYD evisceration does not take part at all and the carcass is retailed uneviscerated. While with delayed eviscerated poultry the carcasses are chilled uneviscerated and then stored (matured) for up to 15 d before being fully eviscerated and retailed as an eviscerated carcass. NYD poultry is no longer permitted in the UK, although delayed eviscerated poultry, such as “Traditional Farm Fresh” turkeys, are still produced. There is a belief that leaving organs within the carcass during maturation improves the organoleptic properties (similar to hanging of game birds). It was also traditionally believed, before the widespread use of refrigeration, that uneviscerated and partially-eviscerated poultry had a longer storage life than fully eviscerated poultry. There is some literature that supports these views.

One particular issue with the production of partially-eviscerated poultry is the difficulty in performing conventional standard post-mortem inspection, since the heart, liver, lungs, kidneys, crop, proventriculus and gizzard remain in the body cavity and can not be visually inspected as they would be in fully eviscerated poultry.

Examples of French traditional commercially produced effilé poultry are shown in Figures 1 to 5. This poultry is supplied to wholesalers and restaurants in the UK. According to the processors a combination of breed and feed create the colour designations in the types of chicken. Black = Black feather breeds, grain fed; Yellow = Free range, corn fed; White = Grain fed, Free range. In the processors opinion, the white has a firmer meat and less intense taste. The volumes sold are Yellow, Black and White in that order. There is a regional preference, with Southern France preferring Yellow, Northern France preferring White, while Eastern France prefers Black. The examples shown here are supplied with feet and heads on and are trussed in a traditionally French manner. Effilé carcasses are also produced without feet.

[1] Within this report the term “partially-eviscerated” is used throughout to describe this product, except when referring specifically to French produced poultry, plants and processes when the term “effilé” is used.

Figure 1. Poulet Noir (black chicken) produced by Fermier des Landais

Figure 2. Poulet Blanc (white chicken) produced by Fermier des Landais

Figure 3. Poulet Jaune (yellow chicken) produced by Fermier des Landais

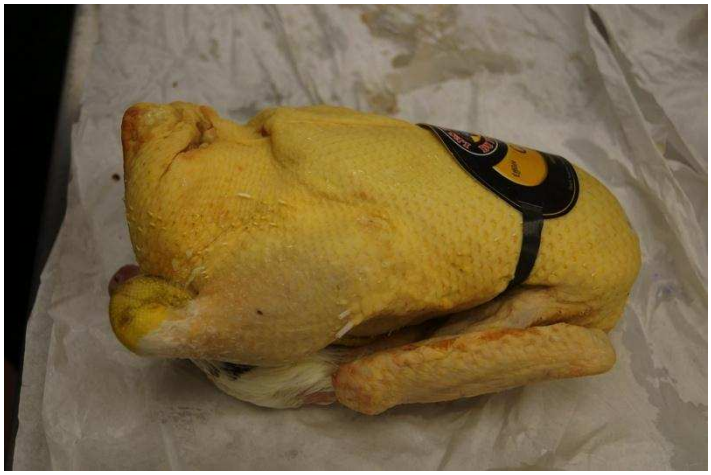

Figure 4. Effilé duck produced by Fermier des Landais

Figure 5. Effilé guinea fowl produced by Fermier des Landais

Three EU Food Hygiene Regulations have applied to all Member States from 1st January 2006, replacing 17 directives, including eight relating specifically to meat. These regulations are:

- Regulation 852/2004 - Hygiene of Foodstuffs.
- Regulation 853/2004 - Specific Hygiene Requirements for Food of Animal Origin.
- Regulation 854/2004 - Organisation of Official Controls on Products of Animal Origin intended for human consumption

All inspection requirements that apply to poultry are contained in Regulation 854/2004. None of these specifically refer to partially-eviscerated poultry.

There are also no specific references to partially-eviscerated poultry carcases in Regulation 853/2004. That Regulation only contains a reference in Section II, Chapter IV (slaughter hygiene for poultry) to "*viscera or parts of viscera remaining in the carcase, except for the kidneys, must be removed entirely, if possible, and as soon as possible, unless otherwise authorised by the competent authority*". The FSA understand this reference is to both delayed and partial-evisceration of poultry (FSA, Personal Communication).

The EU regulations are applied in the UK by:

- The Food Hygiene (England) Regulations 2006 (as amended) (SI 2006/14)
- The Food Hygiene (Scotland) Regulations 2006 (SSI 2006/3)
- The Food Hygiene (Wales) Regulations 2006 (as amended) (SI 2006/31 (W.5))
- The Food Hygiene Regulations (Northern Ireland) 2006 (SR 2006/3)

The European Union has two main regulations that control the marketing standards for poultrymeat:

- Council regulation 1234/2007
- Commission regulation 543/2008

Commission Regulation 543/2008 lays down detailed rules for the application of Council Regulation 1234/2007 as regards the marketing standards of poultrymeat and refers to partially-eviscerated carcases. Under the EU Poultrymeat Marketing Standards Regulations (543/2008) relevant poultry carcases must be presented for sale in one of the following forms:

1. 'Partially-eviscerated' ('effilé', or 'roped') - in which the heart, liver, lungs, gizzard, crop and kidneys have not been removed from the carcass.
2. Eviscerated, without giblets.
3. Eviscerated, with giblets.

The regulation defines giblets as comprising only the heart, neck, gizzard (with contents and horned membrane removed) and liver (without gall bladder), and other parts considered as edible by the market on which the product is intended for final consumption. It states that if the neck remains attached to the carcase, it is not considered as one of the giblets.

This regulation is applied in the UK by:

- The Poultrymeat (England) Regulations 2011
- The Poultrymeat (Scotland) Regulations 2011
- The Poultrymeat (Wales) Regulations 2011
- The Poultrymeat (Northern Ireland) Regulations 2011

3 Aims and Objectives

The overall aim of this project was to carry out a risk assessment of partially-eviscerated (effilé) poultry production (poultry with the heart, liver, kidneys, crop, proventriculus and gizzard left inside the body cavity) with a view to considering whether the risks of partially-eviscerated poultry production can be managed to an acceptable level such that the practice could be authorised in the UK.

To achieve this aim the project was structured to look at the key interactions in a methodical but cost effective manner with work on some objectives carried out in parallel and using material produced in other objectives. The structure consisted of four Objectives. The purpose of these Objectives were the following:

1. Initially a risk assessment of the public health implications of allowing partially-eviscerated birds into the food chain together with a review of all relevant and appropriate literature/company information relating to the control of partially-eviscerated poultry production was carried out. This identified the key risks and risk areas concerning the control and management of the partially-eviscerated poultry production processing chain (from farm-to-fork).
2. An industrial survey was then be carried out to: 1) quantify current partially-eviscerated poultry production in industry and the current controls; 2) obtain data on how non partially-eviscerated poultry production would have to be adapted to produce partially-eviscerated poultry and 3) improve the initial risk analysis by combining the data and information gathered in Objective 1 with that gathered in the industrial survey.
3. A short practical evaluation of the process was carried out to: (1) investigate the difference in chilling time between partially-eviscerated and eviscerated broiler carcasses; (2) investigate any difference between the growth of microorganisms on partially-eviscerated and eviscerated broiler carcasses during chilled storage; (3) investigate the growth of microorganisms in the organs of partially-eviscerated broiler carcasses during chilled storage.
4. A full analysis of all the data and findings of Objectives 1 to 3 was carried out and a final project report produced and agreed with the FSA.

4 Materials and Methods

4.1 Review of Literature on Partially-eviscerated Poultry Production

A review was carried out of all relevant and appropriate literature/company information relating to partially-eviscerated poultry production. The aim of the review was to identify:

1. Published information on partially-eviscerated and un-eviscerated poultry production including details on the methods used, hygienic status in comparison with eviscerated poultry and controls in place.
2. Readily available company knowledge on partially-eviscerated and un-eviscerated poultry production including details on the methods used, hygienic status in comparison with eviscerated poultry and controls in place.

The information summarised in this report was collated from a range of different sources including:

- Scientific literature via searches in the ISI Web of Knowledge, Google search engines and references within other documents.
- Email communication with scientific experts, policy makers and industry representatives

4.2 Review of Poultry Inspection

A review of literature and data on poultry inspection was carried out to identify: (1) the most common causes of condemnation after inspection, (2) which of these conditions were of concern to public health, and (3) what abnormalities may not be identified in the production of partially-eviscerated poultry when compared to the production of fully eviscerated poultry.

The information summarised in this report was collated from a range of different sources including:

- Scientific literature via searches in the ISI Web of Knowledge, Google search engines and references within other documents.
- Email communication with scientific experts, policy makers and industry representatives

4.3 Survey of Industrial Practice

There were three key objectives to the industrial survey. They were to:

1. Quantify current partially-eviscerated poultry production in industry and the current controls;
2. Obtain data on how non partially-eviscerated poultry production would have to be adapted to produce partially-eviscerated poultry;
3. Provide data to improve the initial risk analysis of the hazards of partially-eviscerated poultry production when compared to traditional poultry

production developed in Objective 01, e.g. inspection/rejection records and FCI records.

Since France is the major centre of effilé poultry production in the EU, the first part of the industrial survey was to identify French processors of effilé products. These processors were then contacted either directly or through French contacts to identify companies/plants willing to allow the project team to visit. A full list of the French processors/contacts that were identified and contacted is shown in Appendix D.

Members of the project team visited a representative sample of French effilé processing plants that currently produce effilé poultry and mapped current production methods, inspection techniques and any interventions currently undertaken. Whilst in France the team also had a short meeting with the veterinary inspection service for Dordogne to discuss any regulatory authority concerns about effilé production.

In the UK, the team also visited one plant currently producing partially-eviscerated broilers and had discussions with a second plant that has previously produced partially-eviscerated broilers.

4.4 Practical Evaluation of Processes

Due to the lack of data on the microbiological quality of partially-eviscerated poultry a series of short targeted experimental evaluations were carried out to:

1. Investigate the difference in chilling time between partially-eviscerated and fully eviscerated broiler carcasses.
2. Investigate any difference between the growth of microorganisms on partially-eviscerated and fully eviscerated broiler carcasses during chilled storage.
3. Investigate the growth of microorganisms in the organs of partially-eviscerated broiler carcasses during chilled storage.

Full details of the materials and methods used in the practical studies are contained in Appendices G, H, and I.

It had been anticipated that an evaluation of the use of inside-outside washes would be carried out. However, the survey of industrial practice identified that the traditional French practice was to only wash the exterior of the carcass when producing effilé poultry and that if gut rupture occurred that necessitated the washing of the interior of the carcass then such carcasses were removed from effilé production and reprocessed as fully eviscerated. An exterior pre-chill wash was also used by the UK plant producing skin-off partially-eviscerated broilers.

Unfortunately due to time constraints the combined “dry skinning” partial-evisceration process observed in the UK plant (Plant F) producing skinless partially-eviscerated broiler carcasses could not be evaluated.

4.5 Risk Assessment

A critical review of all relevant and appropriate literature and data was carried out to form a risk assessment of the public health implications of allowing partially-eviscerated poultry into the food chain. This risk assessment considered:

1. What abnormalities may not be identified in partially-eviscerated poultry production when compared to traditional poultry production;
2. Whether the risk of zoonotic pathogens are any greater for partially-eviscerated poultry production when compared to traditional poultry production;
3. The aetiology of those conditions;
4. The public health implications of those conditions and of allowing partially-eviscerated birds into the food supply chain.

As a starting point, we considered the approach used in a recent assessment for the FSA on the microbiological risks of uneviscerated small game birds (Horigan *et al.*, 2013). The main points to consider at each stage of the assessment were:

1. Hazard Identification – assessment of all relevant hazards to identify the major microbiological hazards that current knowledge suggests will be of public health concern due to the production and/or consumption of partially-eviscerated poultry (not including occupational hazards).
2. Release assessment – assessment of the prevalence and microbiological load of the identified hazards in both eviscerated and partially-eviscerated birds throughout the processing chain. The main factors to be considered includes the species of bird (which ones are natural hosts and pose a higher risk of being infected than other species) and the pathogenic load per bird.
3. Exposure assessment – assesses the absolute risk of consumer exposure from contact with partially-eviscerated poultry for each hazard taking into account the pathways necessary for exposure of consumers to the hazard and the probability of the exposure occurring.
4. Consequence assessment – assessment of the relative risk to public health from partially-eviscerated poultry for all the hazards identified. The absolute risk to public health from consumption of all species was assessed, to set in context the relative difference in risk between partially-eviscerated and eviscerated poultry

For this risk assessment qualitative estimates were produced using the following definitions (Table 1), which have been used in previous assessments (EFSA 2006)

Table 1. Definitions of qualitative risk assessment scores (EFSA, 2006)

Term	Definition
Negligible	So rare that it does not merit to be considered
Very low	Unlikely to occur
Low	Rare, but may occur occasionally
Medium	Occurs regularly
High	Occurs very regularly
Very high	Is almost certain to occur

The information summarised in this report was collated from a range of different sources including:

- European Food Safety Authority (EFSA) scientific opinions and risk assessments

- European Commission Regulations
- Scientific literature via searches in the ISI Web of Knowledge, Google search engines and references within other documents.
- Email communication with scientific experts, policy makers and industry representatives

The focus of the risk assessment was primarily on UK evidence. However, evidence and data from other countries have also been used where appropriate and useful, or where UK data were lacking. Where published data were lacking, expert opinion was sought.

5 Results and Discussion

5.1 Review of Literature on Partially-eviscerated Poultry Production

A full review of the literature can be found in Appendix A. Since there are similarities between partially-eviscerated and uneviscerated poultry, literature on uneviscerated poultry was also reviewed.

The literature review identified only one specific publication that described the partial-evisceration process: Pennington *et al.* (1911). Enquires to scientific experts and industry representatives failed to identify any other publications. This 1911 report compared the "*rate of decomposition in drawn and undrawn market poultry*". While this report may be old, it does give a very good description (and the only description we have found in any literature) of two methods for carrying out partial-evisceration. Pennington *et al.* (1911) described these thus:

> "*"Wire" drawing consists in pulling out a loop of intestine by inserting the finger through the vent; cutting the loop, and drawing out the gut by careful traction until it breaks at the gizzard. The vent of a bird so drawn presents a normal appearance; the only indication of drawing is the collapsed abdomen.*"
>
> "*"Boston" drawing is a modification of the "wire" in that a circular incision is made around the vent and the intestines pulled through until rupture occurs at the gizzard.*"

Similar practices were observed in this project in different French plants currently producing effilé poultry.

One French academic contacted had compared effilé with standard fully eviscerated carcasses in the past but had not published their results and did not have a record of the work. They remembered "*that the only difference, in a microbial point of view, comparing with "standard, eviscerated, air chilled broilers" was on the psychrotrophic flora (less Pseudomonas) and consequently on a longer shelf life. This was probably due to the use of less water during the process (manual "effilage[2]") and for washing carcasses at the end (less organic material contamination on the skin).*" (Pierre Jean Marie Colin, personal communication, March, 2014). Similar observations, on both the extension in shelf life and the importance of keeping the carcasses dry, were made by the French effilé producers interviewed in the survey of industrial practice.

It may be postulated from the literature on uneviscerated poultry that partial-evisceration was developed in order to reduce problems of spoilage from "greening" (Barnes & Shrimpton, 1957). This was a problem with the storage of uneviscerated poultry carcasses (a practice common until the 1970s) caused by the growth of spoilage bacteria in the intestines. The removal of the intestines would negate this problem, however no publications have been found to confirm this.

5.2 Review of Poultry Inspection

A full review of poultry inspection can be found in Appendix B.

[2] "Effilage" is a French term for the process of producing effilé carcasses

Regulation (EC) No 854/2004 of the European Parliament and of the Council lays down specific rules for the organisation of official controls on products of animal origin intended for human consumptions. This regulation is applied in the UK by The Food Hygiene (England) Regulations 2006, The Food Hygiene (England) Regulations 2006 (as amended) (SI 2006/14), The Food Hygiene (Scotland) Regulations 2006 (SSI 2006/3), The Food Hygiene (Wales) Regulations 2006 (as amended) (SI 2006/31 (W.5), The Food Hygiene Regulations (Northern Ireland) 2006 (SR 2006/3).

In a meat inspection system, ante- and post-mortem inspections are recognised as valuable tools for surveillance and monitoring of specific animal health and welfare issues (EFSA, 2012). Inspection tasks within the EC Regulation include: Checks and analysis of food chain information; Ante-mortem inspection; Animal welfare; Post-mortem inspection (before and after evisceration).

For eviscerated and partially-eviscerated poultry the above mentioned inspection task are basically identical except for the post-mortem inspection (after evisceration). Since the organs such as crop, proventriculus, gizzards, heart, kidney and liver are left inside the carcass of partially-eviscerated poultry, pathological findings which may occasionally be associated with the presence of some public health hazards may not be easily detectable. In addition, the detection of poultry organ contamination with gall or faecal material, which can sometimes warrant removal, and condemnation of poultry may be difficult.

5.2.1 Conditions of concern to public health identified by post-mortem inspection

There are currently twenty one conditions that are looked for during post-mortem inspection of poultry. In a recent review for the FSA (MLCSL, 2013), only four of these conditions (Perihepatitis, Ascites/oedema, Hepatitis, and Contamination) were judged by the veterinary expert on the consultancy team, in liaison with other experts, to be a cause of public health concern. In addition, we would add airsacculitis based on the evidence of the paper by Russell (2003) that shows a link between airsacculitis with campylobacter-positive carcasses and *E. coli* counts. However, as Singer *et al.* (2007) points out this single study was small, and consequently this relationship between respiratory disease status and potential microbial contamination of the meat is unclear. In addition, pericarditis has also been linked with *S*. Enteritidis (Rampling *et al*., 1989). These are shown in Table 13 in Appendix B, together with the reasons given for considering them to be of public health concern.

5.2.2 Abnormalities of concern to public health that may not be identified in post-mortem inspection of partially-eviscerated poultry

An assessment of which conditions normally identified that may be potentially missed during the post-mortem inspection of partially-eviscerated poultry was judged by the veterinary expert on the project team, in liaison with the other experts, and is shown in Table 2. While we would consider contamination resulting from the breaking of the gut inside the carcass to potentially be a significant public health risk, it is debatable whether such an occurrence is more difficult to detect during the post-mortem inspection of partially-eviscerated poultry carcasses in comparison to fully eviscerated. Our observations of practices in French plants processing effilé poultry suggest that it is detectable. In addition, it should be noted that a recent EFSA

review (2012) considered that the sensitivity of current visual inspection to detect faecal contamination to be low and there to be no direct association between visible contamination and the occurrence of pathogens.

Table 2. Assessment of which conditions of concern to public health may be potentially missed during the production of partially-eviscerated poultry

	Identification	Potentially missed in partially-eviscerated
Ascites/oedema	Accumulation of fluid within body cavity and tissues	No
Cellulitis	Yellowing and thickening of the skin	No
Contamination	Visual inspection of exterior and cavity	Maybe
Hepatitis	Inspection of the liver	Yes
Pericarditis	Inspection of the heart	Yes
Perihepatitis/peritonitis	Inspection of the liver	Yes
Respiratory disease (air sacculitis)	Inflamed air sacs thicker than normal, appear white or opaque rather than transparent	Yes

A comparison of rejections caused by these conditions in 2013 (FSA figures; data for Scotland and Wales were only available for broilers, as there was no or insufficient data for other species in Scotland and Wales) for broilers, ducks, geese, guinea fowl, hens and turkeys are shown in Figure 6 to Figure 11. These data shows that the incidence of these conditions is low as a percentage of the total number of birds processed each year in the UK. However it should be noted that since over 800 million birds are slaughtered each year, in total figures the numbers of birds rejected each year is considerable. However, this in turn should be put in context with the small number of poultry that are likely to be processed as partially-eviscerated carcasses.

The number of condemnations (for poultry processed in the UK in 2013) for the conditions that may not be identified in post-mortem inspection partially-eviscerated, hepatitis, pericarditis, perihepatitis/peritonitis, and respiratory disease (air sacculitis), are shown in Table 3.

Table 3. The reported incidence (as a % of throughput and actual numbers) of the conditions of potential public health concern, that may not be identified in post-mortem inspection of partially-eviscerated poultry that were recorded in UK poultry in 2013 (FSA data)

Species	Country	Hepatitis		Pericarditis		Perihepatitis / peritonitis		Respiratory disease (air sacculitis),	
		%	n	%	n	%	n	%	n
Broilers	England	0.230	1,619,146	0.044	307,760	0.091	636,723	0.003	21,575
Broilers	Scotland	0.190	97,587	0.037	19.071	0.114	58,838	0.000	12
Broilers	Wales	0.305	200,811	0.008	5,416	0.107	70,664	0.000	164
Ducks	England	0.006	746	0.502	60,949	0.051	6,194	0.644	78,228
Geese	England	0.079	114	0.057	83	0.063	92	0.037	54
Guinea fowl	England	0.022	16	0.072	53	0.088	65	0.097	71
Hens	England	0.004	1,382	0.003	1,132	0.300	104,844	0.002	679
Turkeys	England	0.027	3,688	0.090	12,185	0.042	5,690	0.114	15,325

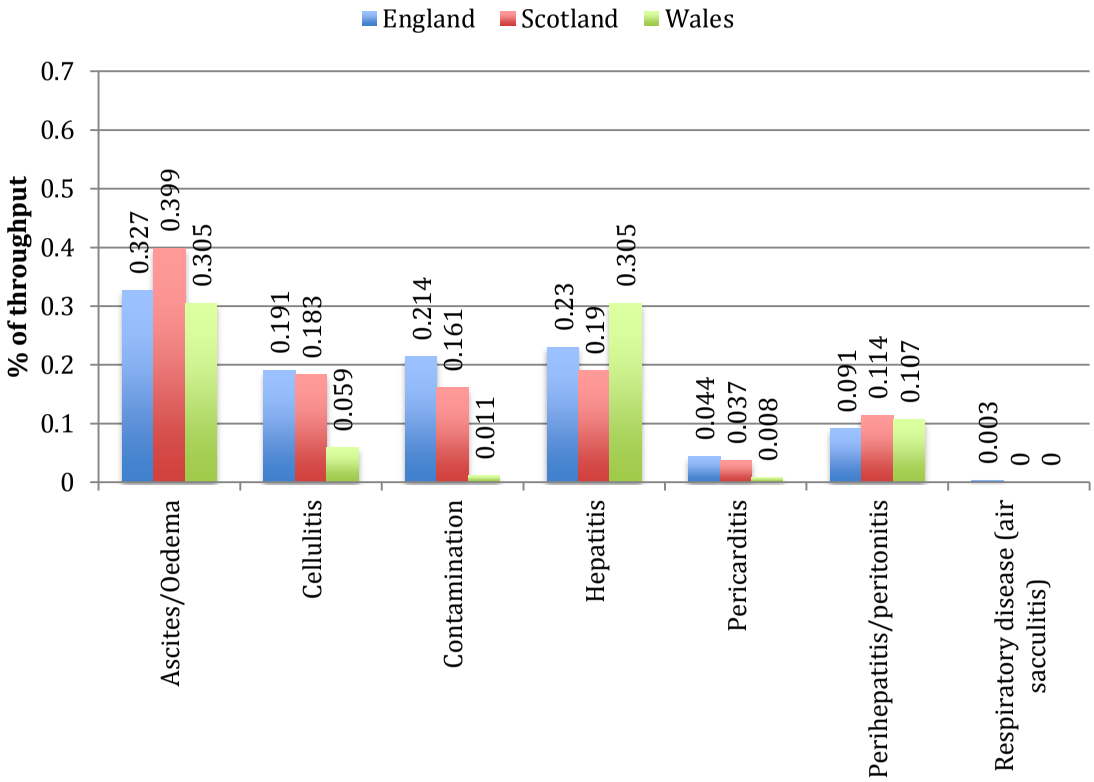

Figure 6. Incidence (as a % of throughput) of the conditions of concern to public health in broilers in England, Scotland and Wales in 2013 (FSA data)

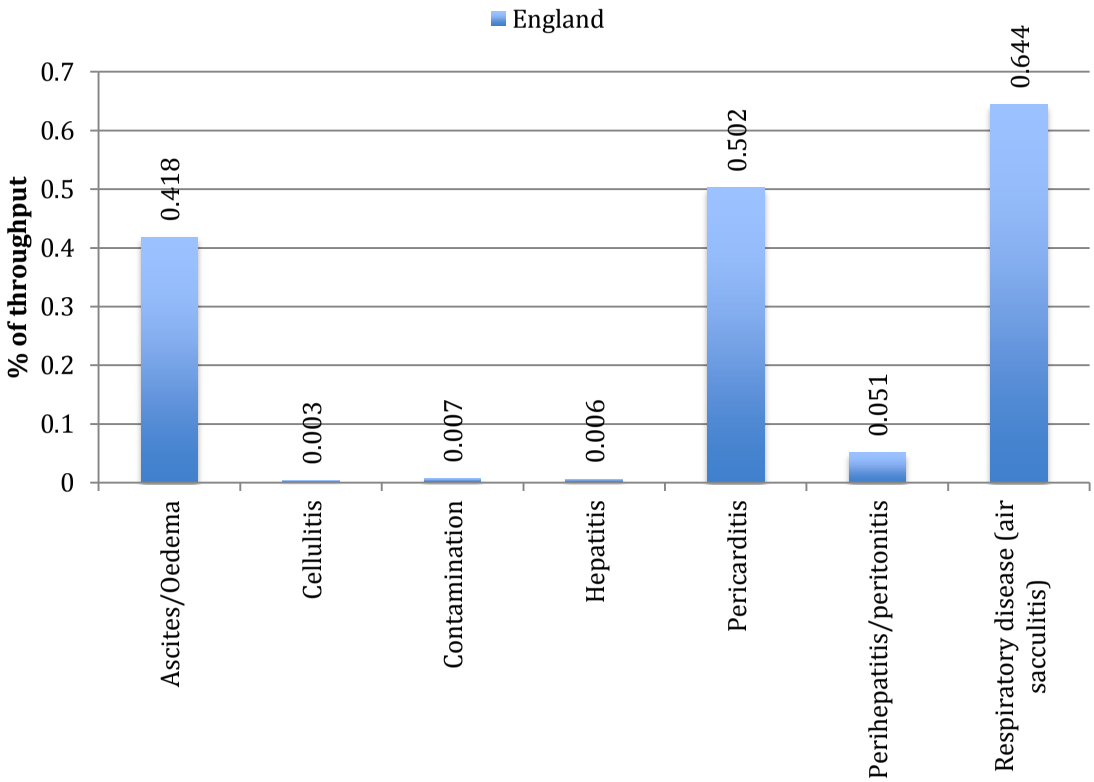

Figure 7. Incidence (as a % of throughput) of the conditions of concern to public health in ducks in England in 2013 (FSA data)

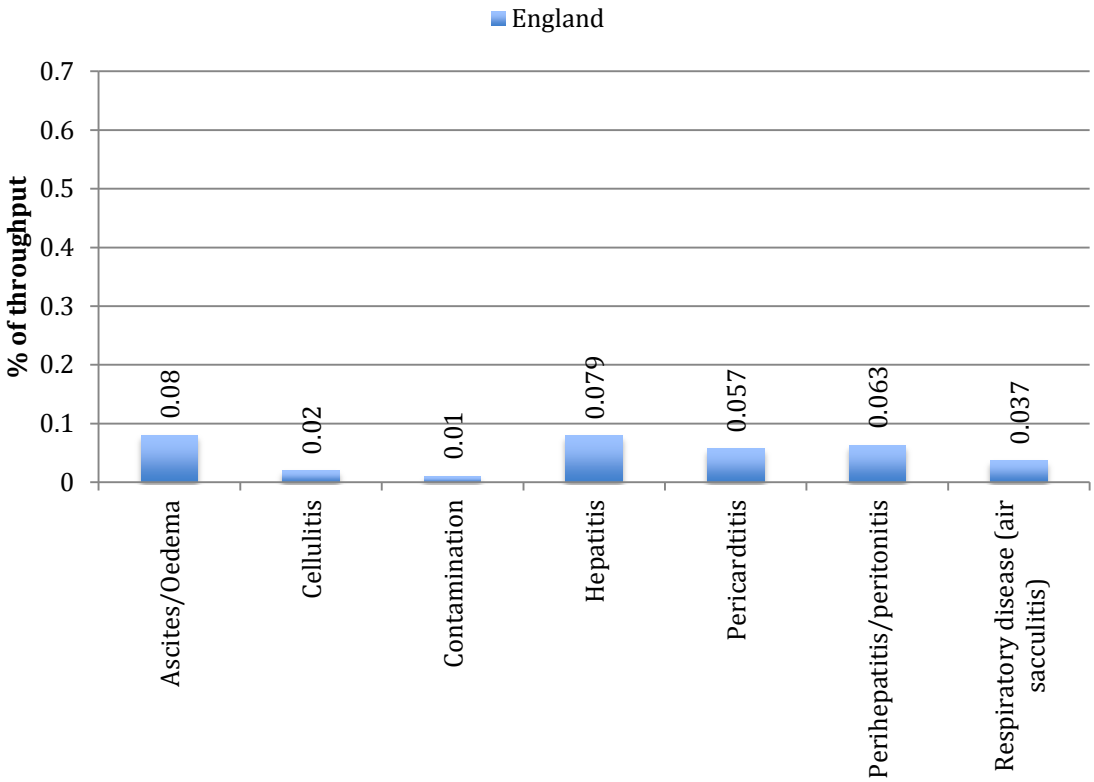

Figure 8. Incidence (as a % of throughput) of the conditions of concern to public health in geese in England in 2013 (FSA data)

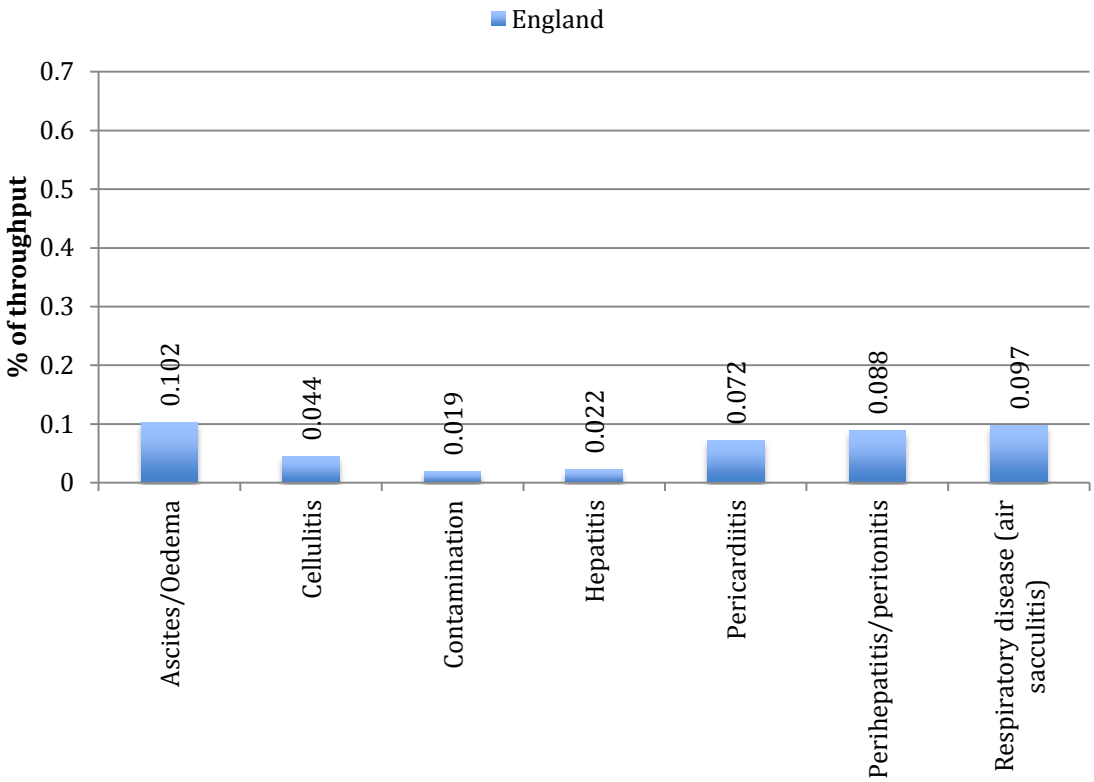

Figure 9. Incidence (as a % of throughput) of the conditions of concern to public health in guinea fowl in England in 2013 (FSA data)

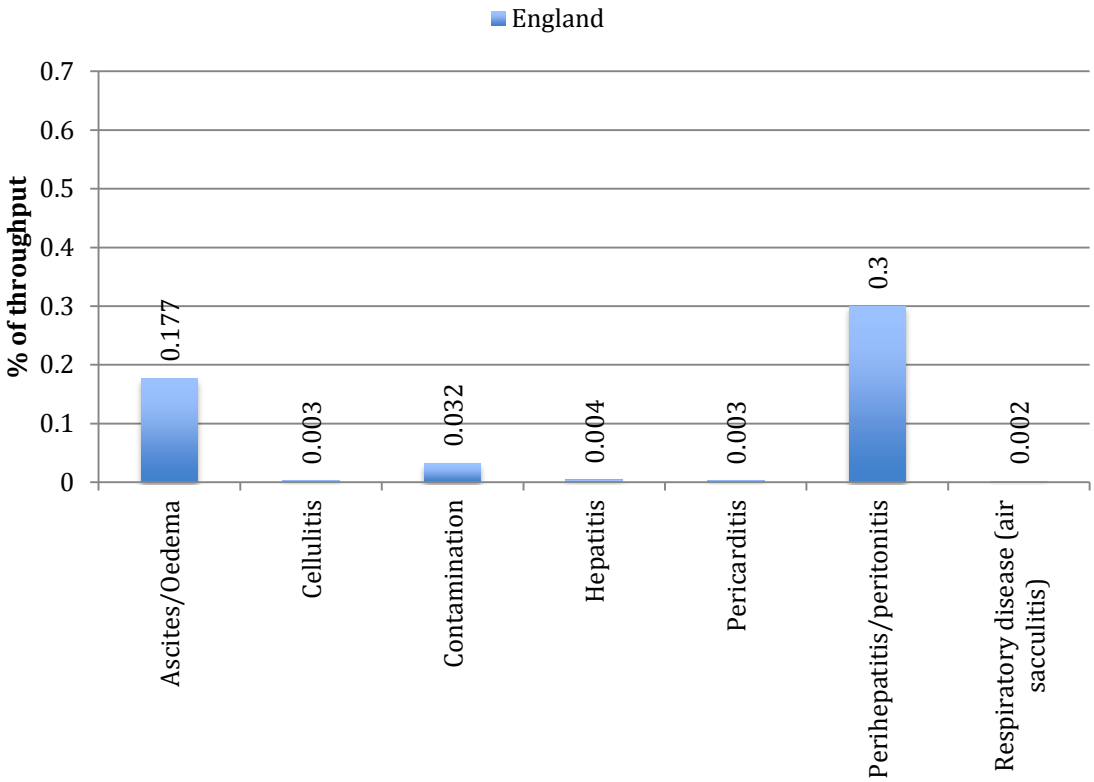

Figure 10. Incidence (as a % of throughput) of the conditions of concern to public health in hens in England in 2013 (FSA data)

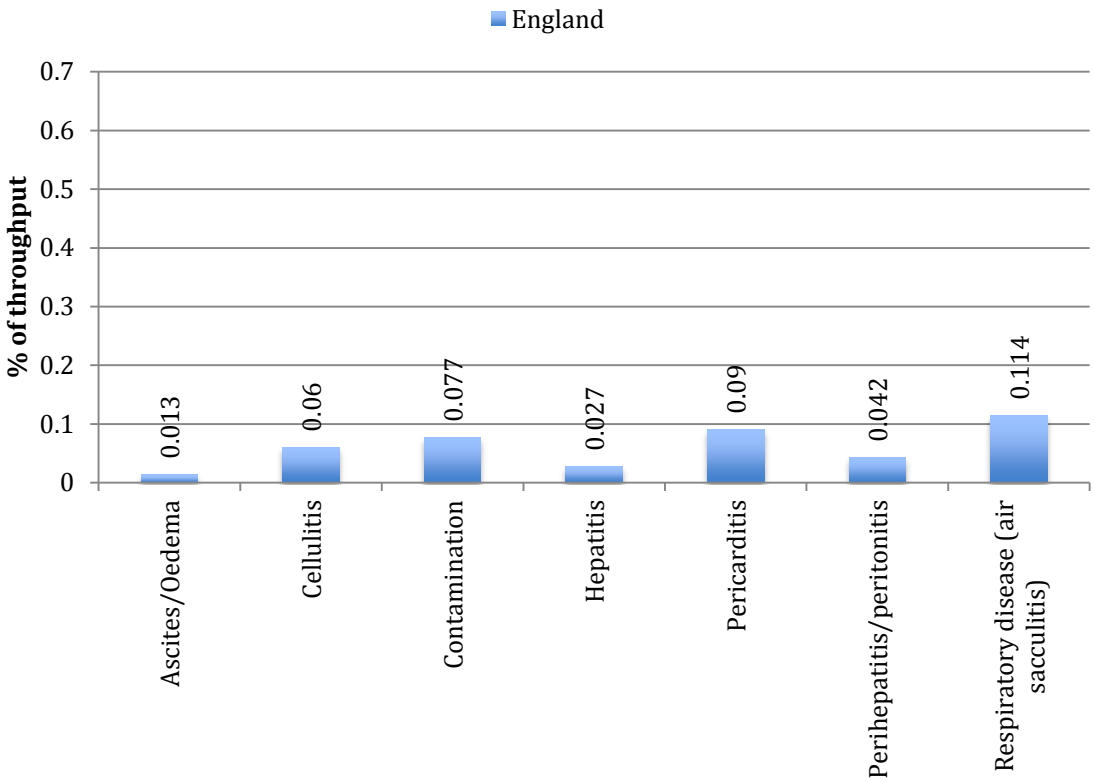

Figure 11. Incidence (as a % of throughput) of the conditions of concern to public health in turkeys in England in 2013 (FSA data)

The frequency of conditions occurring range from the most common (air sacculitis in ducks) occurring on average once every 156 birds, and the least common (air sacculitis in hens) occurring on average only once every 50,000 birds. A key aspect in assessing the risk of non-detection of these conditions in partially-eviscerated carcasses depends to a great extent on whether the conditions occur in flocks, or randomly in individual carcasses. If the latter, the only inspection regime that could detect the conditions shown in Table 3 would be complete inspection of all carcasses. However, if the conditions shown in Table 3 occur within flocks there are a number of feasible approaches to inspection.

Typically in the French plants, suitable carcasses for effilé are selected from the main production line for effilé processing with the remainder passing along a conventional line to be fully eviscerated. In this case, the majority of carcasses from a flock would be fully inspected in a standard fully eviscerated format and thus any flock defects detected could be inferred as a risk for the associated partially-eviscerated carcasses from the same flock.

The previous UK regulations (Poultry Meat, Farmed Game Bird Meat and Rabbit Meat (Hygiene and Inspection) Regulations 1995) could be adopted that stipulated inspection of 5% of carcasses of a 'specific group', with full inspection of the entire group being necessitated if a reportable condition is detected. A logical 'specific group' in this case would be a flock. If 5% of carcasses are inspected the chances of incidentally inspecting (and therefore detecting) an afflicted carcass is low (as prevalence of conditions is low) but the likelihood of detection increases with inspection batch size.

$$C = 1 \quad \frac{n}{b} \div \quad \frac{n\ 1}{b\ 1} \div \quad \frac{n\ 2}{b\ 2} \div \ \ldots\ldots \quad \frac{n\ i}{b\ i} \div$$

Where:

C = overall chance to detect at least 1 incidence of the condition

b = batch size

n = number of negatives in a batch ((1 - prevalence) x batch size)

i = number of birds inspected (5% of batch size)

Using this formula, and nominal flock sizes of 1,000 and 20,000 birds the overall likelihood of detection of the conditions is given in Table 4 and Table 5.

Table 4. Overall likelihood (%) of detecting at least one incidence of a condition of potential public health concern, achieved by full post-mortem inspection of 5% of partially-eviscerated poultry produced from a flock of 1,000 birds

Species	Country	Hepatitis	Pericarditis	Perihepatitis/peritonitis	Respiratory disease (air sacculitis),
Broilers	England	11.1%	2.2%	4.6%	0.2%
	Scotland	9.3%	1.9%	5.7%	0.0%
	Wales	14.5%	0.4%	5.3%	0.0%
Ducks	England	0.3%	22.7%	2.6%	28.2%
Geese	England	4.0%	2.9%	3.2%	1.9%
Guinea fowl	England	1.1%	3.6%	4.4%	4.9%
Hens	England	0.2%	0.2%	14.3%	0.1%
Turkeys	England	1.4%	4.5%	2.1%	5.7%

Table 5. Overall likelihood (%) of detecting at least one incidence of a condition of potential public health concern, achieved by full post-mortem inspection of 5% of partially-eviscerated poultry produced from a flock of 20,000 birds

Species	Country	Hepatitis	Pericarditis	Perihepatitis/peritonitis	Respiratory disease (air sacculitis),
Broilers	England	90.6%	36.4%	60.7%	3.0%
	Scotland	85.8%	31.6%	69.0%	0.0%
	Wales	95.7%	7.9%	66.7%	0.0%
Ducks	England	6.0%	99.4%	40.8%	99.9%
Geese	England	55.6%	44.3%	47.6%	31.6%
Guinea fowl	England	20.2%	52.3%	59.5%	63.1%
Hens	England	4.0%	3.0%	95.4%	2.0%
Turkeys	England	24.2%	60.3%	35.0%	69.0%

The above analysis shows that that suitable post-mortem inspection/sampling regimes could detect conditions of possible concern to public health in partially-eviscerated carcasses; there remains the issue of the conditions that could be not positively identified. On an individual bird basis hepatitis, pericarditis, perihepatitis/peritonitis, and air sacculitis are difficult to inspect/detect ante-mortem in a commercial growing and/or slaughtering operations. There is some ante-mortem information such as abrupt onset of mortality, lethargy, huddling with ruffled feathers, and yellow, mucoid droppings (indicators of possible hepatitis (Villeagas, 2013)) that could feed forward to identify added risk flocks via FCI records. For hepatitis mortality normally occurs at <6 weeks (Villeagas, 2013), so poultry with this condition are unlikely to arrive at the slaughterhouse. (However, some hepatitis afflicted birds do arrive as the detection figures above show.) However, at worst (broilers in England) this is only 0.23% of birds, and provided inspection batch sizes are sufficiently large this should be identified by suggested inspection regimes described above. Perihepatitis/peritonitis is another disease that affects the liver and may exhibit similar symptoms to hepatitis. Air sacculitis presents a challenge for ante-mortem inspection, however, as pneumonia is frequently present in chickens with air sacculitis (FAO, 2014) this could be one of the indicative symptoms.

There still remains some risk, of some partially-eviscerated carcasses with hepatitis, pericarditis, perihepatitis/peritonitis, or air sacculitis not being detected on the farm, or during full inspection regimes of 5% of carcasses. Proportions of carcasses inspected could be increased from 5% to increase likelihood of detections, however there is a practical limit as carcasses fully eviscerated for inspection could not be used for partially-eviscerated products.

An additional hurdle to prevent infected carcasses reaching the consumer is in the preparation for cooking phase where final evisceration is carried out. In France this is performed by skilled professional butchers or chefs with the skills and knowledge to identify any abnormal heart, liver, or airsacs.

5.2.3 Recommendations for post-mortem inspection of partially-eviscerated poultry

Little specific published advice or any regulations have been identified on the post-mortem inspection of partially-eviscerated poultry.

Council directive 92/117/EEC required that "*in the case of partly eviscerated poultry ('effilé') whose intestines were removed immediately, the viscera and the body cavities of at least 5 % of the slaughtered poultry from each consignment shall be inspected after evisceration*". This requirement was incorporated into the UK Poultry Meat, Farmed Game Bird Meat and Rabbit Meat (Hygiene and Inspection) Regulations (1995), in Schedule 9, part 1, 3. This stated the following:

"*In the case of partly eviscerated poultry ("effileé") whose intestines have been removed immediately, the viscera and the body cavities of at least 5% of the slaughtered poultry from each specified group shall be inspected after evisceration. If during such inspection anomalies are discovered in a number of birds, then all the birds in the specified group shall be inspected in accordance with paragraph 1 above.*"

Based on this, Buncic (2006) advised the following protocol for inspection of partially-eviscerated carcasses:

- Inspection of 5% of birds from the batch.
- Examination to focus on external surface, viscera and body cavity.
- If no abnormal conditions are found, other birds are not inspected.
- If any anomalies are found, all birds in the batch must be inspected.

However, this regulation was replaced in 2006 by The Food Hygiene Regulations (2006), which applied three EU food hygiene regulations (852/2004, 853/2004, 854/2004). This regulation does not include any specific details for the inspection of partially-eviscerated poultry.

The Ontario Ministry of Agriculture and Food have the following protocol for inspection and authorisation of uneviscerated (termed undrawn dressed poultry) and partially-eviscerated (termed partially dressed) (OMAF, 2009):

- Requirements for the protocol include records of production data, which must accompany all lots being considered for undrawn dressed poultry (UDP).
    - Such records include age of birds, lot size, mortality rates, treatment records, and average weights.

- Lots with more than 6% mortality rates at barn and/or affected with more than 1% dead birds on arrival are rejected for UDP processing.
- Thus the UDP inspection system employs ante-mortem inspection findings as a tool for approving or rejecting a UDP request. In addition, a sample of the birds are fully dressed, and if more than 2% of those birds have internal conditions undetectable externally, UDP processing is not allowed.
- During UDP inspection, individual birds are examined for external conditions, and may be directed for evisceration and post mortem inspection.
- Records of UDP processing must be maintained.
- Partial dressing of poultry is permitted, provided that a thorough inspection of the meat is not compromised and the dressing method does not contribute directly or indirectly to contamination.

This system is designed to detect diseased lots and direct them to evisceration.

A combination of these two approaches would appear sensible. However as already mentioned the data on post-mortem condemnations show that the incidence of condemnation conditions of concern to public health are very low. The risk from such conditions can also be considered to be low.

5.3 Survey of Industrial Practice

The prime production of partially-eviscerated poultry is carried out in France and industrial practice surveys were therefore focussed in France. Two investigation routes were pursued (a) questionnaire to companies, and (b) visits to effilé processors.

A number of French poultry processors were identified from internet searches and in-country contacts (Appendix D). These were then contacted by email and sent a simple questionnaire on their production to attempt to collect basic information on the French effilé processes. Despite follow up phone contacts by French speaking colleagues this survey revealed no useful information, as the overall response rate was exceptionally low and those who did respond did not produce effilé carcasses.

Successful visits were made to four French and one UK plant producing partially-eviscerated broilers to observe at first hand the partial-evisceration practices. Additionally, a description of the process used in one UK plant that had previously produced partially-eviscerated broilers was also obtained. Full descriptions of the plants visited and processes observed are given in Appendix C. Examples of commercial effilé equipment are shown in Appendix F.

5.3.1 Industrial partial evisceration practices

5.3.1.1 Live bird operations

There were no differences in the treatments of live birds destined for partially or fully eviscerated carcasses. All birds were farmed/raised, collected, transported, lairaged, hung onto shackles, and stunned identically.

5.3.1.2 Sticking

Effilé carcasses are typically supplied with the head on and the neck intact, and visible damage is not desired. Sticking for French effilé carcases was carried out in

a manner that did not show an external wound on the finished (head on) carcass. This was performed in all plants by an incision inside the mouth into the jugular or at the base of the tongue using either a small narrow knife or short bladed scissors. Sticking was carried out in this manner for all carcasses during periods when carcasses could be subsequently selected to go to effilé processing. Thus, fully eviscerated carcasses would also be stuck in this manner.

5.3.1.3 Bleed out, scalding and plucking

There were no differences in bleed out, scalding and plucking for partially or fully eviscerated carcasses. All birds passed along the same line and were processed identically in these stages.

The UK plant used a skinning method for defeathering and thus scalding and plucking stages were not required.

5.3.1.4 Selection for effilé

In France, after plucking there was then a selection of individual carcasses to go to either effilé or standard fully eviscerated processing. Selection was made objectively by a single operative based on the following characteristics:

- Good carcass conformation (No breakages/dislocations, Well proportioned)
- No skin damage
- Uniformity of skin colour
- Correctness of skin colour (this changes with type of effilé, breed and species of bird).

In the UK plant the partial-evisceration processing was performed in batches with no selection on visual quality.

5.3.1.5 Feet washing

Initial observations of effilé carcasses showed some dirt and contamination present on the feet of some of the sample carcasses. This is a concern; particularly if carcasses are trussed in the French effilé manner with base of the feet in contact with the wing skin. Specific feet washing equipment was not observed on any chicken processing line, however the project team were informed that duck feet are washed as part of the effilé process but this was not directly observed during the visits.

5.3.1.6 Evisceration

Different effilé evisceration processes were observed in all plants. All French plants were producing a skin-on effilé carcass, and the evisceration operations were concerned with removal of the intestine and duodenum. The UK plant used a skinning method to produce a skinless final product, and here the skinning and intestine/duodenum removal were inherently linked.

5.3.1.6.1 Partial-evisceration methods

The main techniques for partially eviscerating the carcasses observed in the plants visited could be split into four basic types of method:

1. Non-incision method, during which the operative's finger was inserted through the vent into the oviduct, bent into a hook shape, rotated approximately ¼ turn

and then pulled out. This pulled the intestine out through the vent. The finger was then washed and the intestine and duodenum pulled until rupture occurred at the gizzard (due to a natural weak point approximately 15 mm from the gizzard), and just inside the vent. This process was claimed by the operator to be the traditional effilé method, and that by leaving the vent in place this acted as a seal to prevent water and air ingress in the carcass cavity. The use of a finger rather than a metal hook was claimed to reduce the risk of intestine puncture during the operation. If performed correctly and with skill, the plant using this method claimed that the wall of the intestine would not be damaged during the process. This method was observed at only one of the plants visited.

2. Manual vent-incision method, during which an incision was made in the abdominal wall close to the vent, or through the oviduct adjacent to the vent to provide an opening into the cavity. Then a hooked tool (see Appendix F) or finger was inserted through the hole to extract a loop of intestines, which was hung outside the carcass. Operatives then pulled on the exposed intestines until rupture occurred, relying on the natural weakness just after the gizzard to separate the intestines at the "correct" place (approx. 15 mm from the gizzard). Following drawing of the intestines either: (i) the pulling was continued until the intestines separated at the other natural weak point just inside of the vent; or (ii) the incision was continued around the vent to fully separate the vent and intestines. This latter method is similar to that described by Pennington (1911) as "Boston" drawing (although Pennington describes a circular incision around the vent) and this method was observed at two of the plants visited.
3. Mechanical vent-incision method, during which a machine consisting of an annular knife with a central vacuum was used to remove the intestines connected to a plug cut around the vent (Appendix F; Figure 16). The operative pushed the vent of the carcass into the centre of a rotating annular knife, which made a separation incision around the vent and produced a plug of skin containing the vent. A vacuum system then drew the vent and intestines into a pipe to waste, relying on the natural separation and breakage of the intestines at the natural weak point c.15 mm from the gizzard. This method is similar to that described by Pennington (1911) as "Boston" drawing. This equipment was observed in two of the plants visited and was also used for the first stage of evisceration for producing fully eviscerated carcasses.
4. Skinning integrated method that was only possible for a plant producing skin-off broiler carcasses. The skinning/partial-evisceration operation was carried out in three steps, with each step being carried out by a different operator. The first operator made two cuts on the inner legs of the carcass and the skin was pulled free from the breast. The head was then removed to enable release at this point. The skin was then pulled from the wings using a few small assisting cuts. Once the skin was free on the lower arm of each wing the wing tip (hand) was cut. Cut at elbow. A second operator then inverted and rehung the carcass onto an adjacent clean shackle by the wings. A third operator then removed the feet. The remaining section of skin/feathers was pulled off the lower back down to the posterior area. The tail was cut off to expose the cavity and the vent freed. The skin (with intestines still attached to the inner surface) was then pulled free from the carcass. The intestines were pulled out and allowed to snap off at the natural weak point close to the gizzard.

Further details of these operations are given in the full industrial survey observation report in Appendix C.

5.3.1.7 Post-evisceration wash

In all French plants, maintaining carcass dryness was taken as an inherent part of the effilé process. Online carcass spray washes were external only and of low intensity and flow. Any inadvertent carcass contamination requiring washing was dealt with on an individual carcass basis using a drop hose spray.

5.3.1.8 Trussing and chilling

In the French plants, carcasses were trussed before air blast chilling on trolleys with perforated shelves. For all French plants effilé chicken carcasses were manually picked from the shackles and trussed warm due to the greater flexibility of limbs when warm. (According to Hannan & Shepherd (1956), this practice of trussing the carcass prior to chilling was once common in the UK since tighter trussing is easier before *rigor mortis* develops). Trussing comprised turning the wings behind the back and flexing the legs to hook the feet over the edge of the wing (Figure 1). This produced a compact carcass, which was then placed unwrapped, on trolleys with shaped perforated shelves. The heads were generally positioned outwards and hung over the shelf edge (Figure 20).

In the UK plant, skinless, un-trussed carcasses were hung onto a shackle bar trolley (Figure 21).

All trolleys were then wheeled into the chiller.

The design, conditions, and efficacy of the chillers seen at the plants varied considerably. All plants aimed to chill carcasses to 4°C, using air temperatures claimed to be between -7°C and 1°C and stated chilling times between 2 h and 'overnight'. Chillers were variously batch or continuous. In all the plants a small sample of products were probed for deep muscle temperature at the outlet of the chiller. The targets were stated as being between 0 to 4°C, or <4°C with over temperature carcasses being given more time in the chiller.

5.3.1.9 Other operations (weighing, labelling, packing, distribution)

Weighing, labelling, maturation, packing, and distribution operations varied considerably between plants. Only the largest plant check weighed and graded effilé carcasses by weight. Labelling and packaging varied greatly between the plants. Variants included:

- Cardboard labels tied on the neck and tail of the unwrapped carcass before chilling.
- Labels applied onto bags and other packaging after maturation.
- Adhesive labels applied directly to the carcass.
- Box labelling only with no individual carcass labels.

All labels gave product and processor information, brands, quality marks (e.g. Rouge Label), and a batch tracking code.

Packaging also varied greatly between the plants and depended on type of product, market and species. No vacuum or MAP packing was seen in any plant for partially-eviscerated products. Packaging variants observed were:

- Paper wrapping of individual carcasses
- Unwrapped carcasses in paper lined or plastic lined crates or cardboard boxes
- Individual carcasses in plastic bags.
- Overwrapped trays.

5.3.1.10 Distribution

Distribution temperatures for partially-eviscerated carcasses were the same as for fully eviscerated carcasses, i.e. <4°C.

5.3.1.11 Shelf life

Shelf lives of up to 12 days were claimed by many French processors for effilé processed carcasses, although quality assurance schemes reduced the labelled shelf lives to 10 days. For standard fully envisaged carcasses produced by the same companies the labelled shelf lives given were 7 days. The UK skinless partially-eviscerated broilers were supplied to food services and assigned a 5 day shelf life.

5.3.2 Inspection practices

In France, Food Chain Information (FCI) is used for release of flocks for slaughter but not specifically for effilé as both effilé and fully eviscerated carcasses can be produced from the same flock.

In France, inspection of carcasses was carried out on a continuous basis and involved more than one person. All effilé line operatives were trained in visual inspection to identify externally visible defects that would not be acceptable for final effilé carcasses. All staff were empowered to deselect carcasses from effilé production, with only external indicators on the carcass used for inspection. In the UK, inspection was performed by the OV immediately before the final wash. Rejects were passed back down the line to a remediation operative who usually trimmed the identified contaminated part and rewashed the carcass. Carcasses were then presented for re-inspection.

5.4 Practical Evaluation of Processes

The full results of the practical studies are presented in Appendices G, H, I, and J.

5.4.1 Practical comparison of the chilling of partially-eviscerated and eviscerated poultry carcasses

Fully and un-eviscerated were obtained straight from the slaughter line of a local poultry plant, transported to the laboratory and partially-eviscerated by hand before chilling. Temperature sensors were inserted into the deep breast and thigh of carcasses. Partially-eviscerated and fully eviscerated broiler carcasses were chilled using forced air (c. -2.3°C, 2-3 ms^{-1}) in a conventional blast chiller. Carcasses were chilled in two presentations; hung (untrussed) by the feet on shackles (typical UK method) or placed (trussed) on a perforated shelf (typical French method observed in survey). It was found that due to the presence of warm internal organs partially-eviscerated poultry carcasses were warmer than eviscerated carcasses at the start of chilling. The rate of cooling of partially-eviscerated poultry carcasses was also slower than that of similar fully eviscerated carcasses.

Temperatures were measured in the deep breast and thigh of carcasses. Temperatures in the deep breast were significantly slower to cool to <4°C than in the deep thigh for partially-eviscerated carcasses. Temperatures in the deep breast were also slower to cool to <4°C than in the deep thigh for fully-eviscerated carcasses although this difference was not significant.

Mean chilling times to <4°C were c. 70 min and c. 60 min for the breasts and thighs of fully eviscerated carcasses, respectively. For partially-eviscerated carcasses the mean chilling times were significantly different for the breasts and thighs at c. 120 min and c. 70 min, respectively.

There were no substantial differences in cooling times between the hung and trussed presentation of carcasses to the air stream.

A further trial showed that the slowest cooling point (thermal centre) of a partially-eviscerated poultry carcass can be found in the internal organs. A mean chilling time to 4°C using air at -1.3±0.5°C and 2.4 ms^{-1} was about 133 min for a trussed partially-eviscerated broiler carcass of around 1.5 kg (partially-eviscerated weight). We would expect a hung fully eviscerated carcass of a similar weight to chill in less than 90 min under similar conditions. Thus we would recommend that the temperature of the internal organs should be monitored when verifying chilling times of partially-eviscerated poultry carcasses.

5.4.2 Practical comparison of the growth and survival of microorganisms on partially-eviscerated and fully eviscerated broilers during refrigerated storage

Partially-eviscerated and fully eviscerated broiler carcasses were stored at a mild abuse temperature (i.e. a degree above the recommended 4°C limit) for up to 18 days. Skin samples and cavity swabs were taken periodically from different carcasses and analyses for ACC, *Pseudomonas*, Enterobacteriaceae, Coliforms and *E. coli.*

Overall the results showed that counts on the partially-eviscerated carcasses were comparable with those on conventional fully eviscerated carcasses during storage. These results did not did show partial-evisceration to have any significant effect on the growth and/or survival of microorganisms during refrigerated storage in comparison to conventional full evisceration. However, neither did they support the claim of some French manufacturers of a longer shelf life of partially-eviscerated carcasses in comparison to standard fully eviscerated carcasses.

Enterobacteriaceae and Coliforms were slightly higher on day 0 and *Pseudomonas* lower after 9 days of storage on partially-eviscerated carcasses. These differences may indicate a higher initial microbiological contamination of partially-eviscerated carcasses due to the absence of inside-outside wash phase and also slower growth of main group of spoilage organisms through storage time.

An estimated shelf life based on guidance published by Stannard (1997) and the ICMSF (1996) was calculated at approximately 7 days post-slaughter based microbial counts from this study.

5.4.3 Practical evaluation of the growth and survival of microorganisms in the organs of partially-eviscerated broilers during storage

Partially-eviscerated broiler carcasses were stored at a mild abuse temperature (i.e. a degree above the recommended 4°C limit) for up to 18 days. The internal organs

(heart, gizzard, liver and crop), cavity, skin and feet were sampled after 7, 9, 14 and 18 days. ACC, *Pseudomonas*, Enterobacteriaceae, Coliform and *E. coli* counts were all shown to increase in/on these carcass parts during chilled storage. Higher counts and greater growth were measured on the skin and in the cavity indicating that overall shelf life is determined by external microbial growth rather than spoilage of the internal organs. Results indicated that spoilage of the liver of partially-eviscerated poultry is slower than that of livers that have been removed during evisceration. This is in agreement with the views of French effilé producers. This is unsurprising since it is acknowledged that considerable cross-contamination occurs during the removal and separation of poultry livers from eviscerated carcasses (Hasapidou & Savvaidis, 2011). A short follow-up study showed that storing partially-eviscerated carcasses at 0°C significantly reduced any microbial growth of these same organisms over 7 days of storage. In fact, there was essentially no microbial growth in any of the organs after 7 days at 0°C.

Results of presumptive *Salmonella* ssp. and *Campylobacter* spp. analyses show highest prevalence on the crop and feet. This suggests that the crop is the item remaining that is most likely to contribute to cross contamination in the kitchen in the final preparation before cooking, and that there is merit in removing the crop during processing, as carried out by one of the French processors who were surveyed. The high levels on carcass feet suggest that trussing with the feet in contact with wing skin as in the traditional French effilé process could be detrimental to overall carcass microbial quality.

5.5 Risk Assessment

A critical review of all relevant and appropriate literature and data was carried out to form a risk assessment of the public health implications of allowing partially-eviscerated poultry into the food chain (Appendix K and L).

5.5.1 Hazard identification and selection

The aim of the Hazard Identification step was to identify the major microbiological hazards that current knowledge suggests were of public health concern due to the production and/or consumption of partially-eviscerated poultry (not including occupational hazards). As a starting point we considered the hazards identified in a recent EFSA scientific opinion on poultry meat inspection (EFSA 2012), review of current poultry practice and inspection by Löhren (2012) for EFSA, and assessment for FSA on microbiological risks of uneviscerated small game birds (Horigan *et al.*, 2013). These hazards were reconsidered and compared with the final hazard list developed by these projects to identify whether any of hazards not included in that final list should be considered for partially-eviscerated poultry. Particular consideration was applied to the hazards associated with the conditions of concern to public health that may be potentially missed during the production of partially-eviscerated poultry (Table 13). It was concluded that there were no additional hazards to those previously identified as the most important by previous studies.

Of the hazards considered, two were identified as being of most relevance, and importance, to poultry in the UK:

1. *Campylobacter* spp.
2. *Salmonella* spp.

These hazards were also identified by the recent EFSA scientific opinion on poultry meat inspection (EFSA, 2012), review of current poultry practice and inspection by Löhren (2012) for EFSA, and Horigan *et al.* (2013).

Both of these pathogens are recognised as significant risks to public health by the FSA and poultry industry and subject to national control programmes (Campylobacter Risk Management Programme and UK Salmonella National Control Programme (NCP)) to reduce their prevalence in UK poultry flocks. Birds destined for partially-eviscerated production will be subject to the same controls and benefit from these controls.

Of the two, *Campylobacter* spp. are by far the most important, the EU baseline survey carried out in 2008 (EFSA, 2010b) showing *Campylobacter* spp. to be present on 86% of UK broiler batches. While the prevalence of salmonella positive broiler flocks in GB has significantly reduced in recent years to 0.01% (in terms of target serovars) in 2012 (AHVLA, 2013).

It should be noted that neither of the selected hazards can be detected by visual inspection and are associated with only one of the conditions of concern to public health that may be potentially missed during the production of partially-eviscerated poultry (Table 2). That condition is pericarditis, which has been linked to *S.* Enteritidis. However, there is evidence that since the introduction of microbiological criteria in legislation, EU targets for reducing Salmonella in broiler flocks and the UK Salmonella NCP there has been a significant decline in flock prevalence for regulated salmonella serovars in broilers, particularly *S.* Enteritidis, which was not recorded in any broiler flock in 2012 (AHVLA, 2013).

5.5.2 Comparative assessment of risk for partially-eviscerated poultry production in comparison with standard poultry production

The evidence from France is that although effilé carcasses are distributed and displayed partially-eviscerated, they are fully eviscerated at point of sale to the consumer, i.e. the remaining organs are removed by a trained butcher. The viscera of birds may contain high concentrations of pathogenic organisms, and thus the evisceration process is a known risk, in terms of contamination and cross-contamination. However, this risk is mainly associated with intestinal rupture and consequent spillage of contents onto the carcass and operators' hands during this process (Mead & Scott, 1997). Since the intestines have been removed from partially-eviscerated carcasses this will not be a source of risk during subsequent organ removal and any risk will come from rupture of the other organs. Although some of these organs are a source of pathogens they are less likely to rupture than the intestines during manual removal (based on our own observations and those of current producers of partially-eviscerated poultry, Appendix J) and consequentially may be considered a lower risk. However, our studies have found that the organs, particularly the gall bladder and the liver, may weaken over time during storage. We also believe that the crop is more difficult to remove from a cold carcass than a freshly slaughtered pre-*rigor* carcass.

Since the principal risk during the production of partially-eviscerated is accidental rupture of the intestine (and crop if it is removed) leading to faecal contamination; a feed withdrawal stage in the growing phase before collection and delivery to slaughter plant is an important control method to reduce faecal matter and contamination issues should accidental rupture occur. Published studies (Wabeck,

1972; Papa, 1991; Bilgili, 2002) suggest that a feed withdrawal period of at least 8 h, but not more than 12 h is used before slaughter. The digestion cycle commonly lasts about 6 h and thus broilers kept off-feed for less than c.8 h have an increased likelihood of crop and intestine contents being present during partial-evisceration (Northcutt, 2001). However, after extended periods of feed withdrawal (>12 h) the epithelium begins to degrade, which decreases the mechanical strength of the intestines and presents a greater risk of damage during evisceration (Bilgili & Hess, 1997). Additionally, broilers deprived of feed and water for such extended periods of time experience significant and irreversible weight loss.

Only a few instances of leakage from the intestine after breakage at the natural weak point 15 mm from the gizzard were observed during plant visits. This was not a target observation of the visits, but only one case requiring remedial washing was noticed during the 30 minutes the project team spent observing the evisceration process in Plant A. We believe this incident was due to gall balder rupture rather that faecal leakage. At the time of visit the effilé line speed there was c.180 bph, thus c. 90 carcasses passed in that time, equating to a medial washing rate of c.1.1%. No instances of remedial washing were observed in other plant visits, and since this washing at Plant A may not have been due to intestine rupture we expect a maximum rupture proportion of c.1%. No instances of faecal leakage into the cavity were seen for correctly processed carcasses during our practical trials (section 5.4). Leakage was noticed, however, for carcasses where feed withdrawal was insufficient (i.e. those with full crops and intestines), or for the first few partial-eviscerations carried out by each staff member.

In the French plants the prime cause of leakage was attributed to poor feed/water withdrawal regime by the grower. Water withdrawal was seen as especially important as in their opinion this leads to more easily leaked liquid intestine contents. In manual processing the operative can see if the gut ruptures during removal in which case the carcass can be removed from the partial-evisceration process, thoroughly washed and then fully eviscerated. If the plant is using a vacuum effilage annular knife the separated intestine and contents are vacuumed away without touching the cavity. Small scale practical trials carried out as part of this study showed there was no significant difference in microbial levels in the carcass cavity for fully or partially-eviscerated carcasses (section 16.3.2) indicating that there was no significant leakage during removal of the intestines or from the remaining organs.

The process of partial-evisceration as part of an integrated defeathering by skinning process (“dry skinning”) as observed in a UK plant (Plant F) has not been quantitatively evaluated, and unfortunately no microbiological data was provided by the plant, making a qualitative assessment of the risk difficult at present (and a quantitative assessment impossible). We have not found any scientific publications that have assessed “dry skinning” versus plucking as a process, however the process is advocated in some publications and websites aimed at domestic poultry growers, small holders and hunters (Ussery, 2011). Cross-contamination of pathogens from the feathers and skin on to the exposed muscle via aerosols or the operatives hands is an obvious risk of this process. However, since the feathers and skin are a recognised source of pathogenic contamination (Buhr *et al.*, 2003), removing them in a single process has some merit (providing it can be shown to be possible without significant cross-contamination), and is inherently no different to the skinning process used for processing red meat carcasses. While it may be possible to automate such a process, this process is more likely to be of interest to small

throughput semi-automated plants where many operations remain manual. The process observed at Plant F in this study appeared to be well designed and to be carried out by skilled and trained operatives.

Current legislation requires that poultry carcasses be cleaned prior to chilling (853/2004 Annex III Section II Slaughter Hygiene: Chapter IV point 8). The method required to do this is not described. The FSA Meat Industry Guide recommends the use of an inside-outside washer. Inside-outside washing of partially-eviscerated carcasses would be difficult to carry out as the presence of organs in the cavity prevents water draining from the cavity. Alternative carcass presentations and spray nozzle arrangements would be required for washing the interior cavity, if required. Our practical evaluation showed no significant difference between microbial levels in the cavity of unwashed partially-eviscerated broilers in comparison with levels in commercially eviscerated carcasses that had been subject to an inside-outside wash. Our recommendation would be to follow the French practice of only washing the exterior of partially-eviscerated carcasses.

The organs remaining within a partially-eviscerated carcass will be a reservoir of pathogens, particularly the liver, but this reservoir will also be present for fully eviscerated carcasses supplied with giblets to the consumer. We have found no evidence of pathogen migration from organs into or onto the other (consumed) parts of the carcass. Providing the carcass has been efficiently chilling and compliance with the Food Hygiene Regulations (2006) are undertaken then temperatures would be below 4°C and only limited growth of pathogens (if any) in poultry giblets would be expected. Therefore, there is no evidence of a greater risk from organs remaining in partially-eviscerated carcases adversely affecting public health.

There is a risk of some reportable conditions (hepatitis, pericarditis, perihepatitis/peritonitis, and respiratory disease (air sacculitis)) not being detectable at post-mortem inspection as the relevant organs (liver, heart, airsacs) will remain inside the cavity of a partially-eviscerated carcass. A number of hurdles are proposed to reduce this risk by: (i) on farm inspection for signs of infection indicative of the conditions; (ii) full evisceration and inspection of a proportion of the carcasses from the same flock that the partially-eviscerated carcasses are produced; (iii) final evisceration before cooking by skilled butchers or chefs.

Diseased organs have obviously different appearances (even to the untrained eye) and in our opinion there is very low likelihood of consumption of diseased organs even if not undetected in the partially-eviscerated processing facility.

The chilling of partially-eviscerated poultry carcasses is inherently slower than that of fully eviscerated carcasses due to presence of the internal organs (as confirmed in our study). However, there is no evidence that these slower cooling rates result in any significant growth of microorganisms (James *et al*., 2006; FSA M01054: Quantification of the controls that should be placed on meat prior to mincing) particularly pathogens such as *Campylobacter* or *Salmonella* spp. Cooling times for partially-eviscerated will still be significantly shorter than those of red meat carcasses, which have not been shown to result in microbial growth. Whilst the practice of trussing the carcass before chilling, as is common in France (and was once common in the UK), will inevitably increase the cooling time, our own studies (Appendix G) and those by Hannan & Shepherd (1956) show this increase is not significant enough to warrant concern (<30 min extension to overall chilling time to 4°C).

The feet were identified as a source of possible pathogen contamination not present in conventionally produced fully eviscerated poultry. In the French traditional method of trussing effilé carcasses (as shown in Figures 1 to 5) the feet are packed tight to the body and any contamination on the feet can be deposited onto the skin of the carcass. This risk of contamination was observed in our practical studies Appendix I), and during the industrial survey. In the practical study, both *Campylobacter* and *Salmonella* spp. were detected on the feet of broilers. During the industrial survey, it was observed to be especially a problem with the feet of ducks (Figure 12). Thus, feet may be considered a source of risk and it may be questioned whether retaining them is of benefit. However, according to a recent article in The Times newspaper (Slater, 2014) there is a growing trend for "gourmet" chicken in restaurants in New York and London where the poultry are cooked with the feet on, and in some cases with the head on. It is difficult to predict whether such a trend will lead to consumers wanting to do the same at home. Interestingly one of the things the reporter who sourced a chicken with its head and feet on to cook at home for the article noted was that "*the talons … appear to be full of mud or possibly worse*". If feet are to be retained it is our opinion that a suitable foot washing protocol is required by the processor. As the feet are not consumed a range of sanitising treatments are possible for this task.

Figure 12. Visual contamination on the feet and back skin of retail effilé duck

Similarly a washing / sanitising treatment could be applied to the head that is also not eaten. The head showed high prevalence of presumptive pathogens in our practical trials (Appendix I, section 17.3).

As concluded by Horigan *et al.* (2013), the overall risk will depend upon the cooking step, and whether this is sufficient to reduce the pathogen count to below that required for a dose response within the consumer. A factor that had a significant influence on the risk assessment carried out by Horigan *et al.* (2013) on the microbiological risks of uneviscerated small game birds was the assumption "*that there is a greater tendency to serve game undercooked or 'pink' outside the home than when cooked by the consumer in the home environment*". This assumption was based on a combination of the expert's opinions who considered that "*catering establishments were more likely to serve game birds undercooked*" (Horigan *et al.*, 2013). While consumers were considered by the experts to "*more frequently use cooking methods such as roasting and casseroling that would be more likely to ensure a more thoroughly cooked product*" (Horigan *et al.*, 2013). This being the case, Horigan *et al.* (2013) identified the highest risk to be associated with woodpigeon and mallards outside the home. Following this logic, *Campylobacter* spp. in partially-eviscerated duck cooked outside the home is likely to be a higher risk compared with partially-eviscerated chicken cooked in the home.

6 Conclusions and Recommended Controls

6.1 Review of Literature on Partially-eviscerated Poultry Production

The documentation on the production of partially-eviscerated poultry was scarce and not comprehensive. Available literature on partially-eviscerated and uneviscerated poultry did not allow predictions to be carried out of the hazards connected to production and retail of partly-eviscerated poultry. However, it highlighted important points for risk assessment, i.e. the subsequent removal of the organs; and identified a reason for the historical development of partial-evisceration processing, i.e. the prevention of “greening” during storage of uneviscerated carcasses by the removal of the intestines responsible for this problem.

6.2 Review of Poultry Inspection

The review of current inspection practices identified that there are currently twenty one conditions that are looked for during post-mortem inspection of poultry. Of these the majority of conditions are not related to a public health risk. Seven conditions may be considered to be of concern to public health (Ascites/oedema, Cellulitis, Contamination, Hepatitis, Pericarditis, Perihepatitis/peritonitis, Respiratory disease (airsacculitis)). Of these seven conditions only four (hepatitis, pericarditis, perihepatitis/peritonitis, and respiratory disease (airsacculitis)) may not be identified during post-mortem inspection of partially-eviscerated poultry. However, these conditions should be clearly identifiable by the end user of the poultry during preparation of the carcass for cooking. In our opinion it is unlikely that such infected viscera would be used by the end user, and given the low likelihood of occurrence questionable whether these conditions would constitute any risk to public health.

At present there are no agreed protocols for the ante-mortem and post-mortem inspection of partially-eviscerated poultry. Past UK regulations (Poultry Meat, Farmed Game Bird Meat and Rabbit Meat (Hygiene and Inspection) Regulations 1995) required that at least 5% of a specified group should be fully eviscerated and inspected. Whilst The Ontario Ministry of Agriculture and Food protocol for inspection and authorisation of uneviscerated and partially-eviscerated requires that “*Lots with more than 6% mortality rates at barn and/or affected with more than 1% dead birds on arrival are rejected for UDP processing*”. We would recommend a protocol based on these two protocols. Mortality data is currently recorded in the FCI forms.

6.3 Survey of Industrial Practice

Four French plants and two UK plants were visited during the industrial survey. Although there was a commonality in the practices employed at all of the plants, differences were found between the plants, particularly in the specific method used to remove the intestines from the carcasses in order to produce the final product. Four main methods have been identified that can be used to partially eviscerate poultry, three are manual, one is mechanical. The only UK plant producing partially-eviscerated poultry skinned the whole carcass with the feathers on, pulling the intestines out as the skin was removed.

In the French plants, the live birds from the same flocks were used in both types of processing with carcasses being selected for effilé production immediately after plucking based on a detailed visual inspection of external quality. Since <40% of a batch of birds go into effilé production, it may be concluded that a majority of the birds were conventionally processed and inspected. Thus any serious issues that would affect a flock would be identified during post-mortem examination of the viscera from the fully eviscerated carcasses from the same flock. Any issues would therefore be also associated with the effilé carcasses produced from the same flock.

The maximum line speeds during effilé production of ranged between 220 and 3,600 birds per hour in the plants of the industrial survey. This is substantially less than the 8,000 to 12,000 birds per hour line speeds seen in most of the large UK chicken processors. This is not a major issue as effilé processed carcasses are a niche product suited to smaller (lower speed) processors.

There were six main processing operations that show differences from UK standard operations for effilé chicken processing.

1. Sticking is required to be through the mouth into the jugular vein inside the throat (as opposed to external throat cut).
2. Evisceration processes need to be modified to remove only the intestine and duodenum as described in the various methods above. Effilé processing is not suited to high-speed carousel type evisceration machines therefore operations need to be manual or make use of existing annular knife central vacuum machines. Although not known to be available, it should be possible to fully automate this process using machine vision guided robotics to improve line speeds over currently seen manual operations.
3. Inspection. The French plants place an emphasis of the importance of continuous inspection by their operatives during all stages of processing to ensure that abnormalities are identified and that abnormal carcasses are not processed as effilé. Although, by its nature, such inspection is predominantly limited to the identification of externally visible defects. The relatively slow line speeds used during the processing of effilé carcasses and the manual nature of the processes make such continuous assessment possible.
4. Final washing of effilé carcasses was applied to the exterior only using low pressure sprays. Plants attempted to keep carcasses as dry as possible as it was believed to contribute to extended shelf lives and carcass quality (a belief and practice common in red meat processing).
5. Chilling may need to be modified to be a batch operation with trussed carcasses to mimic the French effilé processes, but this is not necessarily a prerequisite.
6. Subsequent distribution route. In France effilé carcasses are supplied almost exclusively to butchers shops, supermarkets, and food service where skilled and trained intermediaries complete the carcass preparation before consumption. These stages do not typically exist in the UK.

6.4 Practical Evaluation of Processes

Due to the lack of data on the microbiological quality of partially-eviscerated poultry a series of short targeted experimental evaluations were carried out to:

1. Investigate the difference in chilling time between partially-eviscerated and eviscerated broiler carcasses.
2. Investigate any difference between the growth of microorganisms on partially-eviscerated and eviscerated broiler carcasses during chilled storage.
3. Investigate the growth of microorganisms in the organs of partially-eviscerated broiler carcasses during chilled storage.

These studies showed that:

1. Due to the presence of warm internal organs partially-eviscerated poultry carcasses are warmer than eviscerated carcasses at the start of chilling and the rate of cooling of partially-eviscerated poultry carcasses is slower than that of similar eviscerated carcasses.
2. There was no significant difference between the microbiological quality of partially-eviscerated and eviscerated broiler carcasses after chilling and during chilled storage.
3. ACC, *Pseudomonas* spp., Enterobacteriaceae, coliform and *E. coli* counts were all shown to be capable of increasing in/on the heart, crop, feet, gizzard, cavity, skin and liver of partially-eviscerated and eviscerated broiler carcasses after chilling and during chilled storage.

6.5 Risk Assessment

Unfortunately at present there is little quantitative microbiological data on the levels of pathogens on partially-eviscerated poultry on which to base a accurate quantitative risk assessment. However, the evidence gathered does not suggest that there is any substantially greater risk associated with consumption of partially-eviscerated (effilé) poultry compared with eviscerated poultry.

Whilst our studies indicate the incidence is relatively low, the principal risk in production of partially-eviscerated poultry is the leakage of intestinal content into the carcass cavity and/or onto the surface of the carcass. These risks can be minimised by effective training of staff, strict hygiene measures, suitable line speeds that allow the operatives to perform their duties with care, in addition to the implementation of HACCP. When leakage does occur the carcass should be fully eviscerated (i.e. all organs removed and the carcass washed) and not be used for partially-eviscerated production.

Other risks that remain include:

- Some of the organs, particularly the gall bladder and the liver, do appear to weaken during storage, and the crop is more difficult to remove from a cold carcass than a freshly slaughtered pre-rigor carcass. This is a small risk and can be mitigated by taking care and using suitable techniques for the final evisceration before cooking and consumption.
- The chilling rates of partially-eviscerated poultry carcasses are slower than that of fully eviscerated carcasses due to the presence of the internal organs and a carcass is typically trussed before chilling. (Trussing before chilling (and rigor) is not an inherent part of the partial-evisceration process but is commonly associated.) There is no evidence that these slower cooling rates will result in any significant growth of microorganisms.

- The feet were identified as a source of possible pathogen contamination particularly if the carcass is trussed in the traditional French manner with the base of the feet in contact with the skin of the carcass. Feet are considered a source of risk and it may be questioned whether retaining them is of benefit. If they are retained it is our opinion that a suitable a washing protocol is required.
- There is a risk of some reportable conditions (hepatitis, pericarditis, perihepatitis/peritonitis, and respiratory disease (air sacculitis)) not being detectable at post mortem inspection as the relevant organs (liver, heart, airsacs) will remain inside the cavity of a partially-eviscerated carcass. A number of hurdles are proposed to reduce this risk by: (i) on farm inspection for signs of infection indicative of the conditions; (ii) full evisceration and inspection of a proportion of the carcasses from the same flock that the partially-eviscerated carcasses are produced; (iii) final evisceration before cooking by skilled butchers or chefs.
- The cooking step has a major impact on reduction of any potential pathogenic dose to the consumer. The growing tendency to serve game undercooked or 'pink' outside the home constitutes a further risk with partially-eviscerated poultry.

6.6 Recommended Controls

Previous studies on conventional processing have clearly shown that zoonotic pathogens, whose presence cannot be seen with the naked eye but most of which are present in faeces and gut contents, are of prime importance in the safety of raw poultry. The two prime routes of pathogen contamination are from:

1. Those present on the surface of the live animal (skin, feathers or feet).
2. Those from the gut, via leakage or breakage.

Therefore, contamination from skin, feathers or feet and from gut leakage or breakage must be minimized. Most control measures in poultry processing are aimed at reducing this occurrence.

The other common control to prevent/reduce the rate of pathogen growth on the contaminated meat is:

3. To reduce the surface temperature of the meat to below a temperature that allows growth.

On a general level it is clear from the literature reviews (Sections 6.1 and 6.2) survey results (Section 6.3), practical assessments (Section 6.4), and risk analysis (Section 6.5) that in order to reduce risk from partially-eviscerated poultry it is important to:

1. Ensure that feed is withdrawn prior to delivery. Faecal contamination due to intestinal breakage is likely to result in an unacceptable increase in the incidence and levels of pathogens on carcasses and edible offal. Reduction of faecal matter and associated risk in the crop and intestine can be reduced by adequate feed withdrawal regimes of between 8 to 12 h on flocks before delivery to the processing plant.
2. Ensure that birds are only sourced from healthy flocks. Flocks with more than 6% mortality rates at farm and/or affected with more than 1% dead birds on

arrival should be rejected for partially-eviscerated processing. Such data should be available via current FCI records. Ante-mortem inspection of flocks intended for partially-eviscerated processing should particularly pay attention to identifying birds exhibiting obvious clinical signs of hepatitis, pericarditis, perihepatitis/peritonitis, and respiratory disease (air sacculitis) is of particular importance since these conditions are unlikely to be identified during post-mortem inspection of partially-eviscerated carcasses.

3. Clean the feet of carcasses. If feet are to remain on the final product, then effective washing of feet is required prior to scalding.
4. Produce carcasses with the lowest possible initial bacterial numbers. There must be zero tolerance of intestinal breakage during removal. If faecal spillage or intestine breakage occurs during evisceration, the carcass should be fully eviscerated (i.e. all organs removed and the carcasses washed) and not be used for partially-eviscerated production.
5. Fully eviscerate and fully inspect a proportion of the flock from which partially-eviscerated carcasses are produced, to reduce risk from conditions (hepatitis, pericarditis, perihepatitis/peritonitis, and respiratory disease (air sacculitis)) not detectable in inspection of partially-eviscerated carcasses.
6. Clean the carcass prior to chilling. Due to the presence of internal organs washing the interior is not advisable, however the exterior can and should be effectively washed using exterior sprays. Permitted chemical interventions may improve the efficacy of washing.
7. Chill carcasses as fast as possible.
8. Keep an intact cold-chain throughout the entire production chain from the processor to the retailer or catering establishment.
9. Maintain strict sanitary conditions throughout the whole production process, from slaughter through chilling, storage, and fabrication to packaging.
10. Develop and implement a food safety management system based on the principles HACCP, with regular reviews.
11. Introduce facilities, equipment and practices that should limit cross-contamination.
12. Control (and record and regularly inspect) product and environmental temperatures.
13. Determine and verify the storage-life and display-life of all products.

The following critical limits, monitoring procedures and corrective actions for the manufacture of partially-eviscerated poultry are recommended in the table below (Table 6).

Table 6. Recommended controls for processing of partially-eviscerated poultry caresses

Process Step	Critical limits	Monitoring	Corrective action
Feed withdrawal			
Faecal contamination due to intestinal breakage is likely to result in an unacceptable increase in the incidence and levels of pathogens on carcasses and edible offal.	Reduction of faecal matter and associated risk in the crop and intestine can be reduced by adequate feed withdrawal regimes of between 8-12 h on flocks before delivery to the processing plant.	Records of production data which must accompany all batches being considered for partially-eviscerated poultry.	If birds have not be subjected to feed withdrawal of 8-12 h reject for partially-eviscerated processing and process as eviscerated. Review adequacy of growing operations and/or monitoring procedures.
Ante-mortem inspection and arrival			
Ante-mortem inspection should concentrate on identifying four conditions: hepatitis, hepatitis perihepatitis/peritonitis, and respiratory disease (air sacculitis), since these are of most concern to public health and will not be identifiable by post-mortem inspection of partially-eviscerated carcasses.	Batches with more than 6% mortality rates at farm and/or affected with more than 1% dead birds on arrival should be rejected for partially-eviscerated processing.	Records of production data, which must accompany all batches being considered for partially-eviscerated poultry. Such records should include age of birds, lot size, mortality rates, treatment records, and average weights. This data should be available on current FCI records.	If batches have more than 6% mortality rates at farm and/or affected with more than 1% dead birds on arrival reject for partially-eviscerated processing and process as eviscerated. Review adequacy of growing operations and/or monitoring procedures.
Post-mortem inspection			
Only a sub-set of carcasses can be fully post-mortem inspected. Post-mortem inspection should focus on identifying four conditions: hepatitis, pericarditis, perihepatitis/peritonitis, and respiratory disease (air sacculitis), since these are of most concern to public health and will not be identifiable by post-mortem inspection of partially-eviscerated carcasses.	Inspection of 5% of birds from the batch. Examination to focus on external surface, viscera and body cavity. Examination to focus on four conditions: hepatitis, pericarditis, perihepatitis/peritonitis, and respiratory disease (air sacculitis). If no abnormal conditions are found, other birds are not inspected. If any anomalies are found, all birds in the batch must be inspected.	All individual birds should be examined for external conditions, and may be directed for evisceration and post-mortem inspection	If any anomalies are found, all birds in the batch must be inspected. Review adequacy of growing operations and/or monitoring procedures.
Slaughter and dressing			
Carcass meat should be produced with as low a level of microbiological contamination as possible. Birds must be clean enough at slaughter to avoid contamination of the meat during skin/feather removal and subsequent dressing. Different cleanliness levels can be accepted as clean enough depending on the processes used in the plant including post kill cleaning, line speed, operator skill and design of skin/feather removal. Other steps in the dressing process need to be carried out hygienically with particular attention to steps known to be important.	A limit for the cleanliness of animals at slaughter and the use of any intervention such as post kill feather clipping should be established. Limits for other steps in the dressing process as described in the plant specific plan.	Visual assessment of the cleanliness of every bird prior to slaughter. Sorting of birds into groups of cleanliness and monitoring the application of specific interventions. Monitoring of the dressing procedure as described in the plant specific plan.	Birds that are not clean enough should not be slaughtered. When specific interventions are required and have not been applied correctly they must be reapplied where possible. Corrective actions for the dressing procedure as described in the plant specific plan.

Feet washing (optional)			
If product is going to be produced with feet on then the feet must be clean enough prior to evisceration to avoid contamination of the meat during partial-evisceration and subsequent chilling and trussing. Different cleanliness levels can be accepted as clean enough depending on the processes used in the plant including post kill cleaning, line speed, operator skill and design of skin/feather removal. Other steps in the dressing process need to be carried out hygienically with particular attention to steps known to be important.	A limit for cleanliness of feet and the use of any washing processes should be established. Limits for other steps in the dressing process as described in the plant specific plan.	Visual assessment of the feet cleanliness of every carcass prior to partial-evisceration and immediately after evisceration. Sorting of carcasses into groups of cleanliness and monitoring the application of washing interventions. Microbiological trend data may be used to monitor the hygiene and effect of partial-evisceration practice over time. Aerobic colony count (30℃ incubation), Enterobacteriaceae, coliform or *Escherichia coli* counts may be a useful measure of the bacteriological status of carcasses after partial-evisceration (ICMSF, 1998). Monitoring of the trussing procedure as described in the plant specific plan.	Birds that are not clean enough should not be slaughtered. When specific interventions are required and have not been applied correctly they must be reapplied where possible. Corrective actions for the dressing procedure as described in the plant specific plan.
Post-defeathering washing			
External surfaces of carcasses are likely to be contaminated with unacceptable levels of microorganisms. Effective washing will reduce microbiological contamination from previous step.	A limit for the cleanliness of carcasses prior to partial-evisceration should be established. The use of any intervention such as post defeathering washing should be established. Specify washing parameters that will achieve or contribute to the achievement of specified microbiological targets for carcasses, i.e. - complete carcass coverage by showers. - water pressure adequate to remove visible extraneous material. - specified concentration of sanitising agent, if used.	Visual assessment of carcass cleanliness of every carcass prior to partial-evisceration. Microbiological trend data may be used to monitor the hygiene and effect of partial-evisceration practice over time. Aerobic colony count (30℃ incubation), Enterobacteriaceae, coliform or *Escherichia coli* counts may be a useful measure of the bacteriological status of carcasses after partial-evisceration (ICMSF, 1998).	Carcasses that are not clean enough should not be partially-eviscerated. When washing has not been applied correctly it must be reapplied where possible. Increase frequency of monitoring. Review adequacy of operational and/or monitoring procedures.
Partial-evisceration			
Faecal contamination due to intestinal breakage is likely to result in an unacceptable increase in the incidence and levels of pathogens on carcasses and edible offal. Care needs to be taken during partial-evisceration that faecal spillage does not occur from the intestines and that the intestines are not broken during removal to avoid contamination of the cavity.	A limit for faecal spillage and intestinal breakage should be established.	Visual assessment of the cleanliness of every carcass prior to partial-evisceration and immediately after evisceration. Microbiological trend data may be used to monitor the hygiene and effect of partial-evisceration practice over time. Aerobic colony count (30℃ incubation), Enterobacteriaceae, coliform or *E. coli* counts may be a useful measure of the bacteriological status of carcasses after partial-evisceration (ICMSF, 1998).	If faecal spillage or intestine breakage occurs during evisceration the carcass should be fully eviscerated (i.e. all organs removed and the carcass washed) and not be used for partially-eviscerated production. If frequent breakage occurs evisceration practices should be reviewed and improved. QA will identify the cause of any deviation and prevent reoccurrence.

Pre-chill cleaning			
External surfaces of carcasses are likely to be contaminated with unacceptable levels of microorganisms. Effective washing will reduce microbiological contamination from previous step. (Note: Inside/outside washers are used for cleaning eviscerated poultry carcasses prior to chill. Such washers are not suitable for partially-eviscerated carcasses. Washers for partially-eviscerated should be designed to wash external carcass surfaces only and avoid water ingress into the cavity.)	Current legislation requires that poultry carcasses be cleaned prior to chilling (853/2004 Annex III Section II Slaughter Hygiene: Chapter IV point 8). The method is not described. A limit for the cleanliness of carcasses prior to chilling should be established. Specify washing parameters that will achieve or contribute to the achievement of specified microbiological targets for carcasses, i.e. - complete carcass coverage by showers. - water pressure adequate to remove visible extraneous material. - specified concentration of sanitising agent, if used.	Visual assessment of carcass cleanliness of every carcass prior to chilling. Microbiological trend data may be used to monitor the hygiene and effect of partial-evisceration practice over time. Aerobic colony count (30℃ incubation), Enterobacteriaceae, coliform or *Escherichia coli* counts may be a useful measure of the bacteriological status of carcasses after partial-evisceration (ICMSF, 1998).	Carcasses that are not clean enough should not be chilled. When washing has not been applied correctly it must be reapplied where possible, or the carcass be fully eviscerated and washed inside and out. Increase frequency of monitoring. Review adequacy of operational and/or monitoring procedures.
Primary Chilling			
The aim of the primary chiller is to reduce the temperature of the meat in a controlled manner. Optimal air temp, relative humidity, air flow, carcass spacing which achieve greatest microbial reductions (without affecting the meat quality i.e. cold or hot shortening) need to be determined so that they may be used as critical limits.	Current legislation requires poultry carcasses to be chilled to a maximum temperature of 4℃. For storing meat for longer time periods lower maximum temperatures may be required. A time limit should be established within which the internal organs of the carcass should reach the target temperature.	The temperature of the surface and deep muscle from a representative sample of carcasses should be monitored regularly (preferably constantly) to check chiller performance. Alternatively, an air temperature which has been shown to consistently achieve the critical limits based on the temperature of the carcass surface and deep muscle can be monitored instead. Microbiological trend data may be used to monitor the hygiene and effect of chilling practice over time. Aerobic colony count (30℃ incubation) or psychotropic counts may be a useful measure of the bacteriological status of carcasses after chilling or during storage (ICMSF, 1998).	Carcasses that have not reached the target temperature should be chilled further until the target temperature is obtained. Carcasses that have taken longer than the critical limit to reach the target temperature should be fully eviscerated and not be used for partially-eviscerated production. If a deviation from a critical limit occurs, the following corrective actions will be taken: 1. The cause of the temperature exceeding 4℃ will be identified and corrected. 2. When the cause is identified, measures will be taken to prevent it from recurring e.g., if the cause is equipment failure, preventive maintenance program will be reviewed and revised, if necessary.

Storage and distribution			
Environmental and storage temperatures must be maintained, controlled and monitored at all times. Storage areas should be designed to maintain the correct product temperature. Raw materials should be stored separately from finished products. Practices which shut down power required for environmental and storage temperature maintenance should not be implemented under any circumstances. Contingency plans should be available to ensure the continued safety of products in the event of power failures. Meat should be at the correct temperature before loading since most transport refrigeration systems are only designed to maintain the temperature of the load.	Chilled partially-eviscerated poultry should be stored and distributed at <4℃. For long shelf-lives lower maximum temperatures may be required. Limited periods outside temperature control are permitted, to accommodate the practicalities of transport and storage provided that it does not result in a risk to health.	Temperature monitoring of the air temperature and/or product temperature should be continuous, or at least once every hour, as appropriate. Time-Temperature Integrators/Indicators on the packaging can be used to indicate adequate temperatures during storage and distribution, or abuse of the chill chain. The accumulation of microbiological assessments over time may be used as a trend analysis to establish the hygiene and effect of storage practice over time. Aerobic plate count (30℃ incubation) or psychrotrophic counts may be a useful measure of the bacteriological status of the meat during storage and distribution (ICMSF, 1998).	Excessive periods outside temperature control should result in carcasses being condemned.
Retail and catering storage			
Finished products likely to support the growth of pathogens or the formation of toxins are not to be kept at temperatures that might result in a risk to health. The cold chain should not be interrupted. Products should not be stacked higher than the max. level indicated in display cases, or in front of air ducts, or heat generating lamps.	Finished products should be kept at < 4℃. Limited periods outside temperature control are permitted, to accommodate the practicalities of displaying food, provided that it does not result in a risk to health.	Temperature monitoring of the air temperature and/or product temperature should be regular or preferably continuous. Time-Temperature Integrators/Indicators on the packaging can be used to indicate adequate temperatures during storage and distribution, or abuse of the chill chain. Microbiological trend data may be used to monitor the hygiene and effect of storage practice over time. Aerobic plate count (30℃ incubation) or psychrotrophic counts may be a useful measure of the bacteriological status of the meat during storage and retail display (ICMSF, 1998).	In case of refrigeration unit breakdown, the temperature of the products should be checked. If acceptable, the products should be moved to a suitable area; if not, they should be removed from the case, not offered for sale, and destroyed if necessary (Codex Alimentarius, 1999).

Retail and catering butchery *			
The temperature of the meat should be kept <4℃ and regularly monitored. Temperature monitoring of the air temperature and/or product temperature should be regular or preferably continuous.	The temperature of the processing area (cutting area, preparation area, etc.) should be maintained at ≤12℃ (ideally 10℃) to prevent the extensive proliferation of *L. monocytogenes* and *Salmonella* spp. The internal temperature of the meat should be kept at ≤4℃ during evisceration and dressing. For processing times >1 hour, lower maximum temperatures may be required Limited periods outside temperature control are permitted, to accommodate the practicalities of handling during preparation, provided that it does not result in a risk to health. Maximum limits for frequency of breakage of organs in the final completion of evisceration should be set.	The cleanliness of hands and cutting equipment is particularly important to prevent cross-contamination. The temperature history of the meat during preparation should be known. The cleanliness of hands and cutting equipment, and the effectiveness of cleaning should be regularly assessed. This may be carried out by adherence to a protocol and by periodical use of traditional microbiological methods and or non-microbiological rapid methods. Microbiological trend data may be used to monitor the hygiene and effect of storage practice over time. Aerobic plate count (30℃ incubation) may be a useful shelf life test for the meat and *E. coli* has been shown to be a useful indicator of plant hygiene (ICMSF, 1998).	Excessive periods outside the established temperature limits should result in the meat being condemned. Hands and equipment that is not clean as assessed by a rapid method or adherence to a protocol must be recleaned before use. Refine cleaning protocols when trend results from a rapid method or microbiological testing are above or moving towards established limits. Reassess partial-evisceration processes used if breakages exceed critical limits.

* At present we know of no guides or guidelines in English for the preparation of partially-eviscerated poultry carcasses for cooking (see Appendix J for an assessment of this process)

7 Overall Conclusions

A critical review of all available relevant and appropriate literature and data has been carried out, supplemented by a survey of current industrial practice and a practical evaluation of processes, to form a risk assessment of the public health implications of allowing partially-eviscerated birds into the food chain. This risk assessment considered:

1. What abnormalities may not be identified in partially-eviscerated poultry production when compared to traditional poultry production;
2. Whether the risk of zoonotic pathogens are any greater for partially-eviscerated poultry production when compared to traditional poultry production;
3. The aetiology of those conditions;
4. The public health implications of those conditions and of allowing partially-eviscerated poultry into the food supply.

Its conclusions, based on the available data, are:

Regarding the first point.

As noted by Löhren (2012), "*most of the abnormalities detected by the post-mortem inspection are more related to quality or animal welfare than veterinary or food safety issues*". The following abnormalities may not be identified in partially-eviscerated poultry and are a current cause for condemnation and are potentially of concern to public health:

1. Hepatitis
2. Pericarditis,
3. Perihepatitis/peritonitis
4. Respiratory disease (air sacculitis)

These abnormalities are usually detected by post-mortem inspection of the viscera (specifically the liver in the case of hepatitis and perihepatitis/peritonitis, the heart in the case of pericarditis, and the air sacs in the case of respiratory disease; air sacculitis). However, their occurrence is low in comparison with the prevalence of the main zoonotic pathogens that are associated with poultry meat. Also, their public health significance is as indicators of the presence of enteric microbial pathogens rather than any inherent pathology.

Regarding the second point.

We have found little evidence in the literature to suggest that pathology in birds and associated disease is of any significant importance compared with enteric pathogens such as *Salmonella* and *Campylobacter* spp. In common with recent reports (EFSA, 2012; Löhren, 2012; Horigan *et al.*, 2013) it can be concluded that main zoonotic pathogenic hazards in partially-eviscerated poultry are:

- *Campylobacter* spp.
- *Salmonella* spp.

These pathogens are both associated with faecal contamination and cross-contamination, especially that arising from spillage or rupture of the intestines during removal. Such spillage and rupture often occurs during mechanical evisceration. We have observed that it seldom occurs during the manual or mechanical removal of the intestines in partial-evisceration. In the French plants surveyed, when it does occur, such carcasses are fully eviscerated. Our own (limited) studies show little difference between the general microbiological quality of partially-eviscerated and fully eviscerated poultry.

Both of these pathogens are recognised as significant risks to public health by the FSA and poultry industry and subject to national control programmes (Campylobacter Risk Management Programme and UK Salmonella National Control Programme (NCP)) to reduce their prevalence in UK poultry flocks. These controls have significantly reduced the prevalence of salmonella in UK flocks in recent years. Birds destined for partially-eviscerated production will be subject to the same controls and benefit from these controls.

As noted by Löhren (2012) and the recent EFSA report (2012), neither *Campylobacter* or *Salmonella* spp. can be detected by traditional visual inspection, except by detecting heavily contaminated carcasses. Thus, it may therefore be concluded that detection is no different for partially-eviscerated or traditional production.

Regarding the third point.

Both *Campylobacter* or *Salmonella* spp. are generally associated with faecal contamination deriving from the intestines. In general, most studies and risk assessments have identified the intestines of poultry as a major source of pathogenic hazards, and breakage during evisceration causing faecal contamination as an important risk to public health.

It is clear from the literature that the organs left in the cavity of partly-eviscerated poultry carcasses are likely to harbour *Campylobacter* or *Salmonella* spp., especially the crop and liver. There is no published evidence to suggest that any pathogens present in the organs will diffuse into the muscles of the carcass during storage. No data has been found on the growth or survival of these pathogens in the organs during storage whilst in situ. There is some evidence that the storage life of in situ organs is greater than that of separated organs, this is probably due to the cross-contamination of organs during removal.

The feet have been identified in this project as a potential source of *Campylobacter* or *Salmonella* spp. contamination that is not present with standard fully eviscerated poultry. From our observations the removal of the feet and head (including the crop) from partially-eviscerated poultry could reduce the risk to public health and should be recommended. However, there is some evidence of a growing fashion for restaurants to be cooking and serving feet-on and head-on whole roast chickens.

Regarding the fourth point

Based on the current level of knowledge, the conclusions from this risk assessment are that while there are risks of zoonotic infection to the consumer associated with preparation and consumption of partially-eviscerated (effilé) poultry, these risks are generally no different to those associated with the preparation and consumption of traditionally processed poultry and, assuming a general level of compliance with regulations and basic hygiene practices, are unlikely to be responsible for anything

more than sporadic individual infection events in humans. It is our view that the production of partially-eviscerated birds in the UK, subject to the controls outlined in this report, would not result in any significantly increased risk to public health than current poultry processing. However, there is currently a dearth of quantifiable data on which to form a comprehensive risk assessment. In addition a number of gaps and deficiencies have been identified that need to be addressed in order to support an FSA policy decision on partial eviscerated poultry production in the UK. These are listed in the following section.

7.1 Gaps/deficiencies Identified

The assessed risks from the routes that we have covered can only be as accurate as the data used to inform them. Partially-eviscerated (effilé) poultry production is currently limited to a small region specific sector, thus it is no surprise that the availability and quality of data are lacking. However, it is slightly surprising, given that that this form of processing has existed for many years, that there is quite so little data available. Although effilé processing is briefly mentioned in a number of publications, few of these even accurately describe the process. For many factors (particularly ones that require a numerical figure such as concentration of pathogens) no data specific to partially-eviscerated poultry was identified. Nor unfortunately were we able to obtain any microbial data from producers (despite many promises). In addition, little expert opinion knowledge was identified to help assess the risks. There was also a dearth of data on prevalence's and concentration of pathogens on poultry other than broilers, especially ducks and guinea fowl. Data is currently deficient in the following areas:

1. No studies on the prevalence or concentration of pathogens in partially-eviscerated birds have been identified. The true prevalence of pathogens in birds is likely to be affected by exposure and susceptibility. Furthermore, the effectiveness of detecting the true prevalence will depend on detection methods, sample sizes and sensitivity and specificity of the sampling methods used. Prevalence and concentration of pathogens in the live bird can be assumed to be the same as conventionally processed poultry, however there is no data on the prevalence or concentration of pathogens in partially-eviscerated carcasses. In addition, there is very little data on the prevalence and concentration of pathogens in species other than chicken.
2. The prevalence and concentration of *Cl. perfringens* in hepatitic livers, and the public health risk of the handling or consumption of hepatitic livers.
3. The number of birds following each distribution pathway.
4. The frequency of consumption of partially-eviscerated poultry in and outside the home. Since little partially-eviscerated poultry is produced or supplied to the UK, it is difficult to gauge the current, or future, level of consumption of partially-eviscerated poultry in the UK. It is important to have a good idea of the current number of consumers as a significant increase in consumers could lead to a significant increase in risk.
5. The probability/level of cross-contamination during processing – while there is evidence to suggest the potential for cross-contamination to be a factor during processing, there are little data to accurately assess the level of the

associated risk (e.g. how many bacteria are transferred in a cross-contamination event).

6. The survival/growth behaviour of pathogens in partially-eviscerated carcasses from production to consumption. Duration of storage could significantly affect the pathogen concentration both in and on the carcass depending on temperature.
7. The risk of cross-contamination during the combined skinning and partial-evisceration of feathered carcasses (as observed in one plant). In addition, the survival/growth behaviour of pathogens on skin-off and skin-off-partially-eviscerated carcasses from production to consumption.
8. The risk of cross-contamination during the removal of organs from partially-eviscerated poultry, whether performed by the retailer, catering establishment or consumer.

We would recommend that these areas should be addressed in future studies. Of these eight points, we would recommend that priority should be given to addressing points 1, 7 and 8 in order to support an FSA policy decision on partial eviscerated poultry production in the UK.

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9 Appendix A: Literature Review on the Processing of Partially, Un-, and Delayed Eviscerated Poultry

Prior to the 1950s poultry carcasses were commonly supplied uneviscerated (so called “New York Dressed” (NYD)) to retailers in the UK (Godley & Williams, 2009). Evisceration was generally believed to shorten the shelf life of poultry, so was carried out by the retailer or consumer. NYD carcasses were still available, although becoming increasingly less common, in the UK until banned in 1997.

The EU Poultry Meat Directive (92/116/EEC) prohibited the production of NYD for large producers; however, it permitted a derogation from these requirements for farmers slaughtering less than 10,000 birds per year and supplying direct to the final consumer and local retailers. This directive was applied in The Poultry Meat, Farmed Game Bird Meat and Rabbit Meat (Hygiene and Inspection) Regulations 1995, and came into force on the 1st May 1997. The derogation for small processors remained until 2002. Since this date the supply of NYD poultry to the final consumer and local retailers has not been permitted in the UK. The production of delayed eviscerated poultry is permitted, such as in the case of “Traditional Farm Fresh” turkeys. Delayed eviscerated poultry are held under refrigeration for up to 15 d before being eviscerated by the processor and subjected to post-mortem inspection.

Despite the fact that commercially produced uneviscerated and partially-eviscerated poultry are still relatively common in some countries, and the processes far more common in the past, the literature review has shown that there is surprisingly little published data on either of these processes, particularly partial-evisceration. What literature there is, is relatively old (pre 1990s) and predominantly on fully uneviscerated poultry.

Only one specific publication on the microbiological safety of partially-eviscerated products was found: Pennington *et al.* (1911). This report, published in 1911, compared the “*rate of decomposition in drawn and undrawn market poultry*”. While this report may be old, it does give a very good description (and the only description we have found in any literature) of the two methods for carrying out partial-evisceration. Pennington *et al.* (1911) described these thus:

> *““Wire” drawing consists in pulling out a loop of intestine by inserting the finger through the vent; cutting the loop, and drawing out the gut by careful traction until it breaks at the gizzard. The vent of a bird so drawn presents a normal appearance; the only indication of drawing is the collapsed abdomen.”*
>
> *““Boston” drawing is a modification of the "wire" in that a circular incision is made around the vent and the intestines pulled through until rupture occurs at the gizzard.”*

Similar practices were observed in this project, as preferred processes, in different French plants currently producing effilé poultry.

In Pennington *et al.*’s (1911) trials the carcasses were dry picked and hand eviscerated under commercial conditions. At the time, fully eviscerated carcasses were eviscerated (i.e. the intestines and viscera were completely removed) and then heart, liver, and cleaned gizzard, as well as excess body fat were put back into the body cavity. The head and feet were also removed. The carcasses were cooled in air at 1°C for 24 to 48 h. The carcasses were transported under refrigerated

conditions for 1,700 miles, which took on average 7.5 days. The carcasses were stored at the wholesaler at 0°C and the average temperatures measured during retail were 8.9°C. It was during retail at this higher temperature that differences in the dressing and handling methods were shown to have an effect on microbial quality (as shown in Figure 13). This study showed that fully eviscerated broiler carcasses spoiled faster than partially-eviscerated and fully uneviscerated broiler carcasses. The partially-eviscerated carcasses spoiled slower than the fully eviscerated but faster than the fully uneviscerated. Overall of the two methods of partial-evisceration used, the "wire drawn" carcasses were usually better (in terms of microbial quality and other quality indicators) than the "Boston drawn". However, it should be noted that the practice at the time was for the heart, liver, gizzard and excess body fat to be returned to the cavity of the fully eviscerated carcasses after initial removal.

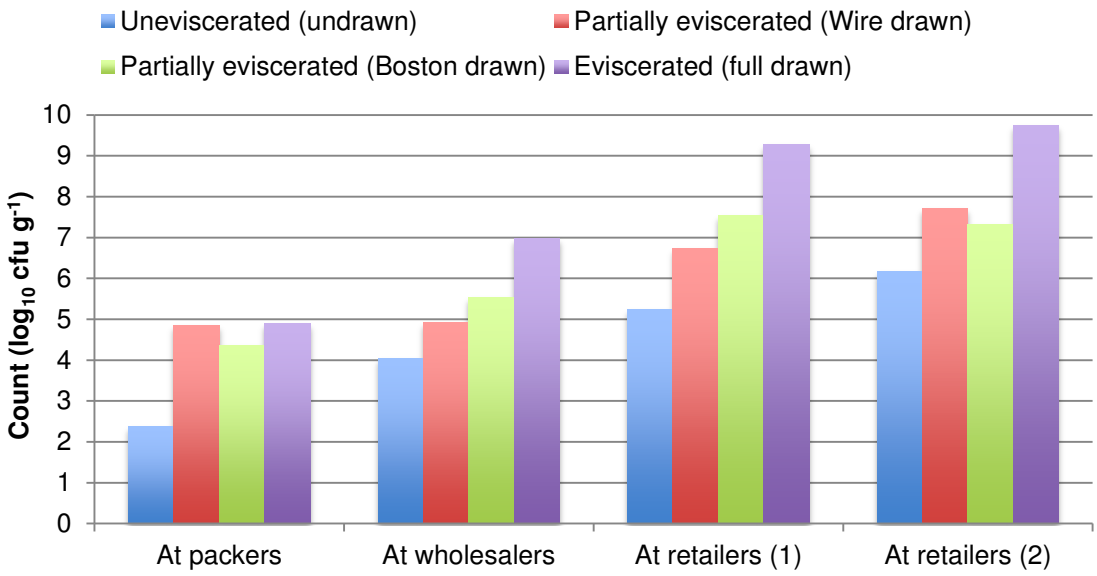


Figure 13. Increase in bacteria in the wall of the abdominal cavity of uneviscerated, partially-eviscerated and fully eviscerated (containing giblets) broiler carcasses during packing, wholesale and retail (adapted from Pennington *et al.*, 1911)

Enquires with scientific experts and industry representatives failed to identify any other publications. One French academic contacted had compared effilé with standard fully eviscerated carcasses in the past but had not published their results and did not have a record of the work. They remembered "*that the only difference, in a microbial point of view, comparing with "standard, eviscerated, air chilled broilers" was on the psychrotrophic flora (less Pseudomonas) and consequently on a longer shelf life. This was probably due to the use of less water during the process (manual "effilage") and for washing carcasses at the end (less organic material contamination on the skin).*" (Pierre Jean Marie Colin, personal communication, March, 2014). Similar observations, both the extension in shelf life and the importance of keeping the carcasses dry, were made by the effilé producers interviewed in the survey of industrial practice.

A number of publications were found on the processing and quality of uneviscerated and delayed eviscerated poultry. These papers are reviewed below. However, it should be noted that many of these publications are quite old, and processing and

microbial methods have changed, and the microbiological status of UK poultry improved.

The practice of "hanging" uneviscerated game birds to improve the flavour and impart "gamey" flavours is well known (Barnes, 1976; Barnes, 1979a, b), and other poultry, such as turkeys (Kijowski *et al.*, 2005; TFTA, 2011) are also hung uneviscerated for this reason. Hanging has also been reported to increase tenderness (Barnes, 1979b), although Griffiths *et al.* (1984) found it to have more of an effect on flavour rather than on texture. The organoleptic changes that occur during the maturation of uneviscerated turkeys were investigated by Griffiths *et al.* (1984). The authors showed that maturation over 8-23 days resulted in a significant improvement in the meat's sensory quality. A number of studies (Shrimpton, 1966; Griffiths *et al.*, 1984) attribute the changes in flavour during the hanging of uneviscerated carcasses to the metabolic products of intestinal microorganism, particularly caecal flora (Shrimpton, 1966). However, this has not been clarified, and French producers of effilé poultry also claim similar changes to flavour in a product where the intestines have been removed.

As well as improved flavour, a number of studies (Lockhead & Landerkin, 1935; Baker *et al.*, 1956) have shown uneviscerated carcasses to have a longer shelf life than eviscerated, particularly when stored at low temperatures (<5°C). Longer shelf-lives have also been claimed for partially-eviscerated carcasses. In a direct comparison of the shelf life of uneviscerated and eviscerated chicken carcasses processed and stored under the same conditions, Barnes & Impey (1975) found to evisceration to shorten the shelf life of chicken carcasses from 28 days (uneviscerated) to 7.9 days (eviscerated) when stored at 4°C. Lockhead & Landerkin (1935) and Baker *et al.* (1956) attributed the increase in spoilage rate and spoilage bacteria on fully eviscerated poultry to the fact that the abdominal region of the carcass is open to contamination and the water used for washing these carcasses may be a means of spreading spoilage bacteria. A recent study by Ziino *et al.* (2008) showed that uneviscerated chickens had better organoleptic characteristics than eviscerated chickens, and that contamination of coliforms in the deep musculature and abdominal cavity were also lower in uneviscerated carcasses than eviscerated carcasses, both stored at 3°C for up to 14 days.

One problem historically associated with the storage of uneviscerated poultry carcasses is "greening". Uneviscerated carcasses may develop skin "greening" during maturation, which is a result of myoglobin reaction in the muscle tissue caused by hydrogen sulphide produced by intestinal microflora (Barnes & Shrimpton, 1957; Shrimpton, 1966). Sams' (2001) book on poultry processing shows a photo of the "puncturing the abdominal skin (of uneviscerated carcasses prior to chilling) to release abdominal gas and prevent bloating", however we have found no other references to this practice. Greening was mainly associated with storage at what would now be considered high temperatures (15°C) and is known to be controlled by storage at lower temperatures. The intestinal organisms are predominantly mesophiles, thus the rate of greening, and hence spoilage, of uneviscerated carcasses is very temperature dependent (Barnes, 1976). For example, greening has been reported to take 24 h at 25°C, around 6 days at 10°C, 17 days at 5°C and not to occur after 31 days at 1°C (Barnes & Shrimpton, 1957). Uneviscerated poultry have been reported keep for a considerable time (2-3 weeks) when stored at <7°C as most of the intestinal bacteria cannot multiply below this temperature (Barnes, 1979b). The occurrence of greening may also be influenced by the birds diet. It has

been reported that wild birds (game) are less susceptible to greening, hence have a much longer shelf life when hung. Barnes (1979b) reports that game birds reared "*on a turkey diet throughout life … spoil in the same way as the uneviscerated chicken or turkey*".

During the maturation period the muscle itself seems to remain sterile (Barnes, 1976; Barnes, 1979a, b; Mead, 2004; Horigan *et al.*, 2013), the main changes have only been reported to take place in the intestine (Barnes, 1976; Barnes, 1979a, b). Barnes (1979b) reported that microorganisms "*multiply particularly in the small intestine where there are more nutrients and initially fewer bacteria in competition for those nutrients*". Therefore, unless a perforation of the intestines has taken place or the bird was ill prior to slaughter, no contamination of meat with intestinal microflora is reported to occur. It may be postulated that partial-evisceration was developed in order to reduce problems from greening, since removal of the intestines would negate this problem, however no publications have been found to confirm this.

In a number of articles and papers, Barnes (1976, 1979a, b) stresses the importance of keeping the skin of uneviscerated carcasses dry and intact during storage. She claims that removing the head, neck or viscera will contaminate the cut muscle surfaces and significantly shorten shelf life.

A further problem that is apparent with uneviscerated poultry is the difficulty in performing cold evisceration without rupture of the intestines (Mead & Scott, 1997; Fernandes, 2009). This is because of distension of the gizzard and intestines as well as thinning of their walls due to microbial and autolytic activity over the maturation period (Fernandes, 2009). Mead & Scott (1997) showed that manual evisceration of the uneviscerated chickens by volunteers experienced in 'cold' evisceration resulted in "*breakage of the intestines at one or more sites, often with leakage of gut contents, or extrusion of faeces from the cloaca because of pressure on the colon during the manipulation involved*". This resulted in contamination of carcasses in all the samples studied and significant cross-contamination and dissemination within the kitchen environment in which the carcasses were eviscerated. No similar reports have been identified in which the preparation of partially-eviscerated poultry carcasses have been studied.

The process of partial-evisceration as part of an integrated defeathering by skinning process was observed in a UK plant. We were unable to identify any scientific studies that have assessed skinning versus plucking as a process, however the process is advocated in some publications and websites aimed at domestic poultry growers, small holders and hunters (Ussery, 2011). There was a proposal to allow the practice (referred to as "hot-skinning") specifically for quail (for the domestic market) as part as proposed amendments to the poultry meat hygiene regulations in 1999 (MAFF, 1999). This was in recognition of the difficulties of skinning the carcasses of quail after plucking.

10 Appendix B: Review of Poultry Inspection

The original purpose of meat inspection was the identification of diseased animals and their removal from the food chain in order to address public concerns about meat safety. Some conditions, e.g. Trichinella (in pigs), pose serious human health problems but most are not zoonotic (i.e. not able to be passed from animals to man) and therefore of no importance to human health. Ante-mortem inspection picked out the obviously sick animals. It has been argued that the only problems of real public health importance detected at post-mortem inspection, using the normal visual inspection procedures, palpation and making incisions in various muscles and lymph nodes, are tuberculosis and the larval forms of various tapeworms (cysticerci). Other conditions for which part or the entire carcass is rejected (e.g. tumours, abscesses, bruises, parasites such as liver fluke and echinococcus cysts) are aesthetically objectionable, but not hazardous to humans. In spite of much discussion, particularly over the last 10-20 years, current inspection (EC Regulations 852, 853 and 854 2004) ante- and post-mortem still looks for similar things, although many animal diseases are now rare. In addition, few that can be diagnosed during either ante- or post-mortem inspection are of public health significance (Bremner & Johnston, 1996; Grist, 2006, Löhren, 2012; EFSA, 2012). The hazards of most importance for public health on poultry meat cannot be detected with the naked eye – e.g. *Campylobacter* spp., *Salmonella* spp., and emerging diseases such as avian influenza. In fact, it has been claimed that dissemination of some of these infectious agents may even be assisted by the traditional meat inspection procedures of palpation and cutting open lymph nodes (Berends *et al.*, 1996; Skovgaard, 1996).

Emphasis has moved to some degree towards applying Hazard Analysis Critical Control Points (HACCP) principles during rearing and in the plant; birds must be identified so that their carcasses can be traced back to the farm of origin. In the increasingly important farm assurance schemes and Food Chain Information (FCI) requirement, details of the farmer's and veterinarian's records of the birds during rearing must be recorded and made available to the processing plant. This includes any diseases, treatments and withdrawal periods, problems with previous birds from the same farm, results of tests for residues (pesticides, heavy metals etc). Particularly with poultry, where ante-mortem inspection at the plant is extremely difficult, and post-mortem inspection quite perfunctory due to the speed of the process line (up to 12,000 birds/h), control of zoonotic infections increasingly depends largely on examination of records from the farm and veterinarian, and closer examination of animals judged to pose the highest risk to human health. This can take the form of laboratory tests before the animals leave the farm – as is already happening with salmonella and campylobacter infections in poultry.

Regulation (EC) No 854/2004 of the European Parliament and of the Council lays down specific rules for the organisation of official controls on products of animal origin intended for human consumptions. In a meat inspection system, ante- and post-mortem inspections are recognised as valuable tools for surveillance and monitoring of specific animal health and welfare issues (EFSA, 2012). Inspection tasks within the EC Regulation include: Checks and analysis of food chain information; Ante-mortem inspection; Animal welfare; Post-mortem inspection (before and after evisceration); Specified risk material and other by-products and laboratory testing.

For eviscerated and partially-eviscerated poultry the above mentioned inspection task are basically identical except for the post-mortem inspection (after evisceration). Since the organs such as crop, proventriculus, gizzards, heart, kidney and liver are left inside the carcass of partially-eviscerated poultry, pathological findings which may occasionally be associated with the presence of some public health hazards may not be easily detectable. In addition, the detection of poultry organ contamination with gall or faecal material, which can sometimes warrant removal, and condemnation of poultry will be difficult.

10.1 Ante-mortem Inspection

As described in the FSA *Manual for Official Controls* (2013), "*the purpose of ante-mortem inspection is to:*

- *Determine whether there is any sign of any condition which might adversely affect human or animal health.*
- *Enable the OV (Official Veterinarian) to make the decisions as to whether the animal can be slaughtered for human consumption.*
- *Determine whether any test should be carried out in relation to disease diagnosis or for residues of veterinary medical products.*
- *Determine whether welfare has been compromised.*"

It notes that "*particular attention should be given when zoonotic or notifiable diseases are a possible diagnosis*".

Ante-mortem inspection is covered by EC regulation 853/2004 which describes the Food Business Operator (FBO) duties, and EC regulation 854/2004 which describes FSA requirements. Details of the tasks, responsibilities and duties are covered in the FSA *Manual for Official Controls* (2013).

When poultry arrives it is accompanied by a Health Certificate for live animals transported from the holding to the slaughterhouse, full OV ante-mortem inspection at the slaughterhouse is not required. In that case, ante-mortem inspection at the slaughterhouse can be performed by a suitably trained MHI. Inspection is to verify:

- Animal identification
- Animal welfare
- any condition that may adversely affect human or animal health.

Where the Food Chain Information received shows that the batch has tested positive for salmonella, the OV must ensure that the appropriate arrangements are in place to:

- Slaughter the batch at the end of the production day where possible, or at the end of a production run where necessary on welfare grounds and
- Undertake cleaning, and where required disinfection, after slaughter

10.1.1 Food Chain Information

As described in the FSA *Manual for Official Controls* (2013), "*FCI is a valuable source of information for decision making in relation to animal health and welfare and is needed for every animal intended for human consumption.*"

The information cycle (FCI and Collection and Communication of Inspection Results (CCIR)) is required by EC regulations 852/2004, 853/2004 and 854/2004. Council Directive 2007/43/EC lays down the minimum rules for the protection of chickens kept for meat production. The Welfare of Farmed Animals (Amendment) Regulations 2010 (England /Wales) and The Welfare of Farmed Animals (Scotland) Regulations 2010 implement Council Directive 2007/43/EC and specify additional Food Chain Information requirements in respect of conventionally reared meat chickens.

Since 01 January 2006, it has been a requirement that the FCI is supplied in respect of poultry intended for human consumption (FSA *Manual for Official Controls,* 2013). The information to be provided by the FBO rearing animals (farmer or producer), not less than 24 h before the arrival of the poultry at the slaughterhouse, is contained in the form 'Poultry FCI' (PFCI). This form has been provided by FSA to all slaughterhouse FBOs with details of the minimum FCI to be provided.

There is a statutory requirement for salmonella on-farm testing of each broiler flock within the period of three weeks before slaughter. The FCI must state whether the result was positive or negative.

Where a positive test result for *S.* Enteritidis or *S.* Typhimurium is indicated on the FCI, the FBO must take the following action (FSA *Manual for Official Controls,* 2013):

- Retain the affected batch(es) and slaughter them at the end of the production day.
- After slaughter, undertake a full cleansing and disinfection of all equipment and machinery, including changing the water in the scalding tanks, and renewing the water in spin chillers.
- Where a positive batch has been processed in the middle or at the end of a production run (either in error or on welfare grounds), then the production run should be stopped as soon as the affected batch has been processed, and a full clean down, as described above, take place before any further processing commences.
- Following production, in the absence of any relevant AM or PM findings, the carcasses can enter the food chain as normal.

Where a positive test result for a lower risk salmonella serotype (i.e. other than *S.* Enteritidis or *S.* Typhimurium) is indicated on the FCI, the FBO should take the following action (FSA *Manual for Official Controls,* 2013):

- Retain the affected batch and slaughter them at the end of the production day, or if this is not possible on welfare grounds, at the end of a production run.

- If slaughtered at the end of a production run, a thorough cleaning of the plucking and evisceration rooms must be undertaken after processing the batch and before any further processing takes place.
- Where a positive batch has been processed in error in the middle of a production run, then the production run should be stopped as soon as the affected batch has been processed, and a thorough cleaning of the plucking and evisceration room undertaken before any further processing commences.
- In any case, after the finish of production for the day, a full cleansing and disinfection of all equipment and machinery, including changing the water in the scalding tanks, and renewing the water in the spin chillers must be undertaken.
- Following production, in the absence of any relevant AM or PM findings, the carcass can enter the food chain as normal.

Where a positive test result is received the OV is to (FSA *Manual for Official Controls,* 2013):

- Check which salmonella serotype is detailed on the FCI and ensure that the relevant clean-down procedure is followed (as detailed in the previous sub-topics.)
- Check that the procedure has been followed in accordance with the FBO's HACCP-based food safety management system.
- Notify the inspection team that the flock is positive, and ensure that the appropriate judgement on pericarditis is followed in accordance with the information contained on the Pericarditis Poultry Condition card.

In a recent review of current poultry slaughter and inspection practices for EFSA, Löhren (2012) concluded that FCI data was mainly used today by the FBO of the slaughter plant for the following purposes:

- Logistic slaughter in case of salmonella findings and / or campylobacter (in some Scandinavian countries)
- Demonstration of freedom from Avian Influenza (marketing purposes)
- Requirements of some retailers and other customers with respect to the usage of certain drugs:
    - Tetracyclines and doxycycline can easily be found by exposing the bones to fluorescent light, even if the tissue residues are well below the MRL levels
    - Some countries, such as Russia, have a zero tolerance for tetracyclines and doxycyline so the use of fluroquinolones is critical, Some retailers request a guarantee that antimicrobials of this group have not been used.

During his investigation Löhren (2012) concluded "*that many OV make little use of the food chain information if it is presented in the way of a standard declaration*".

Where FCI indicates a positive result for salmonella, or where no salmonella testing is recorded, the FBO then follows the appropriate procedure from their HACCP system. These vary between nations but include practices such as:

- Reject affected batch
- Retain the affected batch and slaughter them at the end of the day
- Reduce line speed or increase the number of inspectors
- A full clean down must be made at the end of the batch

Löhren (2012) concluded that FCI is not greatly used to modify inspection procedures throughout Europe, although he argues that increasing the quality of FCI could allow for reduced intensity of inspection on normal flocks and increased intensity on known problem flocks. He also concluded that there is insufficient harmonisation in the implementation of Regulation 854/2004 across the European Member States and intention of a risk-based meat inspection (except for logistic slaughter) is not explained in detail in the specific legislation and not fully understood by the competent authorities of the Member States.

A series of studies by Lupo *et al.* (2013) have looked at the relevancy of FCI and ante mortem inspection. Among the flock's characteristics, which mostly contributed to the condemnation category prediction, were rather late information: mortality during the 7 last days of rearing, observation of health disorders during the last week of rearing and average bird weight at slaughter.

10.2 Post-mortem Inspection

As described in the FSA *Manual for Official Controls* (2013), "*the principal purpose of post-mortem inspection is to supplement ante-mortem inspection and to detect:*

- *Diseases of public health significance diseases of animal health significance*
- *Residues or contaminants in excess of the levels allowed by legislation*
- *The risk of non-visible contamination*
- *Other factors which might require the meat to be*
- *Declared unfit for human consumption or restrictions to be placed on its use*
- *Visible lesions that are relevant to animal welfare such as beating or long standing untreated injuries.*"

Post-mortem inspection is covered by EC regulation 854/2004, which details the:

- Purpose of post-mortem inspection
- Post-mortem inspection procedures and the decisions to be taken concerning meat.

EC regulation 853/2004 details the standards that the Food Business Operator (FBO) should provide and achieve for post-mortem inspection. Details of the tasks, responsibilities and duties are covered in the FSA *Manual for Official Controls* (2013). Further details are provided in the "*Guide to Food Hygiene and Other Regulations for the Meat Industry*" (Meat Industry Guide). Specific requirements for each species are listed in EC regulation 854/2004, Annex I, Section IV.

Post-mortem poultry inspection (after evisceration) is limited generally to visual inspection of the body cavity and organs and the judgement of fitness of meat for human consumption in current post-mortem inspection is based on the identification

of conditions making the poultry meat unfit for human consumption (EFSA, 2012). Post-mortem inspection of carcasses is designed to detect and withdraw from the food chain any carcass that has grossly identifiable abnormalities that could affect the meat safety and wholesomeness. As stated by EFSA, approximately 1-2% of poultry carcasses are condemned predominately due to endemic disease and welfare conditions, and are prevented from entering the human food chain (EFSA, 2012).

Routine post-mortem inspection examines the external and internal surfaces of the carcasses and internal organs after evisceration for disease conditions and contamination that could make all or part of the carcass unfit for human consumption. Regulation 854/2004 describes in details how meat inspection should be conducted for pigs and cattle. However, it does not specify how meat inspection of poultry should be conducted. That leaves it up to the member states to develop appropriate practices and registration codes (Alban *et al.*, 2011).

10.2.1 Condemnations

Current EU legislation lacks a clear catalogue of reasons for condemnation (Löhren, 2012), thus there are currently differences between how different conditions, or diseases are described or identified. The individual conditions or diseases quoted in the FSA *Manual for Official Controls* (2013) are the following:

- Breast Blisters
- Avian Tuberculosis, Erysipelas
- Abnormal Colour (septicaemia – toxaemia)
- AM rejects (cull/runts)
- Ascites - Oedema
- Bruising – Fractures
- Cellulitis
- Contamination
- DOA/DIL
- Dead other than slaughter (uncut–badly bled)
- Dermatitis
- Emaciation
- Hepatitis
- Joint Lesions
- Machine Damage
- Overscald
- Pericarditis
- Perihepatitis/peritonitis
- Respiratory disease (Airsacculitis)
- Salpingitis
- Tumours
- Other factory (processing)
- Other farm (e.g. jaundice, Oregon, white muscle)

Twenty-one poultry condition cards have been developed to achieve standardisation of post-mortem findings in poultry slaughterhouses in the United Kingdom (FSA, 2013).

Post-mortem inspection may take place after plucking, after evisceration, and prior to cooling (Löhren, 2012). Post-mortem conditions that may be identified post-plucking are (Löhren, 2012):

1. Undersized birds
2. Ascites birds
3. Cellulitis (deep dermatitis)
4. Not fully bled birds
5. Birds with skin defects e.g. Sarkomatosa (very rare)
6. Abnormal colour
7. Bruises
8. Broken wings or broken legs
9. Breast blisters

A number of surveys of condemnations at poultry plants have been carried out. As noted by Lupo *et al.* (2008), published condemnation rates from around the world reported have been quite consistent (Table 7). The majority of published surveys have covered broilers, only a few surveys have published data on turkeys (Bremner, 1994; Lupo *et al.*, 2010) or ducks (Bremner, 1994), Löhren's (2012) recent review of poultry practices for EFSA contains data on turkeys, ducks and spent hens, as well as broilers (Table 8). No published data on condemnations of guinea fowl have been found. There is some evidence that there may be a difference in condemnations between intensive and free-range birds, Talebi *et al.* (1993) reported a higher condemnation rate in free-range birds.

Table 7. Rate of total condemnations of poultry at poultry plants

Rate	Country		Date	Reference
1.72 to 1.96	Canada	Broilers	1980-1984	Ansong-Danquah, 1987
2.09	England	Broilers	1992	Yogaratnam, 1995
1.1	England and Wales	Broilers	1992-1993	Bremner, 1994
1.57	Germany	Broilers		Fries & Kobe, 1992
1.0	Switzerland	Broilers		Jakob *et al.*, 1998
1.02	Canada			Herenda & Jakel 1994
2.87	Canada		1991-1996	Klopfenstein & Lahaye 1999
0.97	US		1988-1997	Cervantes, 1999
0.73	Iran	Broilers	2002-2006	Ansari-Lari & Rezagholi 2007
1.23	England	Broilers	2003-2005	Haslam *et al.*, 2008
0.54	US	Young chickens	2005	US NASS, 2005
0.87	France	Broilers	2005	Lupo *et al.*, 2008
1.8	France	Turkeys	2006	Lupo *et al.*, 2010
0.33	Iran	Poultry	2009-2011	Gholami *et al.*, 2013

Table 8. Condemnation rates at poultry meat inspection in different EU member states (adapted from Löhren, 2012)

	Broilers	Turkeys	Ducks	Spent hens
Austria	1.45 %.	0.98 %	n.i.a.	1.45 %
Belgium	1.29 %	0.76 %	0.34 %	2.9 %
Denmark	0.7 %	n.i.a.	n.i.a.	n.i.a.
Finland	2.0 %	4.0 %	n.i.a.	n.i.a.
Ireland	0.017 %	0.02 %	n.i.a.	0.1 %
Ireland	1.1 %	n.i.a.	n.i.a.	n.i.a.
Italy	0.8 %	0.75%	n.i.a.	n.i.a.
Germany	2.35 %	2.13 %	2.75	n.i.a.
France	0.85 %	2.0 %	2.0 %	n.i.a.
Netherlands	0.84 %	n.i.a.	0.67 %	1.1 %
Sweden	0.5 %	n.i.a.	2.0 %	n.i.a.
United Kingdom	1.29 %	0.77 %	2.51 %	1.84 %
Cyprus	1.8 %	1.0 %	n.i.a.	n.i.a
Czech Republic	1.3 %	0.83 %	1.68 %	1.3 %
Estonia	2.65 %	n.i.a.	n.i.a	11.4 %
Latvia	0.6 %	n.i.a.	n.i.a.	n.i.a.
Slovenia	0.75 %	1.15 %	n.i.a	1.4 %
Slovakia	1.26 %	0.33 %	n.i.a.	1.03
Poland	0.37 %	0.815 %	0.25 %	3.374%
Hungary	1.3 %	1.2 %	1.5 %	1.3 %
EU- 27	1.12 %	1.12 %	1.40 %	2.8 %

Bremner (1994) reported on condemnation returns from poultry slaughterhouses in England and Wales from April 1992 to March 1993. Condemnations varied from 1.3% for broilers to 3.14% for hens, and disease was the reason for the majority of condemnations for all the species where there was sufficient information. “Septicaemia/toxaemia/fevered” were the most frequent causes of condemnation of broilers and turkeys, while “Ascites/peritonitis” and “Emaciation/cachexia” were the most frequent causes of condemnation of hens and ducks, respectively (Table 9).

Table 9. Causes of condemnations based on returns from poultry slaughterhouses in England and Wales from April 1992 to March 1993 (adapted from Bremner, 1994)

Order (most common 1st)	Broilers	Hens	Turkeys	Ducks
1	Septicaemia / toxaemia / fevered	Ascites / peritonitis	Septicaemia / toxaemia / fevered	Emaciation / cachexia
2	Emaciation / cachexia	Leukosis / Mareks / tumours		Ascites / peritonitis
3	Ascites / peritonitis			

(Septicaemia was considered a rather non-specific term that included congested birds.)

These surveys show that the majority of condemnations are caused by disease (Bremner, 1994; Ansari-Lari & Rezagholi, 2007; Lupo *et al.*, 2008). Emaciation and septicaemia are among the most common causes reported for condemnation (Table 10). In a survey of Iranian post-mortem condemnations, the most frequent causes of condemnation were emaciation (cachexia) and septicaemia (Ansari-Lari &

Rezagholi, 2007), accounting for 62% of total condemnations. While emaciation and congestion were also the most frequent causes of post-mortem condemnation in a French survey (Lupo *et al.*, 2008), accounting for 64.2% of total condemnations. In a UK survey of one poultry processing plant in 1992 septicaemia was cited as commonest cause of carcass condemnation (Yogaratnam, 1995).

Table 10. Causes of condemnations based on returns from poultry poultry plants

Order	Broilers	Broilers	Broilers	Turkey	Broilers	Poultry
1	Bruises	Cachexia (emaciation)	Emaciation	Emaciation	Acute internal pathology [1]	Cachexia (emaciation)
2	Arthritis	Septicaemia	Congestion (septicaemia)	Arthritis-polyarthritis	Emaciation	Septicaemia
3	Contamination	Poisoning	Infected skin lesions	Congestion (septicaemia)	Ascites	Ascites
4	Airsacculitis	Bronchitis/CRD	Bruises and wounds	Colour, odour or confirmation abnormalities	Skin condition/abscess	Bruises
5	Cyanosis/ Moribund	Bruises	Abnormalities of colour, odour or conformation	Infected skin lesions	Dead on arrival	Bronchitis/CRD
6	Emaciation	Ascites	Arthritis-polyarthritis	Bruises and wounds	Abnormal colour [2]	Poisoning
7	Mutilation	Marek's disease	Ascites	Generalised infectious diseases	Bruising	Overscalding
8	Cellulitis	Synovitis/arthritis		Ascites	Chronic pathology [3]	Contamination
9	Imperfect bleeding	Tuberculosis				Synovitis/arthritis
10	Pendulous crop	Overscalding				Marek's disease
	Canada *	Iran **	France ***	France	UK *****	Iran ******
Reference	Ansong-Danquah, 1987	Ansari-Lari & Rezagholi, 2007	Lupo *et al.*, 2008	Lupo *et al.*, 2010	Haslam *et al.*, 2008	Gholami *et al.*, 2013

* Based on official post-mortem inspection records of poultry in 1 industrial poultry plant in New Brunswick, Canada, between October 1984 and September 1985 (Ansari-Lari & Rezagholi, 2007).

** Based on official post-mortem inspection records of poultry in 11 industrial poultry plants in the Fars province, southern Iran, between 20 March 2002 and 19 March 2006 (Ansari-Lari & Rezagholi, 2007).

*** Based on official post-mortem inspection records of poultry in 15 industrial poultry plants in western France during 2005 (Lupo *et al.*, 2008).

*** Based on official post-mortem inspection records of poultry in 13 industrial poultry plants in western France during February to July 2006 (Lupo *et al.*, 2010).

***** Based on official post-mortem inspection records of poultry in 8 industrial poultry plants in the UK between September 2003 and March 2005 (Haslam *et al.*, 2008).

****** Based on official post-mortem inspection records of poultry in 28 industrial poultry plants in Tehran province between 20 March 2009 and 20 March 2011 (Gholami *et al.*, 2013).

[1] Birds with purulent or fibrinous adhesions to the heart, liver or intestines, or with such adhesions in the air sacs. Birds classified as ''pericarditis'', ''perihepatitis'', ''air sacculitis'', ''respiratory disease'', ''peritonitis'', ''septicaemia'' (diagnosed at the evisceration inspection point) ''*E. coli*'', ''enteritis'' or ''bacterial necrosis''.

[2] Birds easily distinguishable from the majority of birds on the line due to discolouration of the skin over most of the carcase. Birds classified as ''septicaemia'' (diagnosed at the whole bird inspection point), ''fevered'', ''toxaemia'', ''poorly bled'', ''badly bled'' ''abnormal smell'', ''jaundice'' or ''abnormal colour''.

[3] Birds with abnormal growths in one or more anatomical location, which are readily seen with the naked eye. These are classified as ''tumour'' or ''Mareks''.

Reasons for condemnation correspond more to anatomopathological findings than to a diagnosis of a cause leading to the observed lesions at the post-mortem inspection (Fallavena *et al.*, 2000). For example, liver lesions can be related to subclinical necrotic enteritis in chickens without being specific (Lovland & Kaldhusdal, 1999). In addition, post-mortem inspection can also detect conditions such as acute

septicaemia when there is an abnormal colour of carcass and offal (Fisher *et al.*, 1998). Septicaemia (one of the most frequent causes of condemnation), as noted by a number of researchers, is a rather non-specific term. It may include birds that were rejected because of congested, darkened muscles with inflammatory lesions such as airsacculitis and perihepatitis that may be an indication of disease, but it does not specify what the disease might be (Gracey *et al.*, 1999; Bremner, 1994; Ansari-Lari & Rezagholi, 2007; Lupo *et al.*, 2010). Among microbial causes of septicaemia, *E. coli*, *S.* Enteritidis, and *Pasteurella multocida* are important pathogens of human relevance. Therefore, as suggested by Fisher *et al.* (1998), identification of septicaemia might have important public health implications.

As Lupo *et al.* (2010) notes, caution is also required in any direct comparison of reasons for carcase condemnation with results from other studies due to the non-existence of a uniform classification at the international level. For example, Lupo *et al.* (2010) considered that the condemnation reason ‘‘septicaemia–toxaemia-fevered’’ reported by Bremner (1994) could be compared to their term ‘‘congestion’’, since they considered septicaemia as a rather non-specific term that included “congested” birds. The current FSA recommendation has replaced the term “septicaemia–toxaemia-fevered” with “abnormal colour/fevered”.

The latest raw condemnation data from English plants in 2013 on broiler, hens, turkeys, ducks, geese and guinea fowl (and data for Scotland and Wales for broilers) have been supplied by the FSA. We were informed by the FSA there was no or insufficient data for other species in Scotland and Wales. An analysis of the rates of total condemnations of poultry at English plants in 2013 are as shown in Table 11. This data shows a surprisingly higher rate of condemnations for broilers than that quoted by Löhren (2012), and that the highest rate of condemnations is for ducks, while the lowest is for geese.

Table 11. Rate of total condemnations of poultry in England in 2013 (data supplied by FSA)

Species	Rate (% of throughput)
Broilers	2.723
Hens	1.663
Turkeys	1.551
Ducks	2.814
Geese	0.938
Guinea fowl	1.827

The most common reasons for condemnations are similar to that reported in many other surveys (Table 12). Emaciation and septicaemia (now classified as “abnormal colour/fevered”), which are commonly in the top three causes in many surveys (Table 9 and Table 10), are within the top three causes for hens, turkeys, geese and guinea fowl. Although septicaemia is only ranked at 4 and emaciation very low in the ranking for broilers. Respiratory disease is the most common cause of condemnation for ducks, followed by pericarditis and ascites/oedema (Figure 14).

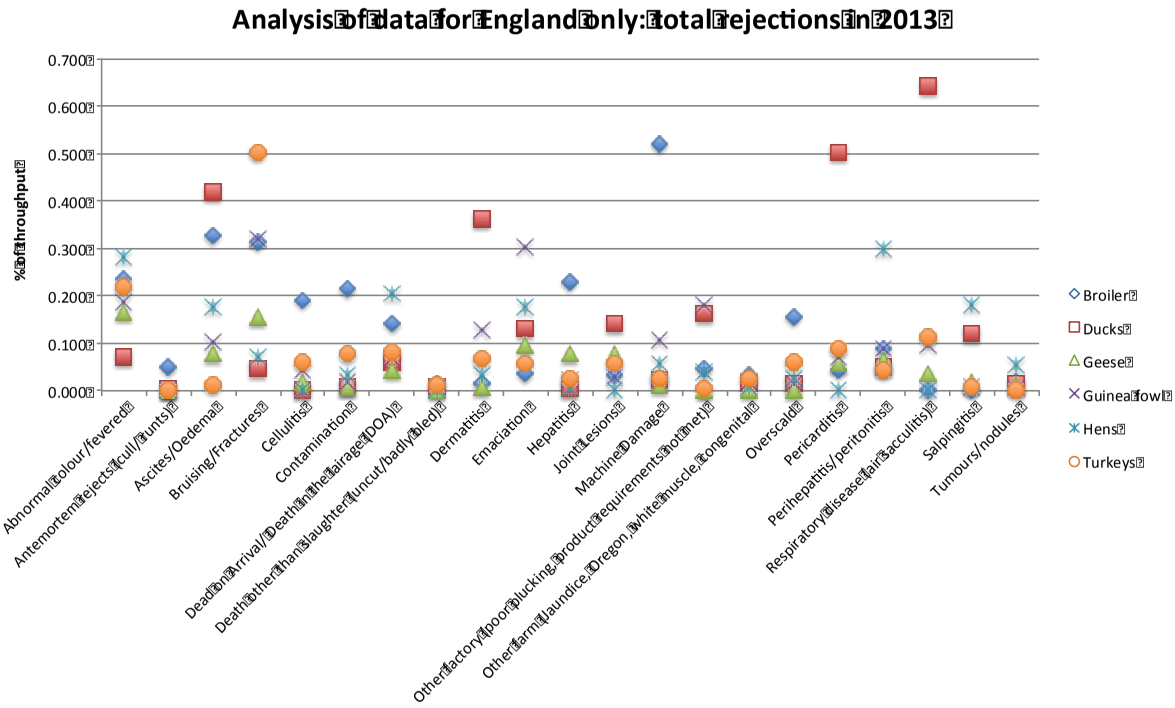


Figure 14. Causes of condemnation in poultry processed in England in 2013 (data supplied by FSA)

Table 12. Causes of condemnation in poultry processed in England in 2013 in ranked order, most common first (data supplied by FSA)

Broilers	Hens	Turkeys	Ducks	Geese	Guinea fowl
Machine Damage	Perihepatitis/peritonitis	Bruising/Fractures	Respiratory disease (air sacculitis)	Abnormal colour/fevered *	Bruising/Fractures
Ascites/Oedema	Abnormal colour/fevered *	Abnormal colour/fevered *	Pericarditis	Bruising/Fractures	Emaciation
Bruising/Fractures	Dead on Arrival/ Death in the lairage (DOA)	Respiratory disease (air sacculitis)	Ascites/Oedema	Emaciation	Abnormal colour/fevered *
Abnormal colour/fevered *	Salpingitis	Pericarditis	Dermatitis	Ascites/Oedema	Other factory (poor plucking, product requirements not met)
Hepatitis	Ascites/Oedema	Dead on Arrival/ Death in the lairage (DOA)	Other factory (poor plucking, product requirements not met)	Hepatitis	Dermatitis
Contamination	Emaciation	Contamination	Joint Lesions	Joint Lesions	Machine Damage
Cellulitis	Bruising/Fractures	Dermatitis	Emaciation	Perihepatitis/peritonitis	Ascites/Oedema
Overscald	Machine Damage	Overscald	Salpingitis	Pericarditis	Respiratory disease (air sacculitis)
Dead on Arrival/ Death in the lairage (DOA)	Tumours/nodules	Cellulitis	Abnormal colour/fevered *	Dead on Arrival/ Death in the lairage (DOA)	Perihepatitis/peritonitis
Perihepatitis/peritonitis	Other factory (poor plucking, product requirements not met)	Emaciation	Dead on Arrival/ Death in the lairage (DOA)	Respiratory disease (air sacculitis)	Pericarditis
Ante mortem rejects (cull/ runts)	Dermatitis	Joint Lesions	Perihepatitis/peritonitis	Salpingitis	Dead on Arrival/ Death in the lairage (DOA)
Other factory (poor plucking, product requirements not met)	Contamination	Perihepatitis/peritonitis	Bruising/Fractures	Cellulitis	Cellulitis
Pericarditis	Overscald	Hepatitis	Machine Damage	Machine Damage	Joint Lesions
Emaciation	Other farm (Jaundice, Oregon, white muscle, congenital malformations)	Machine Damage	Tumours/nodules	Tumours/nodules	Hepatitis
Other farm (Jaundice, Oregon, white muscle, congenital malformations)	Hepatitis	Other farm (Jaundice, Oregon, white muscle, congenital malformations)	Other farm (Jaundice, Oregon, white muscle, congenital malformations)	Contamination	Contamination
Joint Lesions	Cellulitis	Ascites/Oedema	Overscald	Dermatitis	Other farm (Jaundice, Oregon, white muscle, congenital malformations)
Tumours/nodules	Pericarditis	Death other than slaughter (uncut/badly bled)	Death other than slaughter (uncut/badly bled)	Death other than slaughter (uncut/badly bled)	Overscald

Death other than slaughter (uncut/badly bled)	Joint Lesions	Salpingitis	Contamination	Other farm (Jaundice, Oregon, white muscle, congenital malformations)	Death other than slaughter (uncut/badly bled)
Dermatitis	Death other than slaughter (uncut/badly bled)	Other factory (poor plucking, product requirements not met)	Hepatitis	Other factory (poor plucking, product requirements not met)	Salpingitis
Respiratory disease (air sacculitis)	Respiratory disease (air sacculitis)	Tumours/nodules	Ante mortem rejects (cull/ runts)	Ante mortem rejects (cull/ runts)	Tumours/nodules
Salpingitis	Ante mortem rejects (cull/ runts)	Ante mortem rejects (cull/ runts)	Cellulitis	Overscald	Ante mortem rejects (cull/ runts)

* analogous with ""septicaemia–toxaemia-fevered" classification used by Bremner, 1994

10.2.2 Conditions of concern to public health identified by post-mortem inspection

In a recent review (MLCSL, 2013) four conditions (Perihepatitis, Ascites oedema, Hepatitis, and Contamination) were judged by the veterinary expert on the consultancy team, in liaison with other experts, to be a cause of public health concern. These are shown together in Table 13, with reasons given for considering them to be of public health concern.

In addition, we have added airsacculitis based on the evidence of the paper by Russell (2003) that shows a link between Airsacculitis with campylobacter-positive carcasses and *E. coli* counts. However, as Singer *et al.* (2007) points out this single study was small, and consequently this relationship between respiratory disease status and potential microbial contamination of the meat is unclear. Pericarditis has also been linked with *S*. Enteritidis, Rampling *et al*. (1989) found that 58% of 81 carcasses rejected for pericarditis contained *S.* Enteritidis PT4. However, the prevalence of *S*. Enteritidis has been significantly reduced in the UK in recent years, with no broiler flocks testing positive for *S*. Enteritidis in GB in 2012 (AHVLA, 2012).

Table 13. Condemnation conditions in poultry that may be considered to be of concern to public health

Condition	Reason
Ascites/oedema	"In practice the carcass showing this condition is normally septicemic and removed from the line, also for "quality" purposes but included because if they are rejected they are a public health risk" MLCSL (2013).
Cellulitis	*E. coli* has been isolated from such lesions; considered a public health concern in countries such as Canada (Boulianne, 2001; Löhren, 2012).
Contamination	Visual contamination is associated with microbial contamination.
Hepatitis	"Condition leads to bile contamination, which is a reason for rejection and a public health concern rather than a major risk" MLCSL (2013). There is also some evidence of a link between *Cl. perfringens* and hepatitis (Hutchison & Riddell 1990; Herenda & Jakel, 1994; Løvland & Kaldhusal, 1999).
Pericarditis	There is some evidence of a link with *S*. Enteritidis -positive carcasses in birds with pericarditis (Rampling *et al*., 1989).
Perihepatitis/peritonitis	"Identified in that *E. coli*, like salmonella, is a major issue of public health concern and that this condition could indicate such an underlying cause" MLCSL (2013).
Respiratory disease (air sacculitis)	There is some evidence (Russell, 2003) of a link with campylobacter-positive carcasses and high *E. coli* counts in birds with airsacculitis.

10.2.3 Abnormalities that may not be identified in post-mortem inspection of partially-eviscerated poultry

An assessment of which conditions identified in Table 13 may be potentially missed during the post-mortem inspection of partially-eviscerated poultry was carried out by the veterinary expert on the project team, in liaison with the other experts, and is shown in Table 14. While we would consider contamination resulting from the breaking of the gut inside the carcass to potentially be a significant public health risk, it is debatable whether such an occurrence is more difficult to detect during the post-mortem inspection of partially-eviscerated poultry carcasses in comparison to fully eviscerated. Based on our observations of effilé production in France, we would consider it to be detectable. In addition, it should be noted that a recent EFSA review (2012) considered that the sensitivity of current visual inspection to detect faecal contamination to be low and there to be no direct association with the occurrence of pathogens.

Table 14. Initial assessment of which conditions of concern to public health may be potentially missed during effilé production

	Identification	Potentially missed in effilé
Ascites/oedema	Accumulation of fluid within body cavity and tissues	No
Cellulitis	Yellowing and thickening of the skin	No
Contamination	Visual inspection of exterior and cavity	Maybe
Hepatitis	Inspection of the liver	Yes
Pericarditis	Inspection of the heart	Yes
Perihepatitis	Inspection of the liver	Yes
Respiratory disease (air sacculitis)	Inflamed air sacs thicker than normal, appear white or opaque rather than transparent	Yes

10.2.4 Automated post-mortem inspection

Computer vision systems are being used increasingly in the food industry for quality assurance purposes. The system offers the potential to automate manual grading practices thus standardising techniques and eliminating tedious human inspection tasks. Computer vision has proven successful for the objective; online measurement of several food products with applications ranging from routine inspection to the complex vision guided robotic control (Gunasekaran, 1996). Current poultry processing systems are highly automated, including various stages of processing on the kill and evisceration lines as well as additional operations such as cutting and deboning of product. However, safety inspection of poultry carcasses is one area in which automation is not yet fully utilized (Chao *et al*., 2011). Inspection processes are subject to human variability, and the inspection speed restricts the maximum output possible for the processing plants while making inspectors prone to fatigue and repetitive injury problems (Chao *et al.*, 2007).

In the past decade a few studies have investigated both whole-carcass imaging and viscera-organ imaging methods for automated food safety inspection poultry (Chao *et al.*, 2007). The majority of this work has been developed and published by Chao and colleges at the Henry A. Wallace Beltsville Agricultural Research Center and Park and colleges at the Richard B. Russell Research Center, both in the US. Camera systems can help to identify the contaminated carcasses with greater reliability than the human eye (EFSA, 2012). Past studies have used colour imaging in red, green, blue colour space for laboratory inspection of chicken spleens, hearts

and livers was found capable of identifying poultry disease conditions including leukosis, septicaemia, airsacculitis and ascites (Tao *et al.*, 1998; Chao *et al.*, 1999). However, these methods require precise presentation of the visceral organs, which limits their use in laboratory setting. In addition, most poultry processing line equipment is not suited for incorporating this type of viscera imaging (Chao *et al.*, 2007).

For automated poultry carcass inspection, spectral imaging techniques can be used to detect skin discolourations, while Visible/Near-Infrared spectroscopy can be used to detect systemic conditions manifesting in skin and tissue changes (Chao *et al.*, 2004; Chao *et al.*, 2011). Visible/Near-Infrared spectroscopy systems have been demonstrated to achieve classification accuracies of 95 to 94% and 92 to 92% for "wholesome" and "unwholesome" carcasses at line speeds of 140 and 180 birds per minute, respectively (Chao *et al.*, 2004).

Camera systems can help to identify with much greater reliability than the human eye those birds that have an obvious defect. They are currently in use by some processing plants to downgrade birds or to score foot pad dermatitis (Löhren, 2012). Such systems may be of particular use for poultry intended for partially-evisceration processing since often the feet will be retained on such carcasses.

10.2.5 Post-mortem inspection of partially-eviscerated poultry

Little specific advice has been identified on the post-mortem inspection of partially-eviscerated poultry.

Council directive 92/117/EEC stated that "in the case of partly eviscerated poultry ('effilé') whose intestines were removed immediately, the viscera and the body cavities of at least 5 % of the slaughtered poultry from each consignment shall be inspected after evisceration". Based on this, Buncic (2006) advised the following protocol:

- Inspection of 5% of birds from the batch.
- Examination to focus on external surface, viscera and body cavity.
- If no abnormal conditions are found, other birds are not inspected.
- If any anomalies are found, all birds in the batch must be inspected.

The Ontario Ministry of Agriculture and Food have the following protocol for inspection and authorisation of uneviscerated (termed undrawn dressed poultry) and partially-eviscerated (termed partially dressed) (OMAF, 2009):

- Requirements for the protocol include records of production data, which must accompany all lots being considered for undrawn dressed poultry (UDP).
    - Such records include age of birds, lot size, mortality rates, treatment records, and average weights.
- Lots with more than 6% mortality rates at barn and/or affected with more than 1% dead birds on arrival are rejected for UDP processing.
- Thus the UDP inspection system employs ante mortem inspection findings as a tool for approving or rejecting a UDP request. In addition, a sample of the birds are fully dressed, and if more than 2% of those birds have internal conditions undetectable externally, UDP processing is not allowed.

- During UDP inspection, individual birds are examined for external conditions, and may be directed for evisceration and post mortem inspection.
- Records of UDP processing must be maintained.
- Partial dressing of poultry is permitted, provided that a thorough inspection of meat is not compromised and the dressing method does not contribute directly or indirectly to contamination.

This system is designed to detect diseased lots and direct them to evisceration.

10.3 Discussion

Although meat inspection is often a key point for identifying outbreaks of existing or new disorders or disease syndromes in situations where clinical signs are not detected on-farm, current post-mortem inspection methods do not directly contribute to preventing microbiological risks. The sensitivity of visual inspection to detect faecal contamination is considered to be low and there is no direct association with the occurrence of pathogens (EFSA, 2012). Following food safety related weakness highlighted in meat inspection system it was proposed by EFSA in 2012 that current visual inspection process be replaced by the establishment of targets for the main hazards on the carcass and by verification of the FBO's own hygiene management through the use of Process Hygiene Criteria (PHC) (EFSA, 2012).

Omitting visual post-mortem inspection however comes with consequences and two key consequences have been highlighted by the EFSA (2012):

1. Loss of opportunities for data collection about the occurrence of existing or new disorders or disease syndromes or welfare conditions of poultry, and
2. Potential for carcasses with pathological changes currently condemned during visual post-mortem inspection, to be further processed without the infectious nature of some conditions being detected.

In order to compensate for the loss of information about the occurrence of animal disease and welfare condition exploration and application of other approaches was recommended. Two approaches outlined by EFSA (2012) include;

1. Post-mortem checks continue on each carcass that is removed from the food chain, as part of a meat quality assurance system for example, due to visible pathological changes or other abnormalities.
2. Conducting detailed inspection on a defined subset of carcasses from each batch, guided by FCI and other epidemiological criteria, to obtain information about animal disease and welfare conditions. (The intensity (number of birds sampled) of targeted surveillance within each batch should be risk-based, with sampling of birds conducted randomly to provide a representative picture of the health and welfare of birds in the batch).

The need to review current meat inspection procedures has been widely acknowledged for many years (Edwards *et al.*, 1997; Löhren, 2012). Meat inspection has shifted from a product-based process to an integrated approach covering the whole food chain based on risk analysis (Lupo *et al.*, 2009). Safety and quality assurance systems are increasingly aimed to cover the entire food chain and are designed on the basis of the results of formal risk assessments of consumer health hazards (Blaha, 1999).

An integrated approach to meat inspection was suggested which outlined the construction, analysis and use of descriptive epidemiological models, covering the entire period from stable to table (Berends *et al*., 1996). Designing a food safety system to cover the whole food chain is in accordance with current European regulations, as ‘‘relevant food chain information’’ about the flock to be slaughtered now has to be provided to the meat inspectors (Anonymous, 2004a,b). Such an integrated food safety system could lead to flocks being classified into food-safety risk categories at the slaughterhouse (Lupo *et al*., 2009), in an attempt to adapt the subsequent sanitary inspection of a flock according to its food-safety risk category. Previous studies suggested that the sanitary inspection could be better organized if the post mortem abnormalities at slaughter could be predicted as extra attention could be paid to deliveries expected to have a high level of abnormalities (Blaha *et al*., 2007; Lupo *et al*., 2009, 2010).

10.4 Conclusions

With the new Regulation (EC) 854/2004, slaughter of animals with diseases is more strictly prohibited than it was previously. Overall, we can assume, that only healthy birds come to slaughter since the health status of the flocks in the EU is basically good. However we conclude that in the case where the organs are still left inside the carcass as in partially-eviscerated poultry, alternative approaches to normal post-mortem inspection (after evisceration) practice need to be considered and assessed.

This review of current inspection practices has identified that there are currently twenty one conditions that are looked for during post-mortem inspection of poultry. Of these the majority of conditions are not related to a public health risk. Seven conditions may be considered to be of concern to public health (Ascites/oedema, Cellulitis, Contamination, Hepatitis, Pericarditis, Perihepatitis/peritonitis, Respiratory disease (airsacculitis)). Of these seven conditions only four (hepatitis, pericarditis, perihepatitis/peritonitis, and respiratory disease (airsacculitis)) may not be identified during post-mortem inspection of partially-eviscerated poultry. The overall occurrence of these conditions would appear to low, as is the risk of these conditions to public health in comparison to the prevalence of the main zoonotic pathogens (campylobacter and salmonella) that are associated with poultry meat.

At present there are no agreed protocols for the ante-mortem and post-mortem inspection of partially-eviscerated poultry in the UK. Past UK regulations (Poultry Meat, Farmed Game Bird Meat and Rabbit Meat (Hygiene and Inspection) Regulations 1995) required post-mortem inspection of partially-eviscerated poultry to be carried out by fully eviscerating and inspecting at least 5% of a specified group. Whilst The Ontario Ministry of Agriculture and Food protocol for ante-mortem inspection and authorisation of uneviscerated and partially-eviscerated requires that “*Lots with more than 6% mortality rates at barn and/or affected with more than 1% dead birds on arrival are rejected for UDP processing*”. Such mortality data is currently recorded in the FCI forms. We conclude that ante-mortem and post-mortem inspection of partially-eviscerated poultry in the UK should be based on these two protocols.

In a wider context we conclude (in common with many other reviews of inspection) that there is a need to review the appropriateness of current poultry inspection procedures in the context of public health requirements.

11 Appendix C: Survey of Industrial Practice

11.1 Aim

The aim of the industrial survey was to collect information from industrial processing facilities currently carrying out effilé[3] or partial-evisceration processes to inform the project team of current practices, and identify specific practices that would need modification to adopt partial-evisceration practices in the UK.

11.2 Materials and Methods

The full list of French processors that were identified and contacted by email for the effilé processing survey is shown in Appendix D. A sub-set of these plants were wiling to accept a visit from the project team and were visited in December 2013 and January 2014. Details of the companies visited are shown in Table 15.

Table 15. Details of effilé plants visited

Plant	Location	Visit Date	Size (total birds/week)	Effilé Line speed (bph)	Products produced
A	Landes Department, France	10-Dec-2013	Large (c.225,000)	3,600 (max)	Effilé Poulet Noir, Poulet Jaune, Poulet Blanc, Pintade, Standard chicken*, small turkey (<4kg)
B	Gironde Department, France	11-Dec-2013	Small (<20,000)		Effilé Poulet, Standard chicken*
C	Dordogne Department, France	29-Jan-2014	Small (c. 10,000)	220 (typical)	Poulet (Effilé, Pack, & Standard*), Pintade, Canette, Canard, Lapin, Poule, Coq, Pigeon, Caille, Coquelet
D**	Dordogne Department, France	29-Jan-2014	Large (c.180,000)		Standard Chicken*, Effilé Chicken, Special Boucherie
E**	West Midlands, UK	06-Feb-2014	Medium (c.100,000)		Standard Chicken*, Effilé Chicken in the past, Standard (skin-off)
F	West Midlands, UK	06-Feb-2014	Small (2,000 to 3,000)	200-250	Skinless partially-eviscerated chicken (head & feet off)

* Fully eviscerated 'Oven ready', ** Process described only: not viewed first hand

All plants (except F) produced effilé and other types of carcasses. Plant F was a UK processor producing halal skinless partially-eviscerated broilers for the local Asian restaurant market.

During visits the team walked the processing line, took photographs (where permitted), and used a target information checklist (Appendix E) to guide discussions and questioning of host facility staff.

11.3 Results

A combined summary across all plants is given in the following sections

[3] Within this report the term "partially-eviscerated" is used throughout to describe this product, except when referring specifically to French produced poultry, plants and processes when the term "effilé" is used.

11.3.1 Effilé processing plants: General information

In all French plants the initial parts of the process, i.e. growing, transport, hanging, stunning, sticking, bleeding, scald and defeathering were common for effilé and fully eviscerated carcasses. There was then a selection of individual carcases for effilé processing before evisceration started (objectively based on the following characteristics: Good carcass conformation, No skin damage, Correct skin colour (changes with type of effilé, based on breed and species), uniformity of skin colour.

In the UK plant visited partially-eviscerated processing was performed in batches with no selection on visual quality.

Weekly total production across the surveyed French plants varied between c. 10,000 birds per week in the smallest plant to c. 225,000 birds per week in the largest plant. Of these, between 1% to 40% of birds killed would go to effilé depending on the orders received and there being sufficient birds of the required quality. 100% of Plant F production was effilé. The maximum line speeds ranged from 220 birds per hour (Plant C) to 3,600 birds per hour (Plant A) during effilé production although not every shackle was loaded.

In France all effilé line operatives were trained in visual inspection to identify externally visible defects that would not be acceptable for final effilé carcasses. All staff could deselect carcasses from effilé production, with only external indicators on the carcass used for inspection. There was no formal organ inspection station seen on any French effilé line.

In the UK, inspection was performed by the OV immediately before the final wash. Rejects were passed back down the line to a remediation operative who dealt with the issue and then presented the carcass for re-inspection.

Three of the four French plants visited had external audits from Label Rouge as well as the appropriate veterinary authorities. The Label Rouge system is seen as a mark of overall meat quality and whilst not a prerequisite for effilé, the majority of effilé carcasses, are produced to Label Rouge specifications. One plant visited did not use the Label Rouge system as the owner believed he had a superior system and an established trade that did not require the Label Rouge certification.

Carcasses de-selected from the effilé prior to chilling were typically fully eviscerated and remediated to become fully eviscerated standard carcasses. However, once chilled, rejected effilé carcasses were not permitted to be remediated to fully eviscerated and were completely rejected to waste.

11.3.2 Effilé processing steps

11.3.2.1 Growing

All French plants visited used birds from slow growing, bare necked breeds from South West France (e.g. Cou Mu, GA59) reared in free-range conditions. Poulet Noir are produced from black feathered breeds. The chicks are generally reared indoors until 4-5 weeks old. Birds forage free during the day and naturally return to sheds to roost at night. The shed doors are opened at dawn and closed at dusk by the farmer. On collection day, the doors are not opened and the feed is withdrawn for 24 h before the pickers go in to fill up the crates.

Feed regimes for French effilé carcasses are the same as for fully eviscerated. Carcasses for effilé are selected after slaughter so feeding and growing regimes are identical.

Effilé processing predominantly carried out on free-range birds. This is not a perquisite for effilé, but more of an indication of perceived quality. The majority of the French plants used birds produced under the Label Rouge designation. This requires a corn-fed free-range bird slaughtered at 81-90 days old. The typical live weight at slaughter was 2.2-2.4 kg in these plants.

One French plant was vertically integrated, owning both growing houses and the processing facility. In this organisation, chicks were bought at one day old from certified salmonella-free hatcheries and raised free-range on in-house produced vegetarian feed. Birds were slaughtered at 101 days minimum at a minimum weight of 2.2 kg.

Little if any, specific food chain information (FCI) was used when selecting birds for effilé processing. FCI was used to confirm flocks were healthy and could be sent to slaughter, and as part of traceability systems. Individual carcasses were selected for effilé processing from these cleared flocks based on conformation, skin colour, damages, etc.

The two UK plants were supplier by the same local grower. There was no stipulation on breed. The key supply criteria being smaller birds (1.6-2.0 kg live weight) as the larger carcasses were not required by the food service customer base of the plants. The feed withdrawal period in the UK was typically shorter at around 4-6 h particularly as the lighter birds for UK skinless effilé would be from flock thinning. If longer withdrawal periods were used, the remaining un-thinned birds would gorge when feed was reintroduced causing health problems.

11.3.2.2 Lairage

In the largest French plant, there was a standard crate and modules system where the birds were held before hanging in subdued lighting.

The smaller plants were typically supplied locally by smaller growers where the farmer loaded the crates and delivered them by trailer or van to the plant. The plant did not use particularly subdued lighting in the lairage.

There was no difference in the lairage of birds for effilé or fully eviscerated lines.

11.3.2.3 Hanging, stunning and sticking (France)

Hanging was conventional and carried out in reduced light conditions in all plants. This was carried out by 1 to 12 operatives, based on the line speed of the plant, with a normal two leg inverted hanging onto standard shackles. Conventional electric bath stunning was used in all plants. These were of various lengths dependent on the line speed of the plants.

For French effilé carcases sticking was carried out in a manner that did not show an external wound on the finished (head on) carcass. This was performed in all plants by a cut to the base of the tongue with either a small a narrow (c. 20 mm wide) plain knife (Figure 15), or a short (c. 30 mm long) bladed scissors.

Figure 15. Effilé sticking knife

The number of operatives carrying out sticking varied between one to three and was based on the line speeds. All the carcasses were stuck in this way during periods when the later selection for effilé processing was possible. Several plants also had a standard disc-knife auto throat cutter for periods where only fully eviscerated carcasses were being produced.

Observations suggested that knife stuck carcasses gave a more rapid bleed out than scissor stuck carcasses. According to the plants a shorter bleed out time was required for guinea fowl.

There was no difference in hanging, stunning, sticking or bleed out of birds for effilé or fully eviscerated lines.

11.3.2.4 Coning and throat opening (UK)

In Plant F (halal), the birds were taken out of the lairage crates and then placed head down in a non-powered carousel of cones. The throats were slit following halal practices and carcasses were allowed to bleed out as they progressed. The carousel was manually advanced by several cones thus bringing fully bled carcasses back to the operative who would remove them from the cones and hang them onto every 3rd shackle of the main process line on a standard two leg hang.

11.3.2.5 Scalding and plucking (France)

Scalding was typically 3-4 min at 52℃ for chicken (50℃ for guinea fowl). The maximum scalding temperature was 53℃.

There was no difference in scalding of carcasses for effilé or fully eviscerated lines.

Standard mechanical wet plucking machines were used in all plants. Lengths and configurations varied considerably between plants and no post-pluck spray wash was seen in any French plant. We were told that duck effilé plants use wax based feathering.

There was no difference in scalding and plucking of carcasses for effilé or fully eviscerated lines in France.

The UK line used a skinning method for defeathering and thus scalding and plucking stages were not required.

11.3.2.6 Electrical stimulation – One French plant only

One plant used a 1 min electrical stimulation for all carcasses to reduce maturation time. In this plant one operative was located immediately after the electrical

stimulation to inspect, remove feathers, rehang legs displaced from shackles during plucking, etc. Both effilé and fully eviscerated carcasses were electrically stimulated.

11.3.2.7 Evisceration

Different effilé evisceration processes were observed in all plants. All the French plants were producing a skin-on effilé carcass, and the operations were concerned with removal of the intestine and duodenum. The UK plant (Plant F) used a skinning method to produce a skinless final product, and here the skinning and intestine/duodenum removal were inherently linked.

11.3.2.7.1 Plant A Effilé Evisceration

Carcasses are externally visually inspected as they entered the evisceration room for bird health and any processing damage. Loose feathers were removed by hand if seen.

One person selected carcasses for the fully eviscerated or effilé line. The basis for effilé selection was objective and based on personal appraisal of: Good carcass conformation, No skin damage, Correct skin colour (changes with type of effilé, based on breed and species of bird), Uniformity of skin colour.

Carcasses selected for effilé were moved to pass one side of a rubbing plate, while standard carcasses passed by on the other side.

Carcasses selected for effilé were automatically de-shackled and dropped onto a conveyor belt where operatives manually rehung them onto the effilé evisceration line. This was a normal inverted hang with two legs to shackle with the back of carcass toward the operatives. Not all shackles were filled at the time of observation since the degree of filling depended on the frequency of selection for effilé.

The neck of each carcass was manually pulled backwards and located on the pegs of a parallel conveyor running synchronous with the evisceration line. This exposed the carcass breast up to the operatives (similar to an inverted lamb dressing presentation).

A cut was made manually with short blade scissors to the ventral side of the vent to provide an opening into the cavity.

Using a short round-ended hook (wire diameter c. 5 mm, hook radius c. 10 mm), some intestines were manually hooked out by an operative to hang outside the carcass.

Operatives manually pulled on the exposed intestines relying on a natural weakness just after the gall bladder to separate the intestines at the “correct” place (approx. 20 mm from the gall bladder). The plant stated that the gall bladder is seldom damaged (<1%). Gall bladder damage was seen only once during our observations (c. 30 min). If gall bladder contamination is seen, the carcass was deselected for effilé, thoroughly washed and then fully eviscerated to become a standard carcass.

Once pulled and separated, the intestines and duodenum were dropped below the working area onto conveyors running into a waste chute.

No separate intestine/duodenum inspection was carried out, beyond the visual sensing required by operatives to perform the evisceration tasks.

Following partial-evisceration a carcass spray wash was directed horizontally at the vent area. This wash point was only on the effilé line.

Gloves were used by all line operatives with quick (c.1 s) glove washes carried out every 2-4 carcass.

For chickens the head was released from the peg conveyor to allow the carcass to revert back to a normal two leg hang. When processing guinea fowl, carcasses were removed from the line, the legs/wings manually trussed in air (not on a table) and rehung by the head on the shackle line.

11.3.2.7.2 Plant B effilé evisceration

All the carcasses had the intestines and duodenum removed by a machine consisting of an annular knife with a central vacuum (Figure 16). The operative pushed the vent of the carcass in the centre of the annular knife, which made a separation cut around the vent. A vacuum system then drew the cut plug and intestines into a pipe to waste. The approach relies on the natural intestinal weakness close to the gizzard to separate at the correct place (Figure 17). One manufacturer of such machines that has been identified is ACMA (Ateliers de Construction de Matériel Agricole) based in St Victor des Oules, Languedoc-Roussilon, France (www.avicole.fr). See Appendix F.

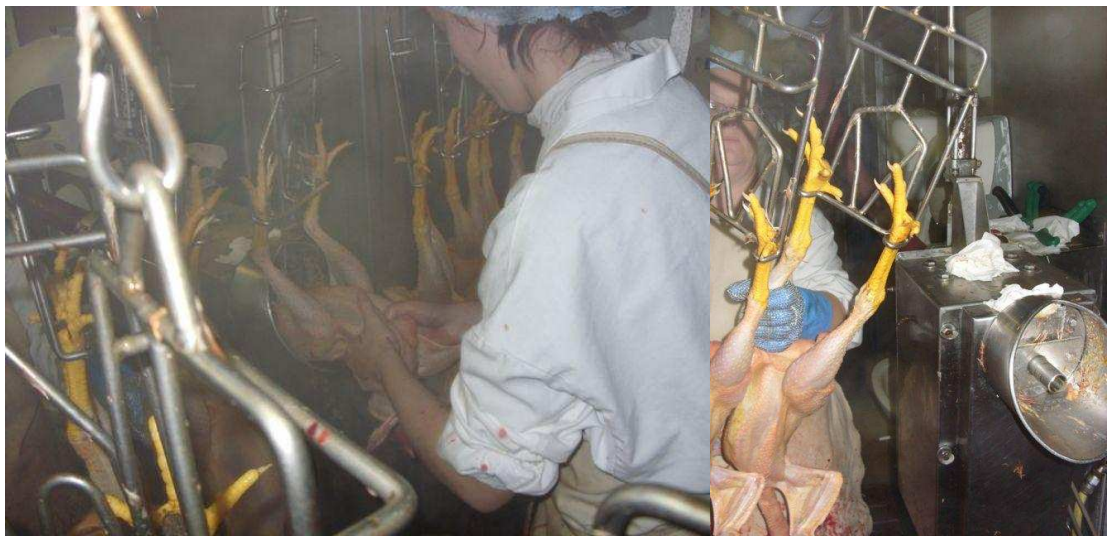


Figure 16. Machine based removal of intestine and duodenum (Plant B)

No inspection of the intestine / duodenum was made as it was within the waste chute.

This partial-evisceration process was carried out for all carcasses whether to be for fully eviscerated or effilé carcasses. The operative of the intestine removal machine selected carcasses for effilé on the basis of external visual quality and signalled subsequent operators to process as effilé by removing one leg from the shackle. [Subsequent line operations (neck skin cut, neck and head removal, and completion of evisceration) were only carried out for carcasses hung by two legs.]

All carcasses were then hung vertically downwards and passed through a wash sprayed from above. Finally, the carcasses were checked for quality of evisceration and poorly eviscerated effilé carcasses deselected from effilé.

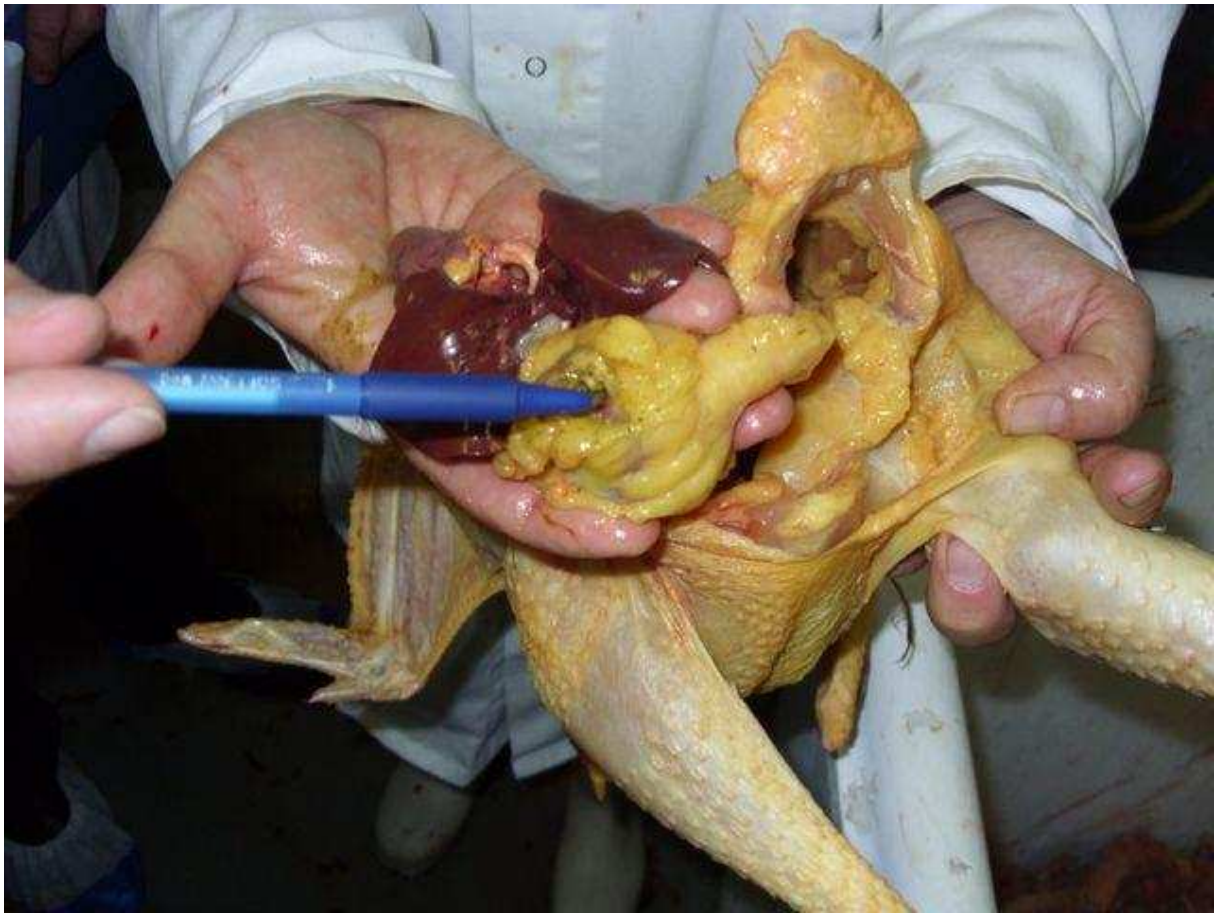


Figure 17. Remaining viscera in effilé chicken from Plant B, pen points at gizzard where duodenum separated

11.3.2.7.3 Plant C effilé evisceration

An operative located after the plucker selected carcasses for effilé and indicated this by locating the neck of the carcass in between the feet using the same shackle (Figure 18).

Effilé evisceration was carried out manually and without any preparatory cuts. The operative's finger was inserted into the oviduct through the vent and bent into a hook shape, rotated approximately a ¼ turn and then pulled out. This pulled the intestine out through the vent. He then washed his figure and the intestine was pulled to snap off at the natural weak points approximately 15 mm from the gizzard, and just inside the vent. This process was said to be the traditional effilé method and that by leaving the vent in place this acted as a seal to prevent water and air ingress into the carcass cavity. The use of a finger rather than a metal hook was claimed to reduce the risk of intestine puncture during the operation. If performed correctly and with skill, the wall of the intestine should not be perforated during the process, nevertheless observation showed that even experienced employees did occasionally cause some damage to the carcass. In such cases, carcasses would be deselected from effilé and undergo full evisceration and internal wash. Operatives did not wear gloves but washed hands frequently between carcasses and steps of eviscerating one carcass. The removed intestines and duodenum were condemned into a waste

bucket with no further inspection. Carcasses were then subjected to short external wash concentrated on the sides of the carcass rather than the vent area.

Figure 18. Plant C carcass hang for start of effilé processing

Figure 19. Bayle Annular Knife Vent Cutter machine with central vacuum

The first stage of full evisceration in Plant C (Figure 19) used a vent cutting annular knife with central vacuum machine (Model 'Pupitre Effilage'; see Appendix F) produced by Bayle based in La Fouillouse, Loire, France (www.baylesa.com). Whilst this could also be used for their effilé carcasses operators in Plant C believed their manual finger method gave a better quality end product.

11.3.2.7.4 Plant D effilé evisceration

The effilé evisceration operation in Plant D was described to us and not seen first hand. This was similar to the no-pre-cut version of effilé carried out at Plant C, but a

metal hook was used in preference to a finger. A short blunt hook ('Crochet de Effilage'; see Appendix F) was inserted into the vent and rotated approximately ¼ turn and then pulled out extracting a proportion of intestine out through the vent. The intestine was then pulled to snap off at the natural weak points approximately 15 mm from the gizzard, and just inside the vent. As only very skilled and experienced workers are selected for the role Plant D claimed that perforation of the intestine inside of the carcass does not happen.

An additional practice carried out in Plant D for effilé chicken was the removal of the crop in addition to the intestine and duodenum. It is considered that these organs pose the greatest risk to carcass contamination and removal makes a safer product. The crop was removed whilst leaving the head and neck attached to the carcass. A knife cut was made along the sides of the neck to reveal the oesophagus that is then carefully pulled away from the carcass. The oesophagus was followed to reach the crop, which was then separated by a knife cut above and below to remove it from the carcass.

11.3.2.7.5 Plant E effilé evisceration

The effilé evisceration process in Plant E was again described to us and not seen first hand. The first operation was to make slit into the cavity close to the vent and then rehang the carcass by the head so that the vent becomes the lowest point. This can cause some intestines to fall out under gravity. Then the operatives use two gloved fingers to reach into the cavity and pinch the intestines free from a point adjacent to the gizzard. The intestine was then separated from the carcass and the cut around the vent completed to release the intestine with vent attached.

11.3.2.7.6 Plant F effilé evisceration

This plant was producing a skinless effilé chicken and had an effilé process inherently connected with the skinning procedures. The skinning/partial-evisceration operation was carried out in three steps, with each step being carried out by a different operator.

1. The first operator made two cuts on the inner legs of the carcass and the skin was pulled free from the breast. The head was then removed to enable release at this point. The skin was then pulled from the wings using a few small assisting cuts. Once the skin was free on the lower arm of each wing the wing tip (hand) was cut. Cut at elbow.
2. A second operator then inverted and rehung the carcass onto an adjacent clean shackle by the wings.
3. A third operator then removed the feet. The remaining section of skin/feathers was pulled off the lower back down to the posterior area. The tail was cut off to expose the cavity and the vent freed. The skin (with intestines still attached to the inner surface) was then pulled free from the carcass. The intestines were pulled out and allowed to snap off at the natural weak point close to the gizzard.

The operatives wore gloves for the evisceration and washed the knife between each carcass. According to the plant, any potential contamination incidents were rectified by either slowing the line to suitable speed where operators could perform their duties more carefully.

The carcasses them passed through OV inspection and a horizontal spray wash booth using mains water.

11.3.2.8 Post-evisceration wash

In all French plants, maintaining carcass dryness was taken as an inherent part of the effilé process. In all plants (French and UK) in-line carcass spray washes were external only and of low intensity and flow. Any inadvertent carcass contamination requiring washing was dealt with on an individual carcass basis using a drop hose spray.

11.3.2.9 Check weighing (Plant A only)

The large plant had check weighting immediately after evisceration, the smaller plant did not check weigh. Typical weight categories of 1.5-1.8 kg, 1.8-2.0 kg, 2.0-2.2 kg, >2.2 kg were seen.

11.3.2.10 Labelling (France)

Labelling varied between the plants. Plant A used cardboard labels tied on the neck and tail (as in Figures 1 to 5) before chilling. Plant B applied labels to bags and other packaging into which the carcasses were packed after maturation. Plants C & D used labels applied directly to the carcass. All labels gave product and processor information, brands, quality marks (e.g. Rouge Label), and a batch tracking code.

11.3.2.11 Trussing (France)

For all French plants effilé chicken carcasses were manually picked from the shackles and were trussed pre-*rigor* (due to the greater flexibility of limbs before the development of *rigor mortis*). Trussing took place in the air, on tables, against the operatives apron. Operatives generally did not wear gloves for the trussing operation.

11.3.2.12 Trolley loading

In plants A-C trussed effilé carcasses were placed unwrapped, on trolleys with shaped shelves. The heads were outwards and hung over the shelf edge (Figure 20, left) except Plant C where effilé chickens were chilled with their head folded onto a trolley in contact with carcass body (Figure 20, right). One plant placed carcasses breast down, the other placed beast up on the shelf. Most of the shaped shelves were perforated, however some (older) trolleys had no perforations. Trolleys were labelled for traceability and in the larger plant there were separate trolleys for different weight grades, or other segregation criteria.

In Plant F (UK), the skinless partially-eviscerated carcasses were hung by the hocks on shackle bars on wheeled trolleys (Figure 21). When full, trolleys were wheeled to a holding / ambient cooling area (c. 7°C on the day of visit) to await batch chilling (typically overnight). Additional refrigeration was installed in the holding area for use in the summer. The ambient holding area also allowed for drying of the skinless carcasses, stated by Plant F to be an important factor in carcass quality.

All the plants used the same trolleys in the primary chiller and the maturation/packing room. After packing, the empty trolleys were washed and returned to trolley loading stations post evisceration ready to be used again.

Figure 20. Effilé carcasses on chilling trolley

Figure 21. Skin-off partially-eviscerated chicken in chiller at Plant F

11.3.2.13 Chilling

At all the French plants all the carcasses (effilé and fully eviscerated) were trussed and chilled on trolleys using the same methods and equipment. Carcasses hanging from shackle trolleys were loaded into the chiller at Plant F. Details of chilling methods were not covered in the discussions with Plant E.

The design, conditions and efficacy of the chillers seen at the plants varied considerably.

Plant A used cross blown air at -5°C to -7°C over five trolley indexing rails moving at different rates to give chilling times of 2 to 2.5 h. Trolleys with heavier carcasses were assigned to a slower index rail.

Plant B had a chilled space that in our opinion was probably under powered for the load. The air temperature was +5°C despite their stated intention to chill carcasses to <4°C. Chilling was an overnight batch process with closed doors and no personnel access (similar to batch primary chilling of pork/beef).

Plant C had an effective chiller set at 0°C and the chilling process took 4-6 h.

Plant D chiller was not seen but was designed to use 0°C air to chill carcases in 4-6 h.

Plant F (UK) had a small chiller running at 1°C, and carcasses were left in overnight.

In all plants a small sample of products were probed for deep muscle temperature at the outlet of the chiller. The targets were stated as between 0 and 4°C, or <4°C with over temperature carcasses being given more time in the chiller.

The larger plant insisted that fast chilling rates (<2.5 h to <4°C) and dry air was important to ensure a high quality finished product. Some smaller French plants did not state such specific chilling requirements.

Weight losses in chilling (where known) were said to be 1-2% as a maximum.

11.3.2.14 Maturation/buffer room (France)

French plants stored the chilled carcasses in a maturation/buffer store for 12-48 h at 0-2°C. Typically other products (pigeons, rabbit, duck, duckling, portions, Poulet de Bresse, etc.) were bought in and stored in this area as well, to fulfil full orders from butchers. Orders were picked from the full range of products in the maturation store, and then transferred to packing.

11.3.2.15 Packing

The picking and packing systems in plants varied. Packing room temperatures in plants were typically 0-5°C.

Plant A had multiple packing stations where a cardboard box was lined with paper. Unwrapped carcasses where placed within and covered with another paper sheet. The box was lidded with cardboard lid and sealed. A label with customer, contents, weights, tracking info, etc. was then printed and applied to the box.

Plant B packed into plastic bags.

Plant C packed unwrapped carcasses into plastic crates lined with paper.

Plant F packed unwrapped carcasses into plastic lined crates for distribution to external customers.

In the smaller plants effilé carcasses were packed into plastic bags, or distributed in paper lined cardboard boxes. Standard carcasses were packed into bags or on overwrapped trays.

No vacuum or MAP packing was seen in any plant for effilé products.

11.3.2.16 Distribution and shelf life

Distribution temperatures for effilé products were the same as for fully eviscerated, i.e. 0-4°C. Plants claimed various shelf life for different products. Each plant runs their own shelf life trials to establish a 'technical shelf life' where organisms proliferate above certain thresholds. There was then a typically 2-3 day safety margin applied to this figure for the 'assigned shelf life' marked onto the products. It was not always clear whether figures related to technical or assigned shelf life during discussions.

Plant	Product	Technical shelf life (d)	Assigned shelf life (d)
A	Effilé Chicken	13	10
B	Effilé Chicken	12	10
C	Effilé Chicken	12	10
C	Standard fully eviscerated	10	7
D	Effilé	11	7
E	Skinless partially-eviscerated	-	5
F	Skinless partially-eviscerated	-	5

Products produced under Label Rouge had a stipulated assigned shelf life of 9 or 10 days as part of the Label Rouge QA scheme.

Plant C mentioned 'Chapon de Bresse'; a dry defeathered effilé product that had a 21 d shelf life although this was specialist product and not considered further by the team.

11.3.2.17 Customers and market

Plant A supplied c. 5,000 customers, split approximately: 70% to butcher's shops, 25% to wholesale for restaurant/food service, and 5% to supermarkets with butchery counters.

The smaller Plant B customers split approximately: 70% to butcher's shops, and 30% to supermarkets.

Plant C distributed approximately 30% to the butcher shops and 70% of production to supermarkets with traditional butchery counters.

Plant F (UK) distributed almost exclusively to food service customers.

The reasons given by processors for consumers/butchers wanting effilé poultry included:

- Traditional product.
- Good quality, richer taste.
- Longer shelf life.
- Butchers want base product to cut/prepare in shop for each customer (service), to oven ready, portions, etc
- Butcher's customers can assure themselves of quality if minimally processed before reaching point of sale.

11.3.3 Effilé processing plants: Additional points

11.3.3.1 What are the benefits effilé poultry as seen by producer?

Criterion	Yes	No	Notes
Ease of processing	6		
Better meat quality	4	2	It is the free range aspect of typical effilé (Label Rouge specification) that gives better quality, not the effilé processing per se.
Customer demand	6		
Higher prices for Effilé	2	4	Effilé poultry is cheaper per kg to produce and buy in France than standard carcasses
Extended shelf life,	1	5	Label Rouge limits to K+10d
Other	Traditional Butchers benefit from introducing product variety to their shops		

11.3.3.2 Details on microbial sampling

Shelf life and organoleptic testing was typically carried out by plants one or two times per year. More frequently if there were changes to the live bird diet. Monthly testing for *Staphylococcus* spp., *E. coli, Salmonella* spp., *Clostridium perfringens, Campylobacter* spp. is carried out on approximately 30 samples/month. There are no campylobacter regulations under EU legislation and campylobacter counts are not a legal requirement.

There are no specific requirements for microbiological quality of effilé and whole chickens are not sampled. This is justified by the lower level of processing and less contamination of cuts in comparison to fully eviscerated chickens. Table 16 summarises microbiological tests and set acceptable limits for bacterial counts for poultry products (effilé and fully eviscerated).

Table 16. Limits for bacterial counts of food contact surface and poultry meat product based on two example reports obtained from Plants B and C

Organism	Acceptable limit (cfu)
Table Trays	
Total Coliforms	0 in 10 cm^2
Anaerobic Colony Count	25 in 10 cm^2
Chicken tight packed in polystyrene tray with film (Plant B)	
Salmonella spp.	Absent in 25 g
Clostridium perfringens	100 in 1g
Escherichia coli β-glucoronidase positive	5000 in 1g
Staphylococcus coagulase positive	500 in 1 g
Pseudomonas ssp.	500 000 in 1 g
Chicken leg Vacuum packed (Plant C)	
Salmonella spp.	Absent in 25 g
Clostridium perfringens	30 in 1g
Escherichia coli β-glucoronidase positive	1000 in 1g
Staphylococcus coagulase positive	500 in 1 g

11.3.3.3 Feet washing? Is this done? How?

No specific feet washing process was observed for chicken. If foot calluses are seen then the carcass is not selected for effilé. Observations showed reasonably clean feet on chicken and guinea fowl. Separate plants produce effilé duck and currently any specific feet washing regimes for duck have not been seen.

11.3.3.4 Is gal bladder damage common? How is this dealt with if detected?

Gall bladder damage is uncommon (<1%) and is typically due to a weak gallbladder - not the evisceration process. If damage occurs, the carcass is washed and deselected from effilé.

11.3.3.5 Any other decontamination treatments?

Post evisceration spray was the only active decontamination measure seen. De-selection in France from effilé by any staff based on external indicators of bird health and/or quality is an additional contamination control measure.

11.3.3.6 How do purchasers know how to process effilé? Are there any guides produced?

Very few domestic customers prepare effilé in the home. Most of the sales are to food service or skilled/trained butchers. Some guides and recipes are produced and available via the websites of plants, Label Rouge, Poulet de Bresse etc

11.3.3.7 Is there a frozen market for effilé carcasses?

No frozen effilé products are permitted due to the perceived risk of contamination from damaged organs in the freeze-thaw process.

11.3.3.8 HACCP plans

All plants had HACCP plans, but had various degrees of openness about the contents of their HACCP plans.

Plant A had three CCPs in the production of standard fully eviscerated and two CCPs in production of effilé chicken. Ante-mortem inspection, and temperature at dispatch from pre-chill to storage chill were considered two CCPs common for both products. The other CCP for oven ready Modified Atmosphere Packaged (MAP) poultry was the proportions of nitrogen (N_2) and carbon dioxide (CO_2) used in the packaging atmosphere.

Plant C did not have CCPs.

Plant D declared same HACCP approach for effilé and standard poultry, but gave no details of what these were.

Plant F made its plans available. Six CCPs were identified and detailed: (1) Poultry delivery and ante-mortem inspection; (2) skinning; (3) removal of feet and evisceration; (4) final inspection before wash; (5) chilling; (6) dispatch.

11.3.3.9 Other comments

A variety of general opinions and observations from experience were expressed to the project team during their visits and these are captured below. Although there may not necessarily be any evidence to support or counter the ideas, the team believe there was some merit in recording the comments.

- The biggest problem with effilé is skin damage caused by scratching of live birds pre hang (France).
- Older carcasses have longer shelf lives (France).
- The dryer the carcass is kept the better the shelf life (France and UK).
- Effilé are a dwindling market and only wanted by the older population (France).
- Demand is stable and consistent (France and UK).
- If only food is withdrawn, chickens drink more and this results in moister faeces, crop and gizzard contents that can exacerbate leakage and contamination problems (France and UK).
- One UK plant (E) stopped producing effilé due to difficulties with the local OV interpreting the effilé production regulations/guidelines as to require complete removal of intestine and duodenum. This OV required separation at the gizzard, which led to unacceptable leakage of gizzard contents into the cavity. The other UK plant (F) identified is still producing effilé as their OV allows a short (c.15mm) length of intestine to remain attached to the gizzard and this reduces leakage substantially and allow the intestines to be separated at their natural weak point. All observed French effilé methods used this natural separation point c.15 mm from the gizzard in their effilé processes whether machine or manually performed.
- The annular knife with central vacuum machines were an excellent tool to produce effilé as they immediately remove the potentially contaminating intestine from the food processing area (UK & France).

11.3.4 Dordogne veterinary services visit

The team met with laboratory staff based in Perigueux who perform official analyses on behalf of the veterinary authorities in the Dordogne department. The objective was to gain a non-company view of the effilé process and determine if there were any particular general public health concerns with carcasses processed effilé.

It was the opinion of the lab staff that there were no specific problems inherent in the effilé process, and provided the plants maintained good manufacturing operations and practices then prevalence of pathogens on effilé carcasses was no different to fully eviscerated carcasses.

Salmonella is the main organism of interest with a target of 0%. For 70,000 samples taken from all foodstuffs taken recently in the Dordogne department less than 2,000 were positive for salmonella (<2.8%). In animals pre-slaughter for similar period salmonella prevalence's were <100 positives in c.5,000 samples (<2%), across all tests. The volume of sampling varied with the size of the plant with larger plants sampling for salmonella on c.25 samples/week with decreasing numbers as the plants got smaller.

E. coli is the secondary organism of interest with running mean 'warning' and 'unacceptable' thresholds that vary across different product types. *E. coli* sampling is mostly used by plants for self monitoring of the general hygiene of their processes. For export to USA there is an *E. coli* limit of <50 per whole bird rinse.

Since campylobacter were considered to be ubiquitous in chicken flocks and on poultry meat there were no current targets for campylobacter.

Overall the laboratory staff interviewed, held the general opinion that any microbiological problems seen in effilé plants, tended to be associated with specific failures in plant operations, or specific local issues, and not inherently connected with the type of carcass being produced.

11.4 Conclusions

In the French plants, the live birds were the same in all cases with carcasses being selected for effilé production immediately after plucking based on a detailed visual inspection of external quality. Since <40% of a batch of birds go into effilé production, it may be concluded that a majority of the birds were conventionally processed and inspected, thus any serious issues that would effect a flock and be identified by post-mortem examination of the viscera will still be identified.

The maximum line speeds during effilé production of the visited plants of ranged between 220 and 3,600 birds per hour in the plants of the industrial survey. This is substantially less than the 8,000 to 12,000 bph line speeds seen in most of the large UK broiler processors. This is not a major issue as effilé processed carcasses are a niche product suited to smaller (lower speed) processors.

The slower line speeds allow for the greater degree of manual involvement that appears to be necessary for:

a. Accurate placement of carcasses against intestine sucking machinery, and/or manual loosening and drawing of intestines.

b. Continuous visual inspection through all processing stages.

If a rapid method for effilé selection could be devised it should be possible to remove carcases from a high-speed line post pluck by using rehanging automation, or manual intervention. Then a lower speed effilé processing line could then produce partially-eviscerated carcasses using techniques and equipment as seen in the industrial survey.

There were six main processing operations that show differences from UK standard operations for partially-eviscerated broiler processing.

1. Sticking is required to be through the mouth into the jugular vein inside the throat (as opposed to external throat cut).
2. Evisceration processes need to be modified to remove only the intestine and duodenum as described in the various methods above. Effilé processing is not suited to high-speed carousel type evisceration machines therefore operations need to be manual or make use of existing annular knife central vacuum machines. Although not known to be available, it should be possible to fully automate this process using machine vision guided robotics to improve line speeds over currently seen manual operations.
3. Inspection. The French plants place an emphasis of the importance of continuous inspection by their operatives during all stages of processing to ensure that abnormalities are identified and that abnormal carcasses are not processed as effilé. Although, by its nature, such inspection is predominantly limited to the identification externally visible defects. The relatively slow line

speeds used during the processing of effilé carcasses and the manual nature of the processes make such continuous assessment possible.

4. Final washing of effilé carcasses was applied to the exterior only using low pressure sprays. Plants attempted to keep carcasses as dry as possible as it was believed to contribute to extended shelf lives and carcass quality (a belief and practice common in red meat processing).
5. Chilling may need to be modified to be batch wise of trussed carcasses to mimic the French effilé processes, but this is not necessarily a prerequisite.
6. Subsequent distribution route. In France effilé carcasses are supplied almost exclusively to butchers shops, supermarkets, and food service where skilled and trained intermediaries complete the carcass preparation before consumption. These stages do not typically exist in the UK.

12 Appendix D: List of French Plants/Contacts Contacted

Plant	***Location***
Sa Gavand et Prudent	01270 SALAVRE
Ronsard Bresse	01560 ST JEAN SUR REYSSOUZE
Allier Volailles Maison David et Perot	03110 ESCUROLLES
Arrivé Auvergne	03260 ST GERMAIN DES FOSSES
Les Fermiers de l'Ardèche	07340 FELINES
Ferme du Mesnil SCEA	14330 LE MOLAY LITTRY
Sarl Volailles Mansloises	16230 MANSLE
Société Le Plenier Boscher Volailles	22530 MUR DE BRETAGNE
L.D.C. Bretagne	22800 LANFAINS
Société de Conditionnement et d'Abattage de Volailles (Socavol)	22800 ST BRANDAN
Blason d'Or	24100 ST LAURENT DES VIGNES
Bernard Royal Dauphiné SA	26300 CHATUZANGE LE GOUBET
Bernard Royal Dauphiné SA	26400 GRANE
Volailles Adrien Labrouche	27130 VERNEUIL SUR AVRE
Ronsard Ile de France	28300 JOUY
Doux	29150 CHATEAULIN
Etablissements E. Robin	29270 CARHAIX PLOUGUER
Arnal	29590 LE FAOU
Tilly-Sabco	29650 GUERLESQUIN
Savel Industries	29870 LANNILIS
Duc	30730 ST BAUZELY
SARL Ets Tournier	31220 CAZERES
Savidoc	31250 REVEL
Fermiers du Gers	32100 CONDOM
GASTRONOME	32100 Condom
Poulets du Gers	32300 MIRANDE
VIVADOUR PRODUCTIONS ANIMALES	32300 MIRNADE
S.A. LAPORTE	32450 SARAMON
LDC Aquitaine	33430 BAZAS
Sarl Brun	33820 ETAULIERS
Ronsard	40240 LOSSE
QUALISUD	40500 Saint-Sever
Les Fermiers Landais	40500 ST SEVER
Dangoumau Landes Volailles	40500 ST SEVER
Etablissement Valeyre et Cie	42620 ST MARTIN D ESTREAUX
Gastronome Ancenis	44150 ANCENIS
Société Industrielle d'Abattage du Léon (Siale)	49280 LA SEGUINIERE
LDC Charmilles	49360 MAULEVRIER
Guillet SAS	49640 DAUMERAY
Les Eleveurs de la Champagne	51110 CAUREL
S.N.V.	53000 LAVAL
Sofral	53110 LASSAY LES CHATEAUX
S.N.V.	53200 AZE

Les Volailles Rémy Ramon	53250 JAVRON LES CHAPELLES
Sté Aupied Ruppert Aupied (S.A.R.A.)	53400 CRAON
Secoué	53420 CHAILLAND
Celtys	56240 PLOUAY
Centre d'Elaboration des Viandes (Celvia)	56460 SERENT
Société des Viandes du Porhoet (Sovipor)	56490 LA TRINITE PORHOET
Ronsard	56500 BIGNAN
Centre d'Elaboration des Viandes (Celvia)	56660 ST JEAN BREVELAY
Doux	56770 PLOURAY
S.N.V.	61140 LA CHAPELLE D ANDAINE
Volailles Peniguel	62240 WIRWIGNES
Groupement des Producteurs de Volailles de Licques (G.P.V.L.)	62850 LICQUES
EURALIS VOLAILLES	64231 LESCAR
Bruno Siebert S.A.	67120 ERGERSHEIM,
Bruno Siebert S.A.	67120 ERGERSHEIM,
Guillot Cobreda	71290 CUISERY
Ets Mairet SA	71330 SIMARD
MICHEL-PROST	71470 MONTPONT-EN BRESSE
L.D.C. Bourgogne	71500 BRANGES
Chevrier volailles	71500 LA CHAPELLE NAUDE
Chevrier volailles	71500 LA CHAPELLE NAUDE
LDC Sablé	72300 SABLE SUR SARTHE
Bas du formulaire LDC Sablé	72540 LOUE
National Union of French Poultry Producers (Syndicat National des Labels Avicoles de France)	75011 PARIS
Gastronome Nueil	79250 NUEIL LES AUBIERS
Gastronome Industrie Sevrienne	79320 MONCOUTANT
Doux	85110 CHANTONNAY
Arrivé	85140 LES ESSARTS
Thomas et Fils	85140 ST MARTIN DES NOYERS
Volailles Elie Freslon	85160 ST JEAN DE MONTS
Bodin la Volaille Biologique (Bodin et Fils SAS)	85210 STE HERMINE
Sarl Marcel Favreau	85300 SOULLANS
S.A.V.I.C. SAS	85310 LA CHAIZE LE VICOMTE
Euralis Gastronomie	85500 LES HERBIERS
Laguillaumie	89380 APPOIGNY
Duc	89770 CHAILLEY
Activités Kompass International (France)	92415 COURBEVOIE

13 Appendix E: Visit Checklist

Visit Objectives and Questions

To observe and record the effilé process first hand with a particular focus on the operations that differ from those for producing fully eviscerated carcasses.

1. We would like to walk the entire line to see the processes and take photographs.
2. Where operations are seen to be different from processing for fully eviscerated carcasses we would like to look in more detail. We expect these areas to be in evisceration, inspection, product presentation/packaging and possibly chilling. We would then like to discuss the benefits / problems of these differences.
3. We would like to discuss some of the background of effilé production.

a. How did the process originate?

b. What are the benefits effilé poultry as seen by producer?
    i. Ease of processing,
    ii. Better meat quality,
    iii. Customer demand,
    iv. Higher prices for effilé,
    v. Extended shelf life,
    vi. Etc

c. Is there anything special about the chickens used?
    i. Breeds.
    ii. Bird sizes / weights / Age at slaughter
    iii. Feed regimes
    iv. Etc

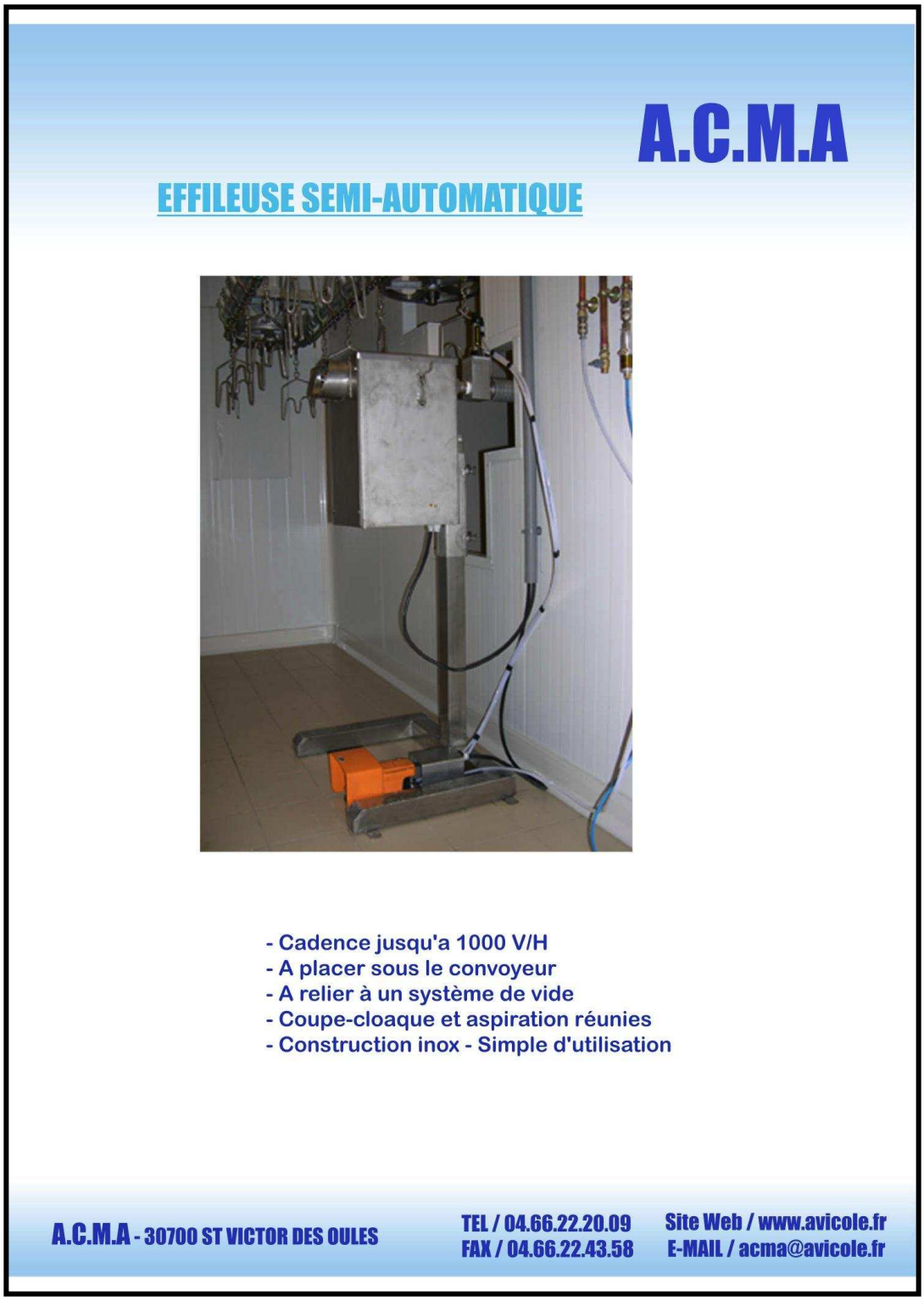
4. How are birds inspected (pre-mortem and ante-mortem)? Is a sub-sample eviscerated? Do they use FCI, Food Chain Information from the inspection of the live bird?
5. Is the removed offal inspected? If so in what way, for what?
6. Additional questions from Effilé inspection 02-Dec

a. How do Black, Yellow, White poulet differ? Is it only breed, or feed regime as well.
b. Feet washing? Is this done? How? (Especially for duck)
c. Defeathering – manual / machine / wax / singe / combination?
d. How kill?
e. How bled? Roof of mouth with small sticking lance? Same for all species?
f. How detect which organs to remove? Tactile only, or other tools/techniques.
g. Partial-evisceration is done hot / warm / cold?
h. Only intestine and duodenum out? Everything else always left in?
i. How much handling during trussing? Is this a possible contamination (Staph. aureus) route?

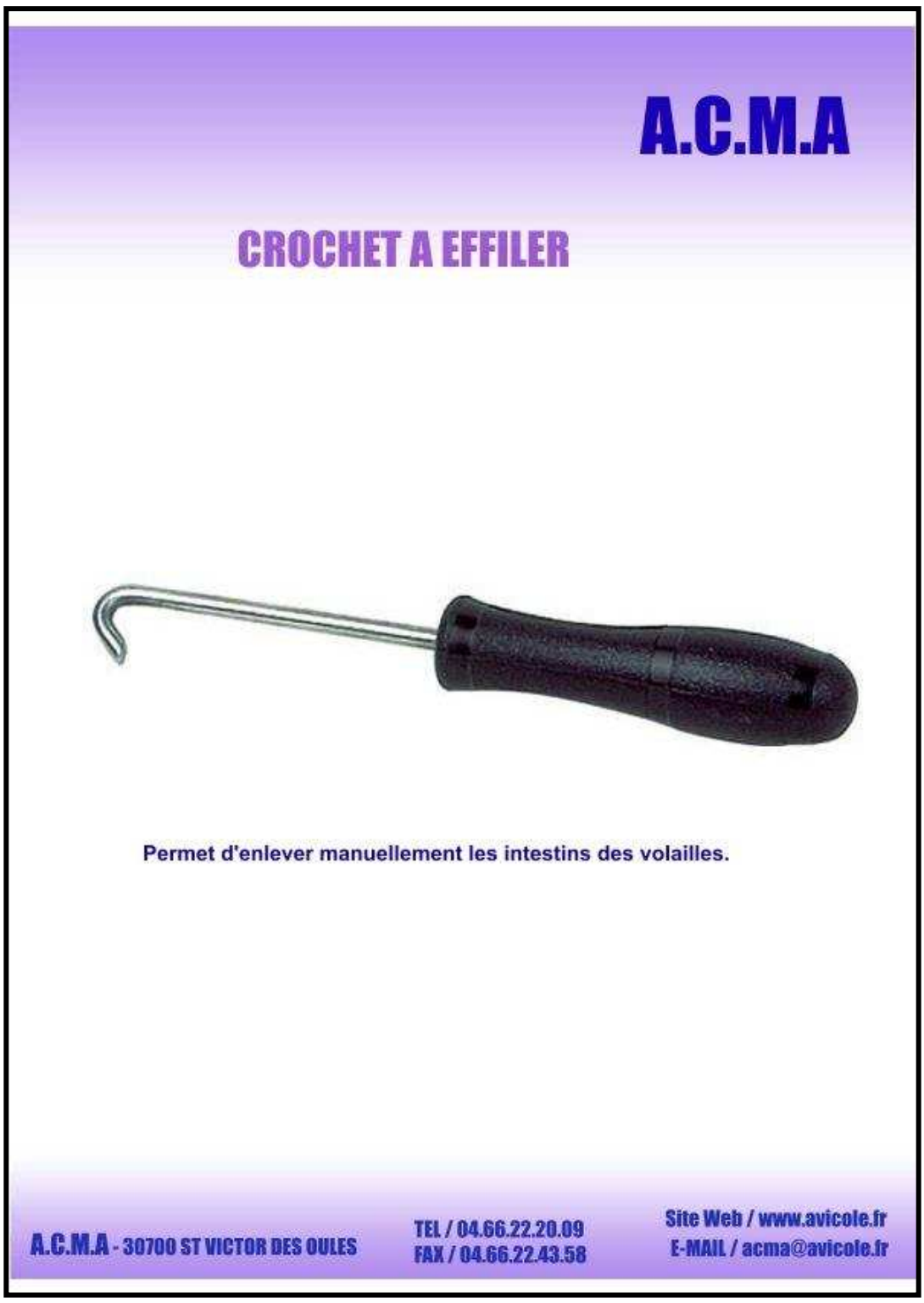
j. Is gal bladder damage common? How is this dealt with if detected?
k. Gloves worn? At evisceration, trussing, other?
l. Is water used for washing? Is bird dryness a factor for longer shelf life.
m. Any other decontamination treatments?
n. Speed of processes bph / operative?
o. Chilling, when after slaughter?, Method?, temperature records?, Weight loss, any maturing, times?
p. Any difference with hanging?
q. Storage and distribution. Any special requirements? What is the shelf life?
r. What packaging used? Does this help hygiene? Paper wrap for dryness?
s. Customers segmentation; Restaurants / Further processors / Butchers / Domestic / other?
t. How do purchasers know how to process effilé? Are there any guides produced?
u. Any known micro-organisms that cause trouble? If so, what & where? Are live flocks tested prior to processing?
v. What microbial sampling is carried out?
w. What is the general microbial quality of effilé? Counts if possible. How are they sampled? How does this compare with eviscerated?
x. Any frozen market?
y. Any further processing of effilé birds ever carried out?
z. Any cooking recommendations for effilé birds and special recipes?
aa. Are there any quality issues (growths etc) with the viscera left in the effilé birds that are a cause of customer complaints/rejections?
bb. HACCP plans

14 Appendix F: Effilé Equipment

ACMA: Effilieuse Semi-Automatique (Semi automatic effilé processing station)



ACMA: Crochet de Effilage (Hook for Effilé Processing)

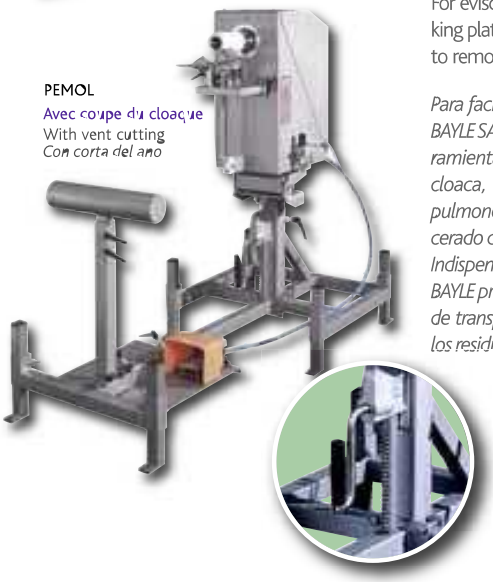


Bayle: Pupitre Effilage (Effilé process station) – Lower left

Eviscération semi automatique
Semi automatic evisceration
Eviscerado semi automático

Pupitre d'effilage
EV desk
Eviscerador

PEMOL
Avec coupe du cloaque
With vent cutting
Con corta del ano



Pour faciliter les opérations d'éviscération, BAYLE SA à étudié toute une gamme d'outillage et accessoires à main : coupe cloaque, sécateur pneumatique, aspirateur à poumons, ainsi que des ensembles pour l'effilage des volailles.
Indispensable dans les salles d'éviscération, BAYLE propose des podiums de travail, des tapis de transport, des ensembles d'évacuation des déchets par le vide ou par air...

To facilitate evisceration BAYLE manufactures a complete range of hand tools.
Vent cutter - pneumatic scissors – vacuum lung gun – equipment to remove chicken intestine.
For evisceration, BAYLE manufactures working platform – transport belt – equipment to remove waste by vacuum or air.

Para facilitar las operaciones de eviscerado, BAYLE SA a estudiado toda una gama de herramientas y accesorios en mano: corta cloaca, podadera neumática, aspirador a pulmones, así como conjuntos para el eviscerado de las aves de corral.
Indispensable en las salas de eviscerado, BAYLE propone podios de trabajo, alfombras de transporte, conjuntos de evacuación de los residuos por el vacío o por el aire ...

15 Appendix G: Practical Comparison of the Chilling of Partially-eviscerated and Eviscerated Poultry Carcasses

15.1 Aim

The aim of this study was to compare the air chilling of partially-eviscerated and standard fully-eviscerated broiler carcasses.

15.2 Materials and Methods

Broiler carcasses were collected from a local poultry plant on three different days. On each day headless un-eviscerated and standard fully eviscerated broilers were collected from the production line after the post-pluck wash and after the inside-outside wash respectively. The warm carcasses were packed into insulated in polystyrene boxes and transported to the National Centre for Food Manufacturing (Holbeach, UK). After arrival, the warm un-eviscerated broilers were partly eviscerated using the 'Boston drawn' method most commonly seen during effilé poultry evisceration observed in French factories. The carcasses were processed approximately 2 to 3 h post slaughter. The oviduct of the un-eviscerated broilers was cut slightly (3-4 cm) to reveal part of the intestines. Intestines were the pulled out by hand and separated from the gizzard using the naturally weak breakage points approximately 15 mm from the gizzard and immediately inside of the vent.

The experimental set-up is shown in Figure 22. Two poultry carcasses (one standard and one partially-eviscerated) were hung on shackles as in conventional UK air blast chilling systems, and 2 carcasses (one standard and one partially-eviscerated) were trussed and placed on a perforated shelf lying with breast part down as observed in French effilé processing facilities. Trussing was performed as seen for effilé carcasses in France with folded wings behind the back and placing feet over the wings as shown in Figure 1.

Figure 22. Chilling trials experimental setup

Pre calibrated single point metal shrouded hypodermic T-type (copper-constantan) probes (0.8 mm diameter, 45 mm length; Electronic Temperature Instruments Ltd, UK), were inserted into the deep breast and deep thigh muscles to measure the slowest cooling parts of all carcasses and connected to data loggers (Comark Diligence EV N2013, Norwich, UK). A further single point wire T-type (copper-constantan) thermocouple (1.2 mm diameter, 100 mm length; RS Components Ltd,

UK) was used to record air temperatures close to the carcass. All temperatures were recorded at 5 min intervals.

The instrumented carcasses were placed directly in a forced air flow with a mean temperature of c.-2.3℃ and air speed of 2-3 ms^{-1}.

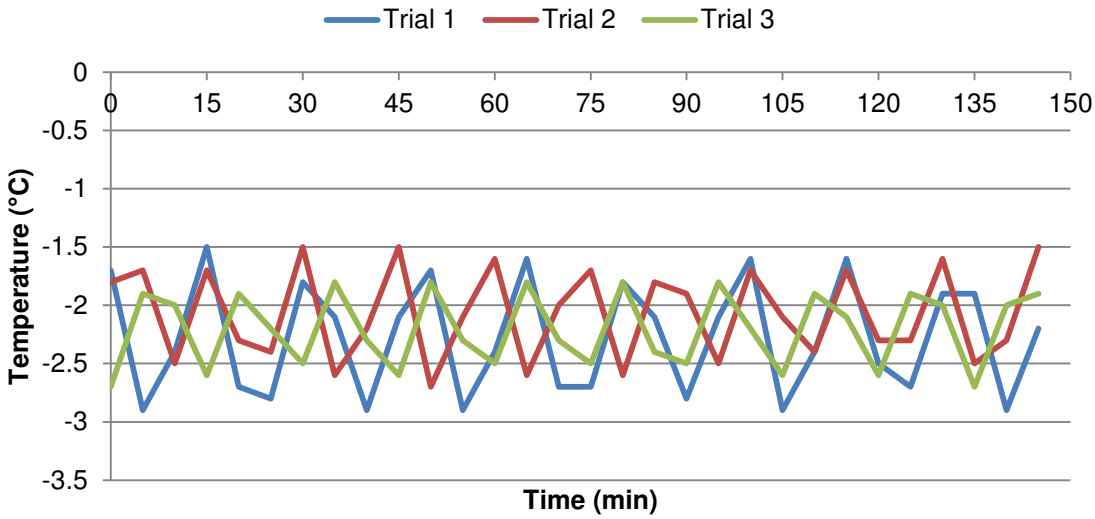


Figure 23. Air temperatures during three chilling trials

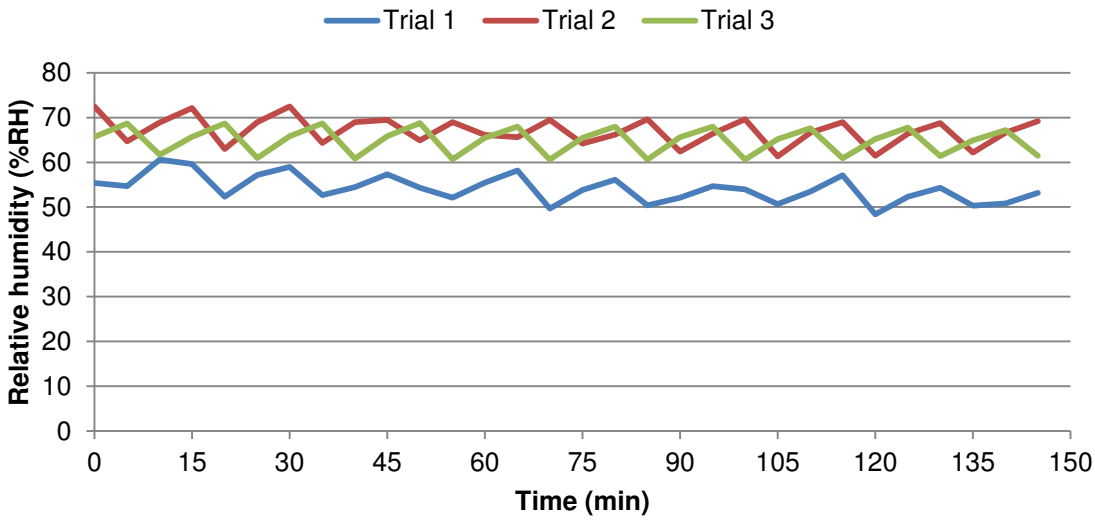


Figure 24. Relative humidity during three chilling trials

Plots of measured temperature and relative humidity in the chill room through each of the three trials are presented in Figure 23 and Figure 24. The chilling air temperature ranged between -1.5 and -3℃. Relative humidity was at the level of 50-60% in trial 1 and 60-70% in Trial 2. This difference may have been a result of condition stabilisation in chill overtime (Trials 2 and 3 were run in the same week whereas Trial 1 was run 3 weeks earlier).

All carcasses were weighed and key dimensions measured after chilling. The carcass measurements were carried out according to the method of James *et al.* (2007).

Statistical analyses were performed using IBM SPSS Statistics 21 software. ANOVA and Tukey post-hoc tests at significance level $p \leq 0.05$ were used.

A further short trial was carried out, on broiler carcasses sourced from a different poultry processor, in which the internal organs as well as the deep breast and thigh temperatures of three partially-eviscerated carcasses were monitored during chilling. The protocol used was the same as described above.

15.3 Results and Discussion

Figure 25 summarises carcass measurements plotted against carcass weight. It can be seen (as expected) that the partially-eviscerated carcasses were generally heavier than standard fully-eviscerated carcasses. Measurements of the perimeter under and around wings, perimeter around thighs and length of the body with legs were generally greater for partially-eviscerated broilers than for the standard broilers. A reason for this could be the position in which the partially-eviscerated broilers were trussed, and also differences in cut lengths between feet and legs for standard broilers. Other measurements were within a similar range for both partially-eviscerated and standard broilers.

Chilling curves in the deep breast and thigh of trussed and untrussed partially-eviscerated and fully eviscerated broiler carcasses are shown in Figure 26. It can be seen that for standard fully eviscerated carcasses the breast and thighs follow very similar cooling patterns for both hanging and lying positions (Figure 26 b and d). However the partially-eviscerated carcasses predominately showed slower cooling of the breasts when compared to thighs (Figure 26 a and c).

It needs to be noted that the initial temperature of the partially-eviscerated carcasses in breast ranged from 36 to 37°C and the thighs ranged from 28 to 33°C. In standard carcasses initial temperatures in both muscles were similar, but lower than in partially-eviscerated carcasses, ranging from 25 to 28°C.

The time required to reach a temperature of 4°C in the thighs and breast of standard broilers were non-significantly different at approximately 60 min (Figure 26 e). However breasts of partially-eviscerated carcasses took c. 120 min to chill to 4°C which is significantly longer than the 60 to 80 min cooling time for the thighs (Figure 26 e). This result is believed to be due to the organs present within the cavity of partially-eviscerated carcasses preventing airflow and prolonging the cooling time needed. This factor could also contribute to the higher temperatures seen in NYD carcasses after transportation and higher subsequent partially-eviscerated carcasses initial temperatures. This supposition is supported by the fact that there was no significant difference in time required to chill thighs to 4°C in broiler carcasses regardless of evisceration type and chilling position (ANOVA, $p>0.05$). Breasts of partially-eviscerated carcasses required generally longer time than breasts of standard broilers to reach a temperature of 4°C but statistical significance was only confirmed for effilé carcasses chilled in lying position (ANOVA and Tukey post-hoc, $p<0.05$).

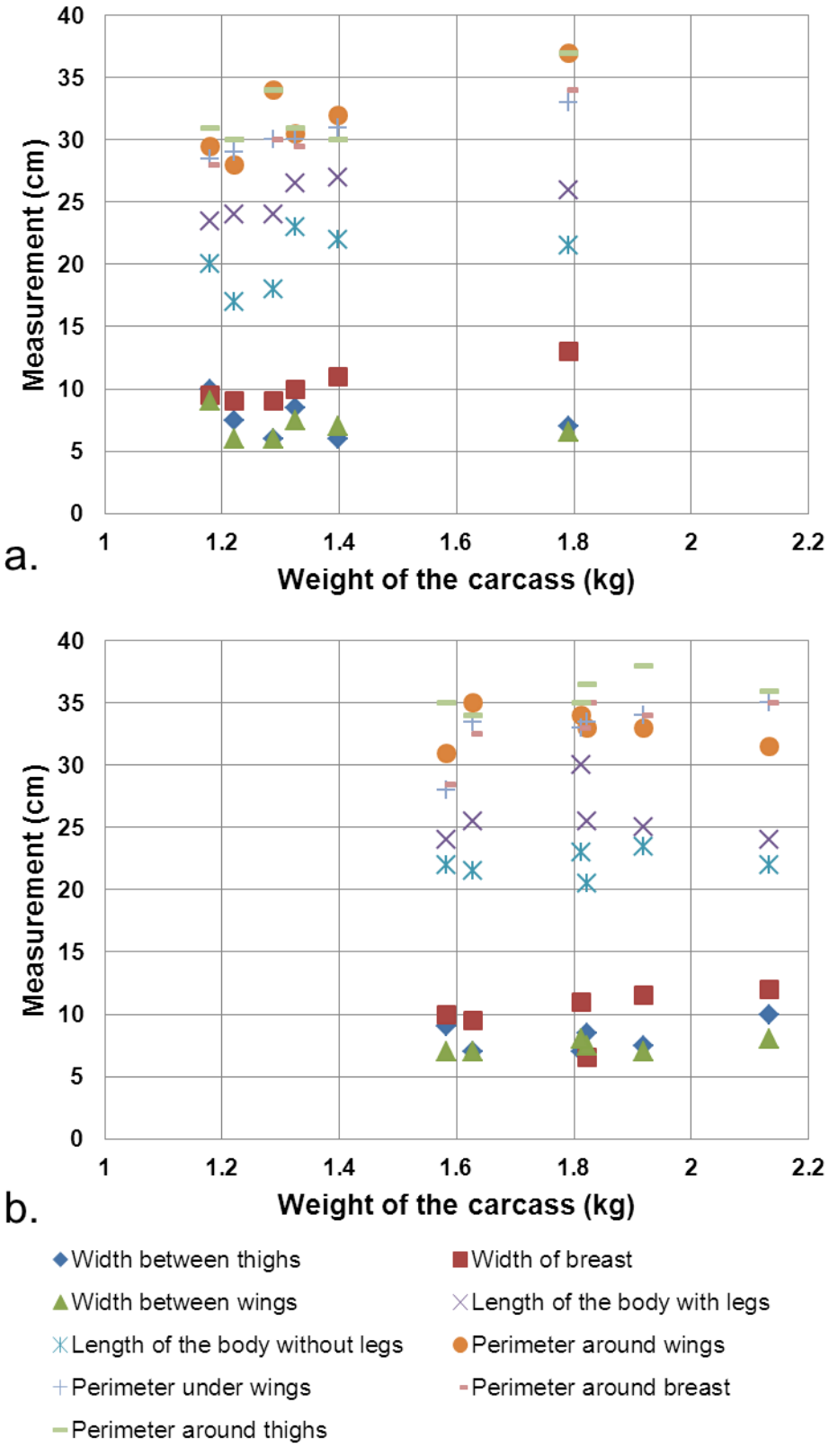


Figure 25. Dimensions and weights of a) Standard fully eviscerated broiler carcasses, b) Partially-eviscerated broiler carcasses

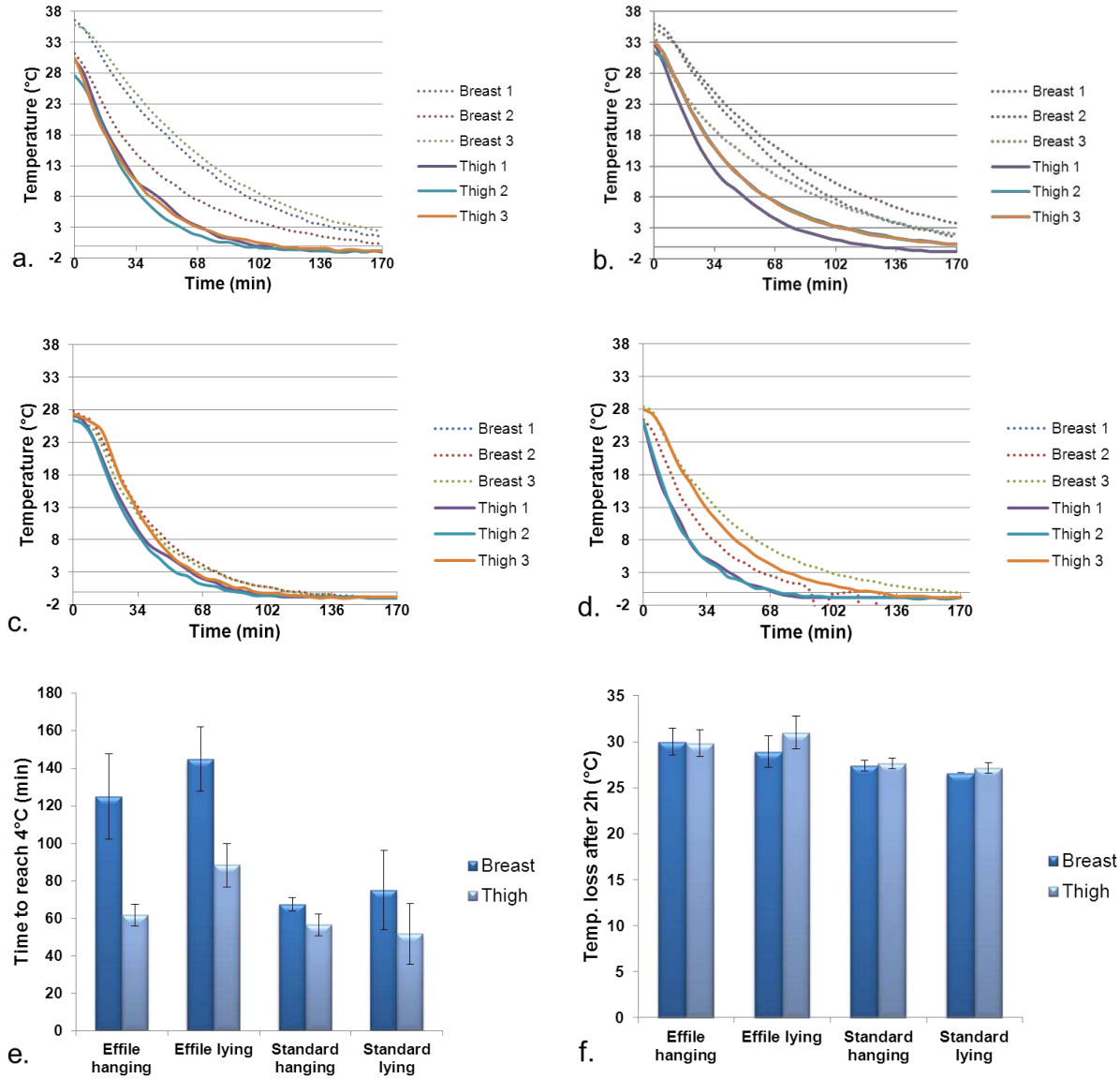


Figure 26. Temperature plots for: a) Three hanging partially-eviscerated broiler carcasses, b) Three hanging fully eviscerated broiler standard carcasses, c) Three trussed lying partially-eviscerated carcasses, d) Three trussed lying fully eviscerated standard carcasses, and e) Time within which muscles reached temperature of 4°C, f) Difference of the temperature between start and after two hours of chilling

Despite this, the differences in the temperature drop within first two hours of the experiment were not different between breasts of partially-eviscerated carcasses and standard fully eviscerated carcasses (Figure 26 f, ANOVA, $p>0.05$). Also temperature drops for thighs and breast for single group of carcasses were within one standard deviation from each other (Figure 26 f). The thighs of lying partially-eviscerated carcasses lost more temperature after two h (31°C) when compared to standard fully eviscerated carcasses (26-27°C) (ANOVA and Tukey post-hoc, $p<0.05$). This result might point at impact of trussing/positioning on chilling of effilé carcass.

The practice of trussing the carcass prior to chilling is common in France (and once was common in the UK according to Hannan & Shepherd, 1956) since tighter

trussing is easier before *rigor mortis* develops. This will inevitably increase the cooling time since, to quote Hannan & Shepherd (1956), "*it changes the bird from a long cylinder to a shorter, broader one*". However these results (and those of Hannan & Shepherd, 1956) show this increase to be not great (<30 min extension to overall chilling time to 4°C).

A further short trial was carried out in which the internal organs as well as the deep breast and thigh temperatures of three trussed partially-eviscerated broiler carcasses were monitored during chilling (Figure 27 and Table 17). The carcasses were slightly smaller (partially-eviscerated weight of c. 1.5 kg) than those used in the previous trials and so the chilling times were slightly shorter (around 10 min; 9%). This trial showed, as would be expected, that the internal organs were slower to chill than the breast. The chilling time (to <4°C) based on a deep breast measurement was approximately 20 min (15%) shorter than that based on the internal organs.

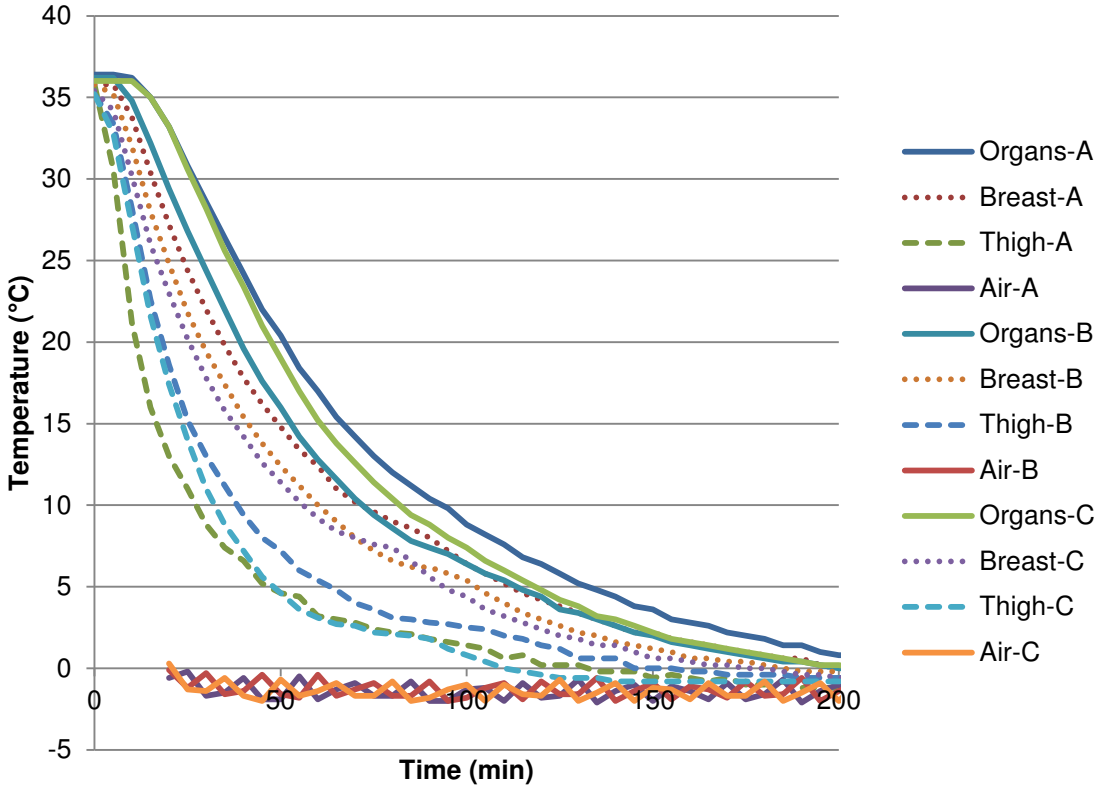


Figure 27. Chilling curves of three 1.5 kg partially-eviscerated broiler carcasses chilled trussed in air at -1.3±0.5°C and 2.4 ms^{-1}

Table 17. Chilling time (min) to <4°C, measured in the internal organs, breast or thigh, of three 1.5 kg partially-eviscerated broiler carcasses chilled trussed in air at -1.3±0.5°C and 2.4 ms^{-1}

Carcass	Weight (g)	Organs	Breast	Thigh
A	1625	145	125	60
B	1503	125	110	70
C	1496	130	105	55
Mean (SD)	1541 (73)	133 (10)	113 (10)	62 (8)

15.4 Conclusions

These trials showed that:

1. The presence of organs within the cavity of a partially-eviscerated carcass significantly slows cooling in the deep breast when compared to a standard fully eviscerated carcass. Cooling of the deep thigh is also slowed but to a lesser non-significant extent.
2. There are no substantial differences in cooling times for hanging and trussed presentations to the cooling airflow.
3. The slowest cooling point (thermal centre) of partially-eviscerated poultry carcasses can be found in the internal organs. Thus this should be monitored when verifying chilling times of partially-eviscerated poultry carcasses.

16 Appendix H: Practical Comparison of the Growth and Survival of Microorganisms on Partially-Eviscerated and Fully Eviscerated Broilers During Refrigerated Storage

16.1 Aim

The aim of this practical evaluation was to determine potential differences in the microbiological spoilage of standard fully eviscerated and partially-eviscerated poultry during refrigerated storage at a slightly abusive storage temperature (i.e. a degree above the recommended 4°C limit).

16.2 Materials and Methods

Broiler carcasses were collected from a local poultry meat producer on 3 different days. On each day headless un-eviscerated and standard fully eviscerated broilers were collected from the production line after the post-pluck wash and after the inside-outside wash respectively. The warm carcasses were packed into insulated in polystyrene boxes and transported to the National Centre for Food Manufacturing (Holbeach, UK). After arrival, the warm un-eviscerated broilers were partly eviscerated using the 'Boston drawn' method most commonly seen during effilé poultry evisceration observed in French factories. The oviduct of the un-eviscerated broilers was cut slightly (3-4 cm) to reveal part of the intestines. Intestines were the pulled out by hand and separated from the gizzard using the naturally weak breakage points approximately 15 mm from the gizzard and immediately inside of the vent.

Figure 28. Trolley with perforated shelves and shackles used for chilling of partially (placed on shelves) and standard (placed on shackles) eviscerated poultry carcasses

All carcasses were then chilled in a temperature controlled room with air temperature of approximately -2°C for 3 to 4 h on a purpose built trolley with perforated shelves and shackles (See Figure 28). Partially-eviscerated broilers were trussed in the

French effilé manner as described in Appendix G and placed on the perforated shelves. Standard fully eviscerated broilers were hung by the legs on the shackles.

Following chilling carcasses were transferred to cardboard boxes lined with food grade, greaseproof paper and transferred to storage refrigerator (1/+4℃ Professional Foster Refrigeration, King's Lynn, UK).

The number of replicates at each storage time and from which collection day the samples originated is shown in Table 18. Five sampling days were used for the test: 0, 7, 9, 14 and 18 d. Visual assessment of the carcasses was carried out on these 5 sampling days and additionally on day 21.

Table 18. Batch, replicate and sampling details for the growth/survival study

Collection day	Type of evisceration	Sampling day				
		0	7	9	14	18
		Number of replicates				
1	Fully eviscerated	2	0	2	2	0
	Partially-eviscerated	3	3	3	3	3
2	Fully eviscerated	2	2	0	0	0
	Partially-eviscerated	1	3	0	0	0
3	Fully eviscerated	1	0	2	2	0
	Partially-eviscerated	1	0	0	3	0
Total Standard		5	2	4	4	0
Total Partially-eviscerated		5	6	3	6	3

On day 0, 5 replicates of each partially-eviscerated and eviscerated carcass were analysed. On remaining days at least 2 eviscerated carcasses and 3 partially-eviscerated carcasses from the same collection day were analysed. This practice was applied in case any substantially different microbiological contamination was present between batches. On day 18 only partially-eviscerated carcasses were analysed.

To assess the impact of the inside-outside wash on the microbiological quality of poultry carcasses, the cavity of standard fully eviscerated carcasses (subjected to this wash) and partially-eviscerated broilers (not subjected to this wash), were sampled.

Composite skin samples were obtained from each carcass. Sampled areas were middle-upper part of breast and back between wings and neck. A template was used to excise a total sample skin area of 42.5 cm^2. The weight of the skin samples ranging from 4 to 9.5 g. Prepared samples were immersed in 15 ml of sterile buffered peptone water (BPW-3M, Minnesota, US).

For cavity sampling carcasses were split along the median plane using poultry shears. Then sponge-swabs were taken from the full cavity area of fully eviscerated carcasses, and from the accessible area not obscured by the giblets for partially-eviscerated carcasses. Sponge-swabs were immersed in 15 ml of BPW. The test was carried out on sampling days 0-14.

To assess whether the safe shelf life of partially-eviscerated carcasses was limited by external microbial growth or internal microbial growth, the liver and heart of partially-eviscerated carcasses were also analysed during storage.

Whole livers and hearts were excised from partially-eviscerated chickens on each of testing days, with the exception of day 18, when only the liver was analysed. Hearts and livers were diluted with BPW in the ratio 1:2 according to weight.

All samples were homogenized in Stomacher blender (Stomacher® 400 Circulator, Seward, Worthing, UK) at 250 rpm for 1 min (skin) and 2 min (all other samples). They were then analysed using spread plate method for aerobic colony count (ACC) and *Pseudomonas* as well as using 3M Petrifilm™ method (as described in (3M, 2010; 3M, 2008)) for Enterobacteriaceae and Coliforms/ *Escherichia coli*. For enumeration of ACC samples were incubated for 72 h at 30°C on plate count agar (Oxoid, Hampshire, UK). For enumeration of *Pseudomonas* samples were incubated for 48 h at 25°C on *Pseudomonas* agar base supplemented with CFC selective agar supplement (Oxoid, Hampshire, UK).

The limit of detection value for ACC and *Pseudomonas* test for skin samples was 0.5 $\log_{10}$ cfu cm^{-2} or 1.4-1.7 $\log_{10}$ cfu g^{-1}, for cavity 2.2 $\log_{10}$ cfu $swab^{-1}$ and for heart and liver 1.5 $\log_{10}$ cfu g^{-1}. For tests carried out using Petrifilm™ limits of detection were - 0.5 $\log_{10}$ cfu cm^{-2} or 0.4-0.7 $\log_{10}$ cfu g^{-1} (skin) 1.2 $\log_{10}$ cfu $swab^{-1}$ (cavity) and 0.5 $\log_{10}$ cfu g^{-1} (heart and liver).

The counts below the limit of detection or above the maximum measurement range were included in statistics. Counts under the limit of detection were calculated as the $\log_{10}$ of a half the limit of detection. Counts above the measurement range were calculated as $\log_{10}$ of the maximum measurement.

Statistical analyses were performed using IBM SPSS Statistics 21 software. T-tests at significance level $p \leq 0.05$ were used to compare $\log_{10}$ (microorganisms counts/ sample unit) on different testing days between eviscerated and partially-eviscerated carcasses.

16.3 Results and Discussion

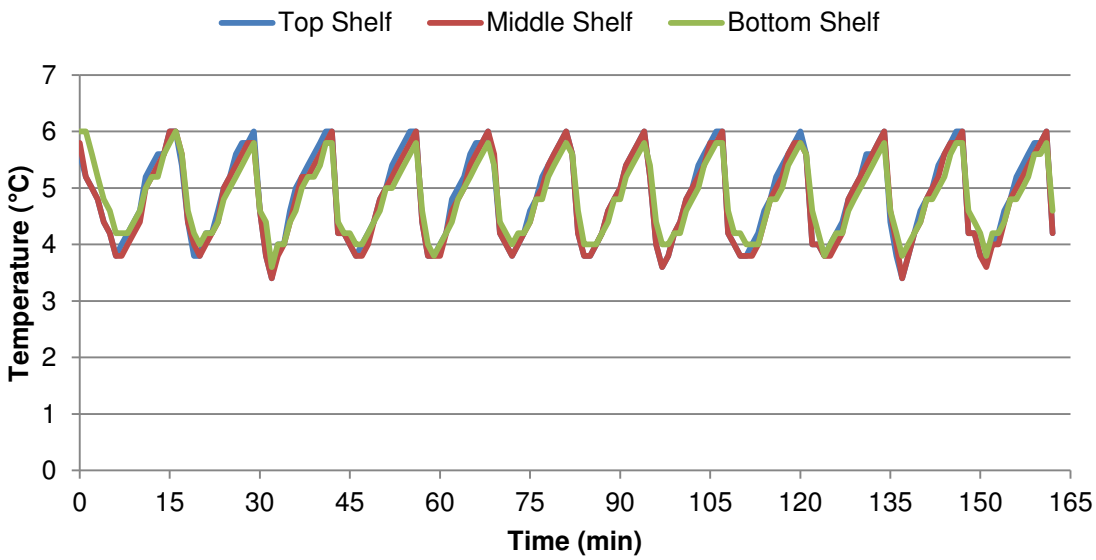


Figure 29. Representative record of air temperatures in the refrigerator used in the storage study

The mean measured air temperature surrounding the carcasses during the storage was 4.8±1.3°C (see Figure 29).

16.3.1 Visual assessment of the quality of partially-eviscerated broilers during refrigerated storage

No noticeable changes in the appearance of the partially-eviscerated poultry carcasses were observed during the first 14 days of storage. The only detectable signs of carcass aging was an increasing weakness of the gall bladder noted during liver separation (for growth on individual organs trials see Appendix I) and also diffusion of the bile from gall bladder to the liver.

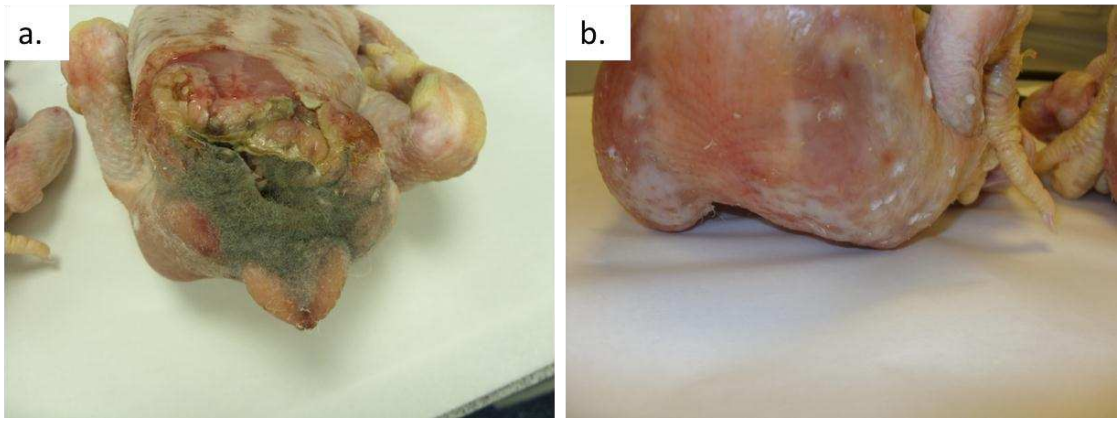


Figure 30. Visible microbiological growth on partially-eviscerated eviscerated carcasses after 21 days of storage a) vent area of the broiler overgrown with moulds, b) breast part of the carcass- visible white growing colonies on skin surface

By day 18 a yellowish slime had appeared on the skin surface of partially-eviscerated carcasses, and moisture had stated to accumulate inside the partially-eviscerated carcasses cavity.

By day 21 obvious visible microbial growth occurred on the carcasses (see Figure 30). The vent area of the carcasses were overgrown with mould and breast part of carcasses developed growth of white colonies.

16.3.2 Microbiological growth on/in partially-eviscerated and standard eviscerated broilers during refrigerated storage

Figure 31 and Figure 32 show the mean counts (a. ACC; b. Pseudomonas; c. Enterobacteriaceae; d. Coliforms; e. *E. coli*) measured during refrigerated storage (at a mild abuse temperature) on the skin and cavity, respectively, of partially-eviscerated and eviscerated broiler carcasses.

Partially-eviscerated carcasses showed significantly ($p<0.05$) higher initial Enterobacteriaceae levels on the skin and in the cavity, Coliforms on the skin and ACC in the cavity when compared to standard broilers. All other initial organism/carcass part combinations showed a non-significant difference between partially and fully eviscerated carcasses.

The *E. coli* counts were significantly higher for skin and carcass cavity of partially-eviscerated broilers on days 1 and 7 when compared to eviscerated broilers.

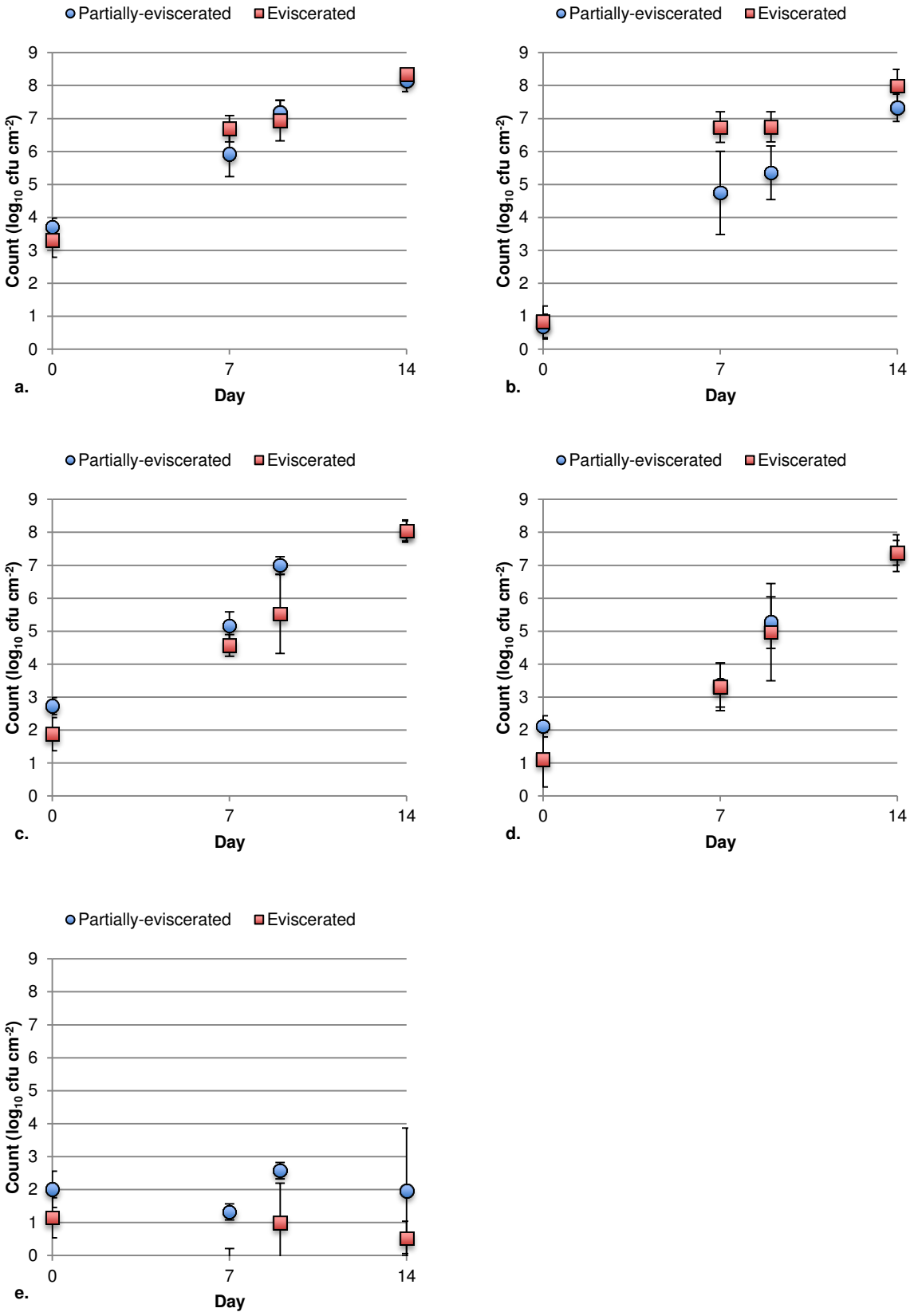


Figure 31. Mean bacterial counts (a. ACC; b. Pseudomonas; c. Enterobacteriaceae; d. Coliforms; e. *E. coli*) measured on the skin of partially-eviscerated and eviscerated broiler carcasses during storage

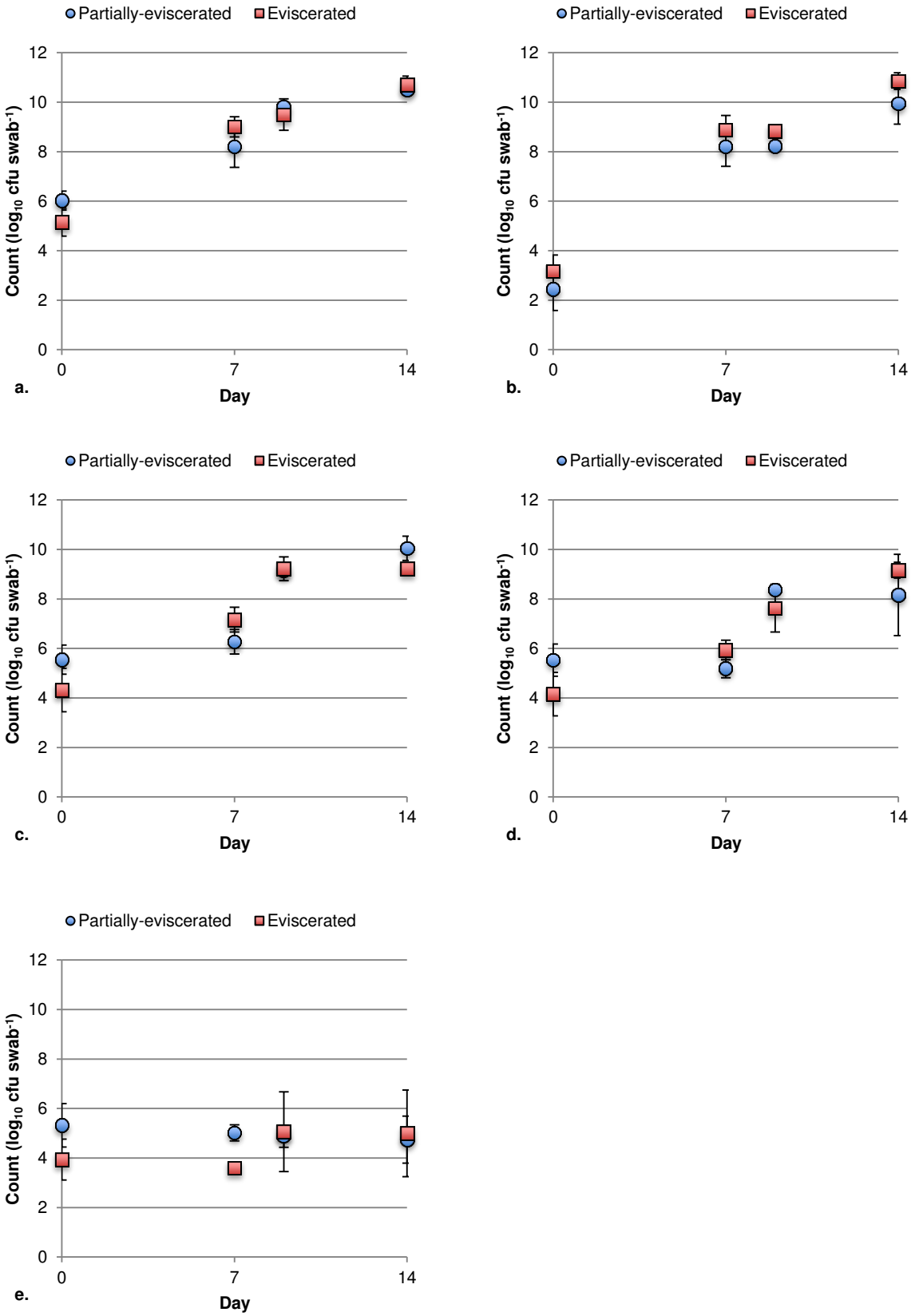


Figure 32. Mean bacterial counts (a. ACC; b. Pseudomonas; c. Enterobacteriaceae; d. Coliforms; e. *E. coli*) sampled from the cavity of partially-eviscerated and eviscerated broiler carcasses during storage

However, at later sampling days populations of ACC, Enterobacteriaceae, Coliforms and *E. coli* were similarly abundant in both partially-eviscerated and eviscerated carcasses. This result suggests a slight (but not significant) initial beneficial impact of the full evisceration process (including inside-outside wash) on initial microbiological quality of poultry carcasses but no significant benefits extending into carcass safety during refrigerated storage.

The population of *Pseudomonas* spp. was initially similar on the skin and cavity surface of both types of carcass, but after day 7 it appeared to increase faster on eviscerated carcasses. This observation was statistically significant on day 9 ($p<0.05$).

Results of microbiological counts of ACC, *Pseudomonas* spp. and Enterobacteriaceae for skin of fully and partially-eviscerated broilers were compared with data available in the literature where similar study conditions (storage at a nominal 4°C) and samples (excised skin of the broilers) were analysed. Barnes & Impey (1975) analysed skin on the surface of standard eviscerated and uneviscerated broiler carcasses whereas Mielnik *et al*. (1999) provided data on standard eviscerated carcasses. Counts of ACC were similar for test start day in this and cited two studies regardless of evisceration type (between 2-3 $\log_{10}$ cfu cm^{-2}). On later days: 9 and 14 Mielnik *et al.* (1999) recorded slightly higher counts compared to obtained in this study. Nevertheless, it needs to be noted that the result uncertainty not given in Mielnik *et al.* (1999) could render these author's and our results comparable. ACC counts on skin of uneviscerated broilers in the study of Barnes & Impey (1975) were lower than those on the skin of partially-eviscerated broilers on day 18. This result indicates that partial-evisceration may shorten the shelf life of poultry carcasses, when compared to fully uneviscerated product. The literature shows higher counts for *Pseudomonas* spp. in standard fully eviscerated broilers when compared to both standard and partially-eviscerated poultry carcasses studied here. Overall it could be noted that ACC and *Pseudomonas* spp. results generated in our study were very similar (slightly lower) to these reported by others for standard eviscerated poultry. The Enterobacteriaceae count was higher in this study compared to Mielnik *et al.*'s (1999) with the exception of the first sampling day. It is anticipated that difference in used method of analysis (here Petrifilm® and in Mielnik *et al.* violet red bile agar) might have an impact on the recovery of organism population.

16.3.3 Shelf life of partially-eviscerated and standard eviscerated broilers

ACC are a general indicator of the microbiological cleanliness of a carcass and it is generally accepted that counts over 7 $\log_{10}$ cfu g^{-1} in meat samples are considered as "*the point at which insipient spoilage can be detected*" (ICMSF, 1986). The skin of both evisceration forms had reached counts of 7 $\log_{10}$ cfu g^{-1} by day 7 of the storage test (Figure 33) although no visual spoilage could be detected (see visual assessment section 16.3.1). Nevertheless, this result is in agreement with the literature where a shelf life of 6-7 days (based on ACC 7 $\log_{10}$ cfu g^{-1} criterion) was reported for chicken breast fillets stored in similar conditions (no atmosphere modification and storage at 4°C in Chouliara *et al.*, 2007 and Patsias *et al.,* 2008).

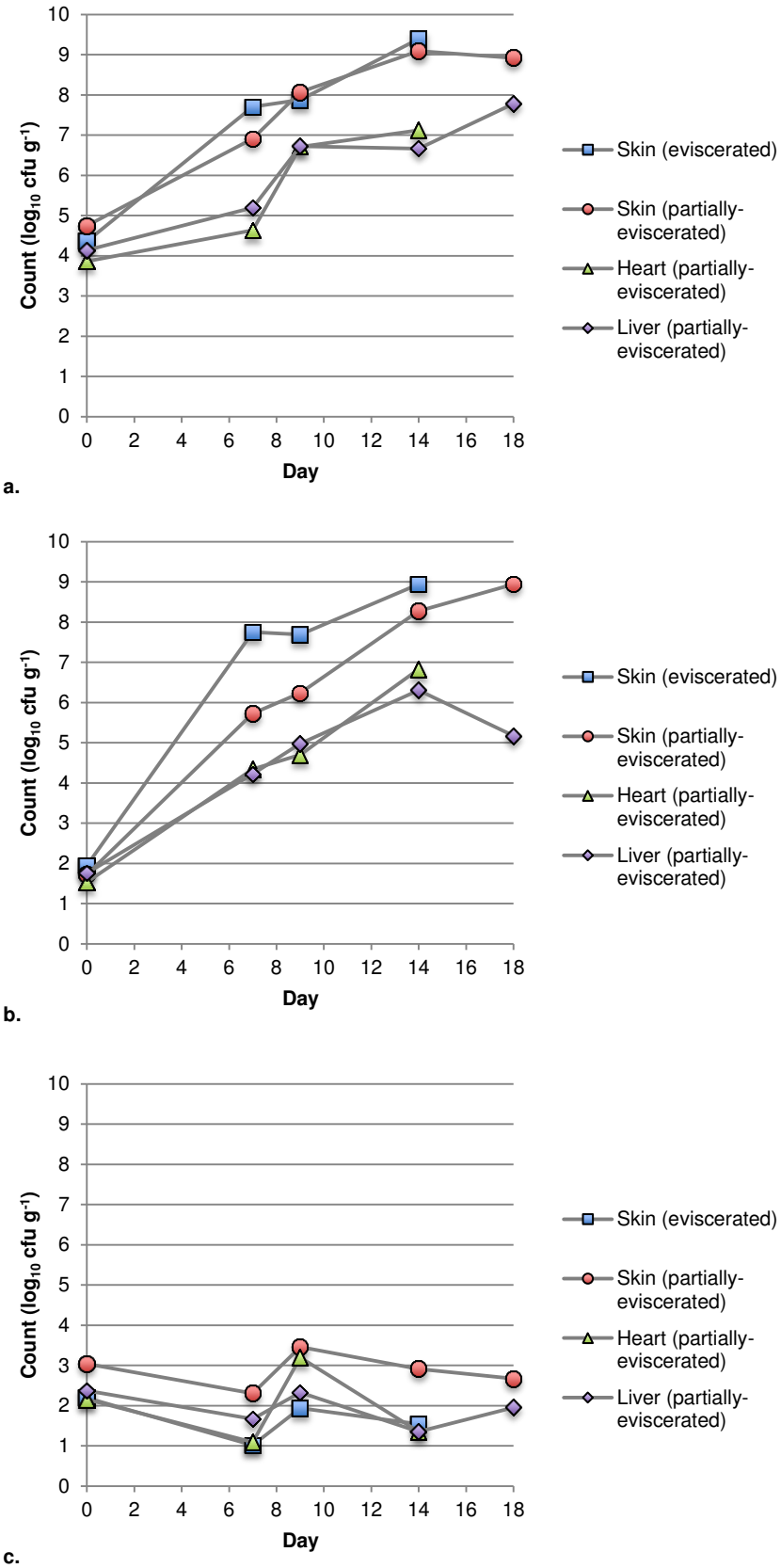


Figure 33. Mean bacterial counts (a. ACC; b. Pseudomonas; c. *E. coli*) on the skin of eviscerated and partially-eviscerated broiler carcasses, as well as heart and liver of partially-eviscerated carcasses during storage

According to guidance for poultry meat shelf life testing, acceptable criteria for *Pseudomonas* count is also 7 $\log_{10}$ cfu g^{-1} (Stannard, 1997). In our study, on average partially-eviscerated carcasses reached this level between days 9 and 14, whereas standard fully eviscerated carcasses reached this level before day 7. This result might point out a beneficial impact of partial-evisceration processing on retarding growth of *Pseudomonas* spp. as previously published counts for pseudomonads in chicken breast meat were in agreement with result obtained for standard eviscerated poultry carcass presented in this study (Chouliara *et al.*, 2007; Patsias *et al.,* 2008).

The edible part of the giblets (heart and liver) had initially similar counts for ACC, *Pseudomonas* spp. and coliforms when compared to the skin. However, because growth of all microbial populations for liver and heart samples was slower than for skin, a longer shelf life could be claimed for these two giblets. Using the criteria 7 $\log_{10}$ cfu g^{-1} count for ACC (cited in Appendix H; Stannard (1997) and ICMSF, (1986)), the shelf life of heart and liver can be estimated as 9 days post slaughter. It is also worth noting that pseudomonas growth never attained the threshold level of 7 $\log_{10}$ cfu g^{-1}.

A shelf life of 9 days is considerably longer than previously reported in the literature for giblets separated from chicken carcass, e.g. approximately 3 days for livers stored in aerobic conditions at 4±0.5°C (Hasapidou & Savvaidis, 2011). This is in agreement with French effilé producers who claimed that separated offal have much shorter shelf life due to increased contamination during handling, when compared to those left in the effilé poultry carcass cavity.

Stannard, (1997) also recommends a maximal count of 4 $\log_{10}$ cfu g^{-1} for *E. coli* for safety during refrigerated storage of raw meat. In our trials, the *E. coli* count did not exceed 4 $\log_{10}$ cfu g^{-1} for any of the studied samples on any of the sampling days (see Appendix I). However, as can be noticed in Figure 31e and Figure 32e the *E. coli* count did not change with time on either the skin or in the cavity, thus we would recommend that criteria should not be used as a shelf life termination indicator for poultry products.

16.4 Conclusions

The aim of this practical evaluation was to determine potential differences in the microbiological spoilage of standard fully eviscerated and partially-eviscerated poultry during refrigerated storage at a slightly abusive storage temperature (i.e. a degree above the recommended 4°C limit). This study showed some slight differences between the microbiological quality of partially and fully eviscerated broiler carcasses over 14 days of storage at a slightly abusive temperature. The population of Enterobacteriaceae and Coliforms was higher on day 0 and pseudomonas lower after 9 days of storage on partially-eviscerated carcasses. These differences may indicate a higher initial microbiological contamination of partially-eviscerated carcasses when compared to conventionally processed fully eviscerated carcasses but these initial differences reduce as the storage duration progresses. Overall, there was little difference between the degree of growth of the microorganisms quantified on either of the evisceration forms. Thus these trials did not confirm the claim of the French manufacturers of a longer shelf life for partially-eviscerated (effilé) carcasses in comparison to standard eviscerated carcasses, though neither did they show partial-evisceration to be detrimental to shelf life. An

estimated shelf life for partially-eviscerated broiler carcasses of at least 7 days was determined using guidance published by Stannard (1997) and the ICMSF (1986). A slightly longer (9 days) shelf life was estimated for heart and liver stored inside partially-eviscerated carcass cavity. This result indicated an effect of partial-evisceration processing on prolonging the shelf life of the edible giblets (particularly the liver).

17 Appendix I: Practical Evaluation of the Growth and Survival of Microorganisms in the Organs of Partially-Eviscerated Broilers during Refrigerated Storage

17.1 Aim

The aim of the study was to assess microbiological growth on the different parts contained in partially-eviscerated carcass, focusing on the appendages and organs that are not present on standard fully eviscerated poultry. Samples were stored at a slightly abusive storage temperature (i.e. a degree above the recommended 4°C limit). A short comparison trial was also carried out in which the carcasses were stored at 0±0.2°C for up to 7 days in order to assess the effect of storage at a lower temperature.

The crop, feet and gizzard typically are present on partially-eviscerated poultry carcasses but not on fully-eviscerated carcasses. If these are initially more contaminated, or spoil faster, this may also affect the microbiological quality of the poultry carcass. For example, in one of the French effilé plants visited the crop was removed from partially-eviscerated carcasses as it was thought to be responsible for shortening the product's shelf life. Additionally some of the giblets, such as heart and liver are edible and so the assessment of their shelf life inside of the partially-eviscerated broiler is essential for consumer information.

This study included an assessment of microbial populations as described in Appendix H, as well groups of organisms responsible for foodborne disease incidents connected to poultry consumption, namely *Salmonella* spp. and *Campylobacter* spp.

17.2 Materials and Methods

For this study all carcasses used for shelf life assessment in Appendix H were used and samples were taken on same days as stated in cited appendix. Whole crops, livers and hearts were excised from partially-eviscerated broilers on each of testing days as given in Appendix H, with the exception of day 18, when only the liver was analysed. Crops were weighed in the stomacher bags with 15 ml of sterile buffered peptone water (BPW) (3M, Minnesota, US) added. Hearts and livers were diluted with BPW in the ratio 1:2 according to weight. Both feet of the carcass were swabbed with a sponge-swab, which was then immersed in 15 ml of BPW. Part of the gizzard connecting with duodenum at the partial-evisceration breakage point was swabbed using a cotton-bud swab, which was then immersed in 10 ml of BPW.

All the samples with the exception of cotton-bud swabs were homogenized with in Stomacher blender (Stomacher® 400 Circulator, Seward, Worthing, UK) at 250 rpm for 2 min. Cotton-bud swab samples were homogenized on laboratory vortex.

Previously reported data in Appendix H were also used for comparison on log increase of different organisms on different parts of partially-eviscerated broiler carcasses.

Methods for analysis of *Pseudomonas* spp., ACC, Enterobacteriaceae, *E. coli* and coliforms were previously described in Appendix H. For indication of presence of *Salmonella* ssp. xylose lysine deoxycholate (XLD) agar (Oxoid, Hampshire, UK) was

used. Samples were inoculated on a medium using the spread plate method and incubated at 37℃ for 24 h. For enumeration of presumptive *Campylobacter* spp., a *Campylobacter* blood-free selective agar with CCDA selective supplement (Oxoid, Hampshire, UK) was used. Samples were inoculated on medium using spread-plate method and incubated in anaerobic condition at 42℃ for 48 h.

The range of limits of detection for different microbiological tests and samples is summarised in Table 19.

Table 19. Limits of detection for microbiological analyses (log_{10} cfu $sample^{-1}$)

Sample	Test	
	ACC, *Pseudomonas*, *Salmonella,* Campylobacter	Enterobacteriaceae, *E. coli*, Coliforms
Cavity	2.2	1.2
Crop	2.2	1.2
Feet	2.2	1.2
Gizzard	2.0	1.0
Heart	2.2-2.5	1.2-1.5
Head	2.8-3.1	1.8-2.1
Liver	2.8-3.2	1.8-2.2
Skin	2.2	1.2

All data were calculated as described in Appendix H.

A short comparison trial was also carried out using the same protocol in which the carcasses were stored at 0±0.2℃ for up to 7 days in order to assess the effect of storage at a lower temperature. Uneviscerated carcasses were sourced from a different processing plant to that used in the other trials. Six warm carcasses were processed and chilled as previously described. Three carcasses were analysed immediately after chilling on day 0, while three were stored as previously described for 7 days at 0±0.2℃ before analysis. Heads were separated from the carcasses alongside the bleed-out cut and shaken in BPW by hand for 2 min. The dilution ratio for the sample was 1:2. All other taken samples: skin, liver, heart, crop, feet and carcass cavity were sampled and prepared for microbiological analyses in same way as for broiler carcasses used for the previous shelf life trial.

17.3 Results and Discussion

17.3.1 Microbial growth on different parts of the broiler carcass during its shelf life and shelf life of giblets

Figure 34 presents microbial populations in different parts of a partially-eviscerated carcass over the duration of shelf life test. Care must be taken when comparing counts between the different organs because there are differences in the sampling areas. The largest log increase of ACC population over the duration of the test carried out at 4.75°C was seen for skin and carcass cavity (4.3 and 4.5 log respectively) and the lowest increase for the crop (1.3 log). Similarly, coliforms and Enterobacteriaceae were growing fastest on skin (4.8 and 5.2 log increase respectively) and slowest on the crop (1.3 log and 1.6 log respectively). The counts of *E. coli* did not appear to increase significantly for the duration of the trials for any of the carcass parts sampled.

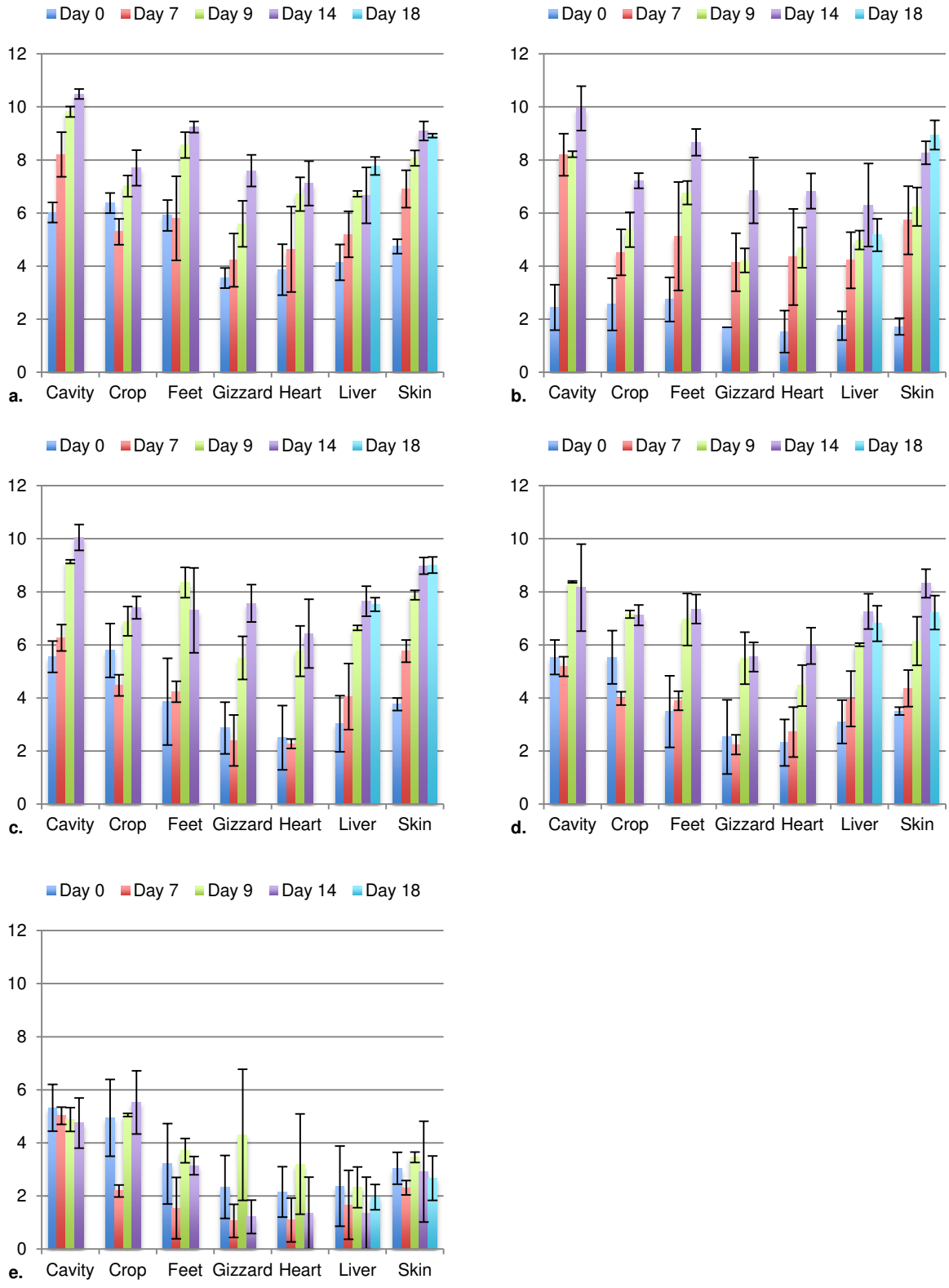


Figure 34. Microorganism (a. ACC; b. *Pseudomonas* spp.; c. Enterobacteriaceae; d. Coliforms; e. *E. coli*) growth on different parts of the broiler carcass during 18 days of storage at 4.8±1.3°C (mean and standard deviation, n=3). Sample unit are per g for heart, liver, crop and skin, and per swab for feet, cavity and gizzard

The results indicate that additional anatomical parts present in partially-eviscerated poultry carcasses would not affect shelf life of the product because skin tissue and carcass cavity is more prone to microbiological spoilage and thus reach the thresholds for spoilage based on numbers of organisms present before other parts of the carcass. Thus, the claim of one French effilé producer that the presence of the crop shortened the shelf life of the carcass was not confirmed.

Despite relatively low log increase of bacterial counts in the crop, it should be noticed that the initial contamination of this organ with ACC, Enterobacteriaceae, and coliforms was higher in comparison to other sampled carcass parts. The crop can thus be considered an important source of possible microbiological contamination during in-kitchen preparation of partially-eviscerated poultry for consumption. These results indicate that there is merit in the practice carried out by on of the French effilé producers of removing the crop during processing, since it could reduce the risk of cross contamination during preparation of partially-eviscerated poultry in the kitchen before cooking and consumption.

The edible part of the giblets (heart and liver) had initially similar counts for ACC, *Pseudomonas* spp. and coliforms when compared to the skin. However, because growth of all microbial populations for liver and heart samples was slower than for skin, a longer shelf life could be claimed for these two giblets. Using the criteria 7 $\log_{10}$ cfu g^{-1} count for ACC (cited in Appendix H; Stannard (1997) and ICMSF, (1986)), the shelf life of heart and liver can be estimated as 9 days post slaughter. It is also worth noting that the pseudomonas growth never attained the threshold level of 7 $\log_{10}$ cfu g^{-1}.

A shelf life of 9 days is considerably longer than previously reported in the literature for giblets separated from broiler carcass, e.g. approximately 3 days for livers stored in aerobic conditions at 4±0.5°C (Hasapidou & Savvaidis, 2011). This is in agreement with French effilé producers who claimed that separated offal have much shorter shelf life due to increased contamination during handling, when compared to those left in the effilé poultry carcass cavity.

A short comparison trial was also carried out, with carcasses sourced from a different processing plant, in which the carcasses were stored at 0±0.2°C for up to 7 days in order to assess the effect of storage at a lower temperature (Figure 35). Initial counts on these carcasses were similar to those sourced fro the previous trials. There was very little (if any) increase in mean counts during storage at 0°C, and in some cases mean counts were slightly lower on day 7 than day 0. This is not unexpected since even *Pseudomonas* spp., which are capable of growth at 0°C, will only grow very slowly at this temperature (Dominguez & Schaffner, 2007). These results clearly show the importance of storing chilled poultry meat at as low a temperature as possible. Had we had time to continue the trials for 18 days, as carried out in the trials at 4.8°C, we would expect the results to demonstrate far less growth than was apparent at 4.8°C and consequentially a longer shelf life for the partially-eviscerated carcasses than that determined at 4.8°C.

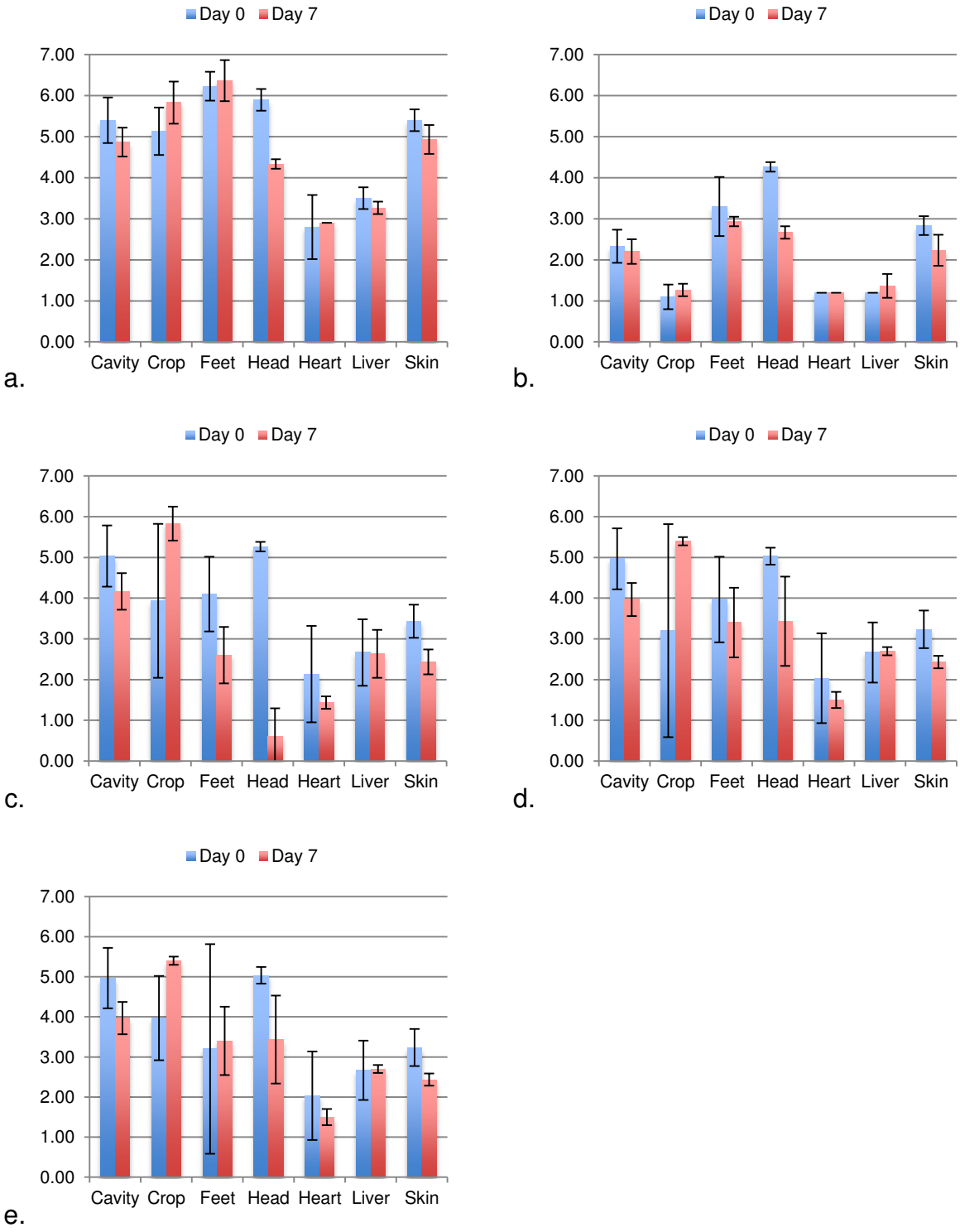


Figure 35. Microorganism (a. ACC; b. *Pseudomonas* spp.; c. Enterobacteriaceae; d. Coliforms; e. *E. coli*) growth on different parts of the broiler carcass after 7 days of storage at 0±0.2℃ (mean and standard deviation, n=3). Sample units are log_{10} cfu per g for crop, heart, liver, and skin, and log_{10} cfu per swab for cavity, feet, and head

17.3.2 Prevalence of Salmonella ssp. *and Campylobacter* spp. *in analysed parts of partially-eviscerated carcass*

Table 20 and Table 21 show prevalence of presumptive *Salmonella* ssp. and *Campylobacter* spp. in analysed parts of partially-eviscerated carcasses.

The prevalence of presumptive *Salmonella* spp. was highest in the crop and on the feet. Taking into consideration the low sample numbers in this study, the prevalence of 35% is in quite a good agreement with the literature. For example, Hargis *et al*. (1995) reported 52% of analysed crops to be salmonella positive. The fact that the feet were also heavily contaminated with presumptive *Salmonella* spp. may indicate increased risk for the consumer as feet of partially-eviscerated broiler are placed in contact with carcass skin if the carcass is trussed in the French effilé manner (see Figures 1 to 6).

Table 20. Prevalence of presumptive *Salmonella* spp. in analysed partially-eviscerated broiler carcass parts

Anatomical part	Day					Total positive %
	0	7	9	14	18	
Crop	3	1	2	2	-	35
Feet	2	1	3	2	-	35
Gizzard [a]	0	0	1	3	-	24
Head [b]	2	0	-	-	-	33
Liver	2	1	1	2	2	31
Analysed number of carcasses on given day	8	6	3	6	3	-

[a] Samples originating only from shelf life trial carried out at 4.75°C

[b] Samples originating only from shelf life trial carried out at -0.2°C

The prevalence of presumptive *Campylobacter* spp. (Table 21) was highest among the studied samples for head (67%) and feet (43%), and lowest for gizzard (18%).

Table 21. Prevalence of presumptive *Campylobacter* spp. in analysed partially-eviscerated broiler carcass parts

Anatomical part	Day					Total positive %
	0	7	9	14	18	
Crop	2	6	0	2	-	43
Feet	6	0	1	1	-	31
Gizzard [a]	1	2	0	0	-	18
Head [b]	3	1				67
Liver	5	3	0	0	1	35
Analysed number of carcasses on given day	8	6	3	6	3	-

[a] Samples originating only from shelf life trial carried out at 4.75°C

[b] Samples originating only from shelf life trial carried out at -0.2°C

It needs to be noted that feet of nearly all the commercial broilers used in this study exhibited calluses (Figure 36), which could increase the chances of retaining pathogenic contamination. French produced effilé poultry is checked for calluses during production process and poultry with this condition is de-selected from effilé. In addition, French effilé poultry is only produced from free-range birds and this may impact on the health condition of broiler feet since no carcasses with foot calluses were observed in any of the French effilé plants visited as part of the survey of industrial practice.

Figure 36. Callus on foot of partially-eviscerated carcass used in the study

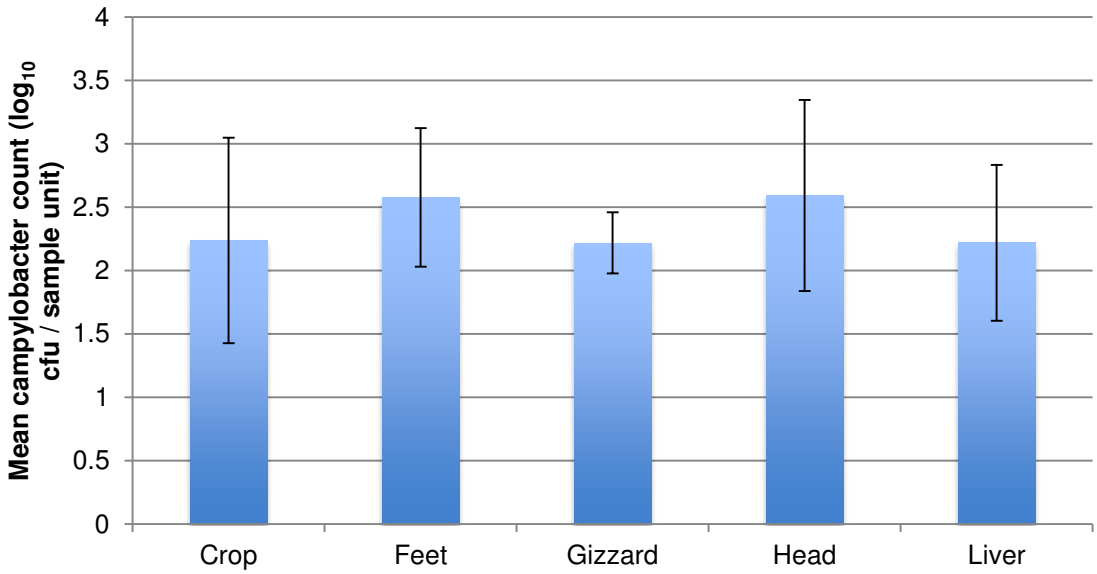


Figure 37. Mean (n=6) *Campylobacter* count in different parts of partially-eviscerated broiler carcass (error bars represent standard deviation). Per g for liver, crop, head and per swab for feet and gizzard

The count of *Campylobacter* spp. in positive samples (Figure 37) was very similar (on average between 2.2-2.6 $\log_{10}$ cfu/ sample unit). These results are only indicative as they include most of the samples with counts close to the detection limit. These indicative counts for campylobacter in crops were lower than previously reported in the literature (4.5-5.0 $\log_{10}$ cfu g^{-1}) (Berrang *et al.,* 2000).

The levels of *Campylobacter* spp. seen are above the lower UK industry target level of <2 $\log_{10}$ cfu g^{-1} (FSA ,2010). However, the target levels are defined for a pooled sample of three 10 g neck-skins, and these results are for internal organs and parts of a carcass not currently included in/on a standard carcass. Feet and gizzard samples are cfu per foot or per gizzard (not per gram) and thus levels per gram would be close or below the lower <2 log target.

17.4 Conclusions

This study provided information on the microbiological growth on different parts of partially-eviscerated poultry carcasses during storage. All tested anatomical parts of the carcasses displayed increased growth of the microorganisms such as ACC, Pseudomonas, Enterobacteriaceae, and Coliforms through the storage period. Thus higher total counts per carcass could be expected for partially-eviscerated when compared to standard eviscerated poultry, as organs are present and contribute to the total number of organisms on/in the carcass).

Nevertheless, as demonstrated in this study data showed that shelf life of partially-eviscerated carcasses is not affected by the giblets inside of the carcass cavity or other anatomical parts not removed from the carcass in partially-eviscerated processing. Thus, the belief that the crop shortens the shelf life of the partially-eviscerated carcass was not supported in this study. However, the removal of the crop and head of the partially-eviscerated poultry might contribute to cross contamination of the edible part of the carcass. The partially-eviscerated processing appears to have a beneficial impact on the shelf life of broiler liver, increasing it from 3 to 9 days.

The high prevalence of presumptive *Campylobacter* spp. and *Salmonella* spp. on broiler feet, head and crop not present in standard poultry but present on feet on partially-eviscerated carcasses may indicate increased risk for cross contamination of the meat with pathogens. Thus partially-eviscerated processing may require additional control measures, such as feet and head cleaning and crop removal.

The short trial carried out at 0°C demonstrates, not surprisingly, that the growth of spoilage microorganisms is significantly lower at 0°C than 4.8°C, and consequentially the microbiological quality of chilled partially-eviscerated carcasses will be significantly better if stored at a temperature as low as possible (i.e. close to the freezing point).

18 Appendix J: Practical Evaluation of the Preparation of Partially-Eviscerated Poultry Carcasses for Cooking

At present we know of no guides or guidelines in English for the final preparation of partially-eviscerated poultry carcasses for cooking, i.e. the removal of giblets remaining in the carcass after partial-evisceration. Although we have not seen any published guidelines on performance of this process, we believe these to exist in French, and there are various on-line sites that recommend/show how French effilé (partially-eviscerated) poultry are traditionally prepared for cooking, such as the following:

- http://www.pouletbresse.com/site/index.php?Itemid=14&id=3&option=com_content&view=article
- http://lesotlylaisse.over-blog.com/article-habiller-et-vider-une-volaille-effilee-en-images-65870187.html
- http://webtv.ac-versailles.fr/restauration/Vider-une-volaille

All of these show the head and neck being removed for cooking. However we understand from a recent article in The Times newspaper (Slater, 2014) that there is a current vogue in some London restaurants to serve whole roast chicken with the feet, or even the feet and head, still attached.

Although not directly required by the scope of this study, a short practical evaluation was carried out (based on the instructions of the websites listed above) to assess how easily final evisceration can be accomplished. No microbiological assessment was carried out.

Based on this, we would say that there are eight main stages to the process (depending on whether the head or feet are to be retained):

1. Remove the feet (optional).
2. Remove the head (optional).
3. Skin the neck (Figure 38) (optional).
4. Remove the neck (optional).
5. Separate trachea, oesophagus and crop from remaining neck skin (Figure 39).
6. Using fingers, separate trachea, oesophagus and crop and from the connective tissue securing them to the membrane around the neck cavity (Figure 40).
7. Working through the vent, remove excess fat from inners sides of the cavity. If vent opening is too small make a small knife incision to expand the opening.
8. Using a hand inserted through the vent opening, free the giblets as a single unit from the cavity lining (Figure 41). Then using a hand cupped around all organs pull out all giblets out in one smooth motion. Provided the trachea, oesophagus and crop have been fully loosened in steps 5& 6 they will pull out with giblets (Figure 42). Figure 43 shows the completed carcass and giblets.

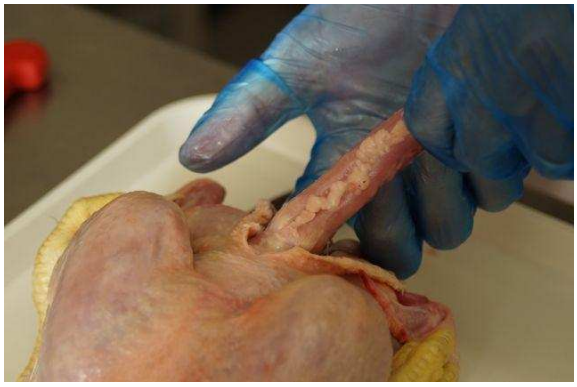


Figure 38. Neck skinning and removal

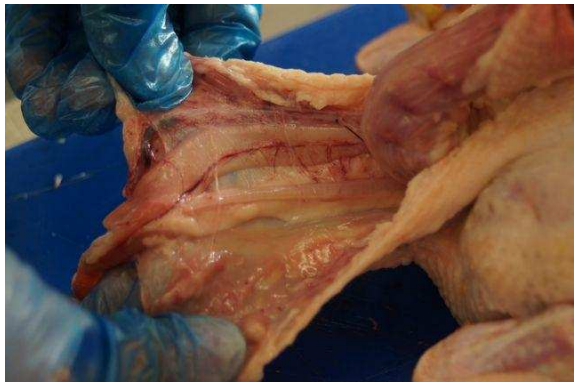


Figure 39. Separation of trachea and oesophagus from neck skin

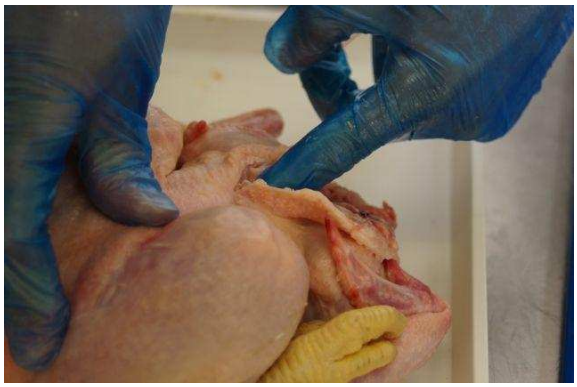


Figure 40. Opening of neck cavity

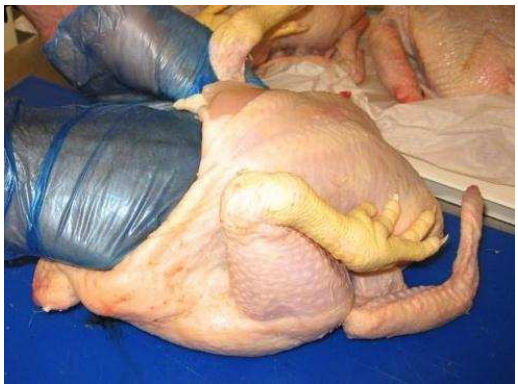


Figure 41. Scooping out of giblets

Figure 42. Giblets from partially-eviscerated broiler carcass

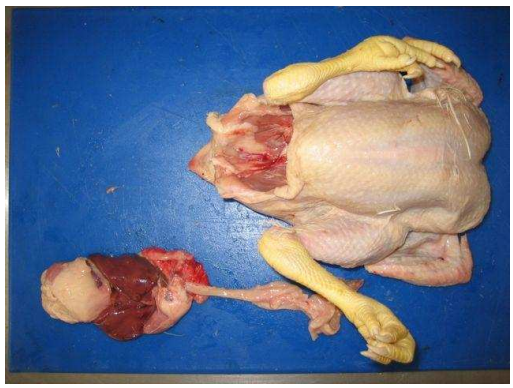


Figure 43. Finished carcass (feet on, head off)

We found the organs to be robust (i.e. they did not rupture) during this final evisceration process and (provided the worker does not have large hands) relatively easy to accomplish without any previous training. In our experience, the key element for success is ensuring the full separation of the trachea, oesophagus and crop from the neck region before scooping out the giblets. In our opinion, based on our practical experience of carrying out this evaluation, there would appear to be relatively little risk of further contamination or cross-contamination at this final preparation stage (especially compared to the evisceration of NYD as studied by Mead & Scott, 1997). Although a more structured (microbiological) evaluation is recommended. It is likely that the largest risk would be from any contents remaining in the crop; however, further study is necessary to define the magnitude of this risk.

19 Appendix K: Risk Assessment of the Main Microbiological Hazards Associated with the Consumption of Poultry Meat

Numerous cases and outbreaks (an incident in which two or more linked cases experience the same illness) of foodborne illness worldwide have been attributed to the consumption of chicken products (Bremner & Johnston, 1996). Outbreaks involving large numbers of people are usually due to *Salmonella* spp., *Cl. perfringens,* and *Staph. aureus* (ICMSF, 1998; Health Protection Agency, 2011a). The Health Protection Agency (2011a) has published data of foodborne diseases outbreaks in England and Wales between 1992-2010 with poultry meat as the presumed vehicle (Figure 44). The primary hazard for most outbreaks associated with the consumption of poultry between 1992-2010 was *Salmonella* spp., although figures from 2011 show *Campylobacter* spp. to be responsible for more outbreaks. *Campylobacter* spp. is a more common cause of human diarrhoeal disease than salmonella, although it is rarely associated with outbreaks (NACMCF, 1997; ICMSF, 1998; EFSA, 2012; Defra, 2013).

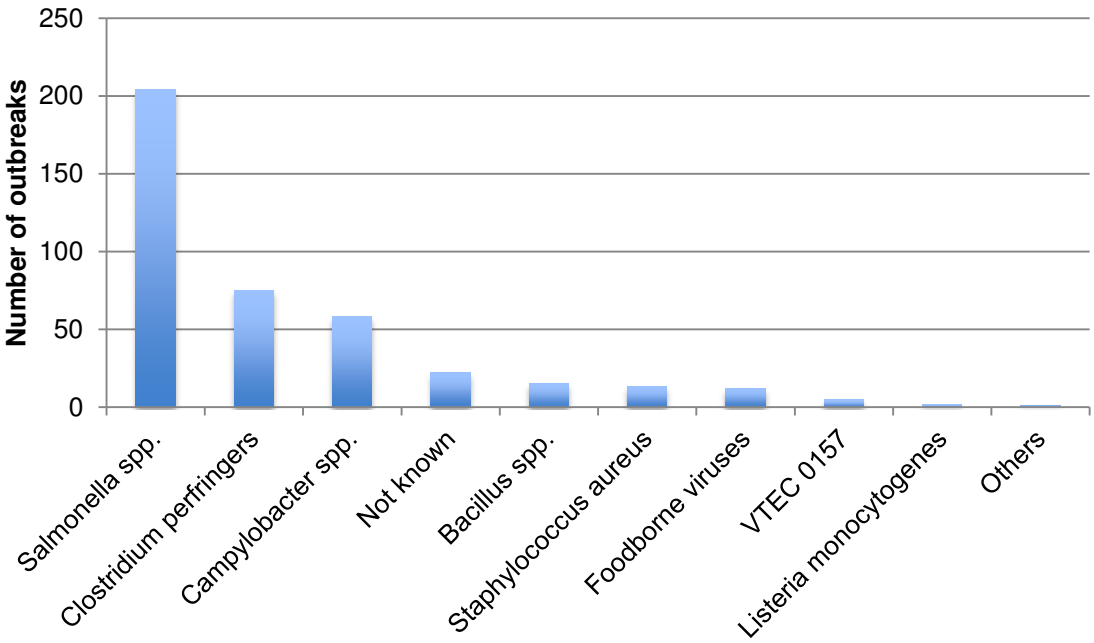


Figure 44. Foodborne disease outbreaks in England and Wales from 1992-2010 reported to the Health Protection Agency where the presumed vehicle was poultry meat (HPA, 2011a)

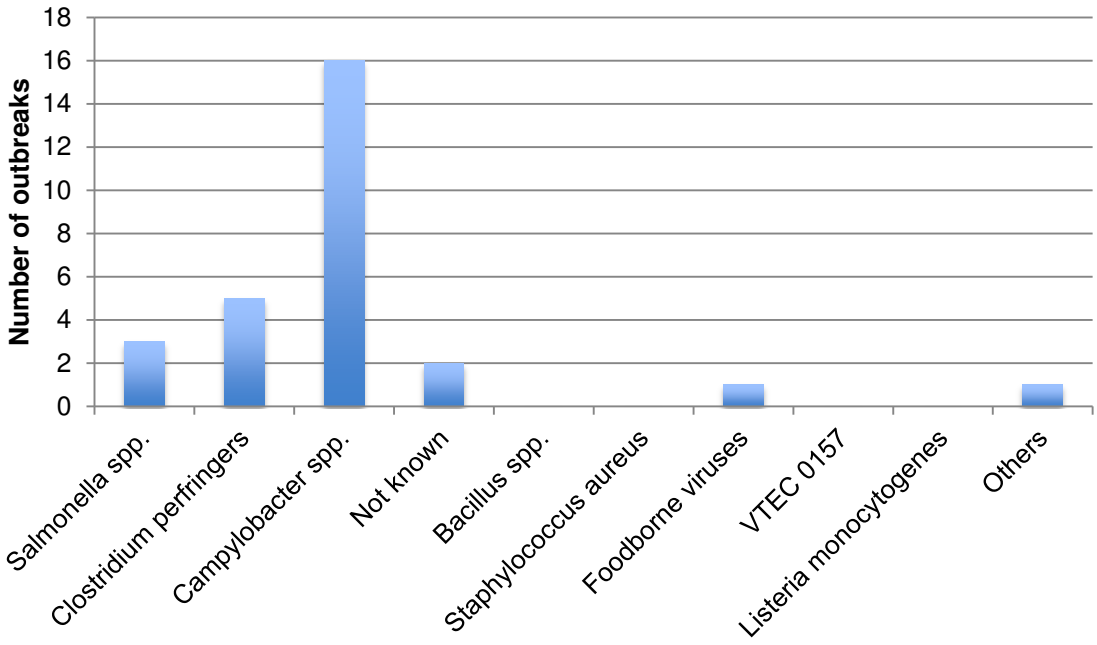


Figure 45. Foodborne disease outbreaks in England and Wales from 2011 reported to the Health Protection Agency where the presumed vehicle was poultry meat (HPA, 2012)

Table 22. Overall human incidence and deaths and hospitalisations data reported by EU Member States as described in Decision (2119/98/EC) on communicable diseases and DALY estimates (Havelaar *et al.*, 2012; EFSA, 2012). Foodborne biological hazards of poultry origin identified to be transmissible to humans through consumption of poultry meat

Hazard	Incidence in humans (reported confirmed cases per 100 000 EU population)			Severity in humans (reported confirmed hospitalisations/deaths among confirmed cases, %)			DALYs per 1 000 cases
	2008	2009	2010	2008	2009	2010	
Campylobacter spp.	38.5	39.9	44.4	N/A / 0.01	4.36 / 0.01	2.40 / 0.12	41
C. difficile	N/A	N/A	N/A	N/A	N/A	N/A	N/A
E. coli (toxicoinfectious strains including VTEC)	0.6	0.73	0.73	N/A / 0.06	4.1 / 0.16	9.9 / 0.21	143
ESBL/AmpC (*E. coli*)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
ESBL/AmpC (Salmonella)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Salmonella spp. (non- typhoidal)	27.6	19.9	18.3	N/A / 0.05	11.43 / 0.04	13.1 / 0.07	49
Y. enterocolitica	1.3	1.2	1.2	2.25 / 0.02	4.44 / 0.01	8.68 / 0	[40–50] assumed to be comparable to Salmonella
Toxoplasma gondii	0.1	0.2	0.1	0 / 0.19	4.24 / 2.07	6.75 / 0	3 170/6 360 (acquired/perinatal)

Table 23. Data on biological hazards of poultry origin that may be transmissible to humans through the handling, preparation and consumption of poultry meat. Data reported by EU Member States in the frame of the Zoonosis Directive (2003/99/EC) (EFSA, 2012)

Hazard	Data on flock prevalence (%)			Data on prevalence in carcasses (%)		
	Anseriformes	Broiler chickens	Turkeys	Anseriformes	Broiler chickens	Turkeys
Campylobacter spp.	N/A	71.2	N/A	N/A	75.8	61.2
C. difficile	N/A	N/A	N/A	N/A	N/A	N/A
E. coli (toxicoinfectious strains including VTEC)	N/A	N/A	N/A	N/A	N/A	N/A
ESBL/AmpC (*E. coli*)	N/A	N/A	N/A	N/A	N/A	N/A
ESBL/AmpC (Salmonella)	N/A	N/A	N/A	N/A	N/A	N/A
Salmonella spp. (non-typhoidal)	27.1	4.1	12.1	N/A	15.6	10.7
Y. enterocolitica	N/A	N/A	N/A	N/A	N/A	N/A
Toxoplasma gondii	N/A	N/A	N/A	N/A	N/A	N/A

European data on the incidence and severity of diseases in humans associated with the consumption of poultry meat and the prevalence in poultry carcasses were assessed by EFSA (EFSA, 2012; see Table 22 and Table 23, and EFSA report for details).

The aim of the Hazard Identification step was to identify the major microbiological hazards that, current knowledge suggests, were of public health concern due to the production and/or consumption of partially-eviscerated poultry (not including occupational hazards). As a starting point we considered the hazards identified in a recent EFSA scientific opinion on poultry meat inspection (EFSA 2012), review of current poultry practice and inspection by Löhren (2012) for EFSA, and assessment for FSA on microbiological risks of uneviscerated small game birds (Horigan *et al.*, 2013). These hazards were reconsidered and compared with the final hazard list developed by these projects to identify whether any of the hazards not included in that final list should be considered for partially-eviscerated poultry. Particular consideration was applied to the hazards associated with the conditions of concern to public health that may be potentially missed during the production of partially-eviscerated poultry (Table 13). Table 24 shows the main hazards considered and the reasons for inclusion/exclusion from the final list. Those hazards taken forward are discussed in the subsequent sections of this report.

Table 24. Short list of microbiological hazards considered and reasons for inclusion/exclusion in full risk assessment (hazards taken forward to the final risk assessment are highlighted in red)

Hazard	Inclusion/ exclusion characteristics
Bacillus cereus	Ubiquitous pathogen. Vegetative form need temperatures above those used for refrigeration to grow to levels of concentration of public health relevance, and thus the risk of disease seems not to be related with occurrence in raw meat but rather with improper hygiene during food preparation and storage.
Campylobacter spp.	Organism is a frequent cause of infection in humans and has been associated with the consumption of poultry. Handling, preparation and consumption of broiler meat may account for 20 to 30 % of human cases of campylobacteriosis, whereas 50 to 80 % may be attributed to the chicken reservoir as a whole (EFSA, 2012).
Clostridium botulinum (Mostly Type C) poison	Ubiquitous pathogen. Vegetative form need temperatures above those used for refrigeration to grow to levels of concentration of public health relevance, and thus the risk of disease seems not to be related with occurrence in raw meat but rather with improper hygiene and storage. Infection in humans is usually associated with preserved long life foods.
Clostridium difficile	Data on zoonotic infections by *Cl. difficile* in humans are not currently available; the disease is typically associated with healthcare settings. There is no evidence of poultry meat playing a role in the epidemiology of human infections with *Cl. difficile*.
Clostridium perfringens (Type A and C)	Ubiquitous pathogen. Some evidence of association with some of the conditions that may not be identified during the post-mortem inspection of partially-eviscerated poultry.
Pathogenic *Escherichia coli*	Occurrence is moderate to high in poultry and associated with some of the conditions that may not be identified during the post-mortem inspection of partially-eviscerated poultry.
Listeria monocytogenes	Ubiquitous pathogen. Organism is found in poultry species and is able to grow at low temperatures with the potential to increase on the carcass surface during storage, especially if moisture is present, and in the gut.
Salmonella spp.	Organism is a frequent cause of infection in humans and has been found on game bird carcasses.
Staphylococcus aureus	Ubiquitous pathogen. Vegetative form need temperatures above those used for refrigeration to grow to levels of concentration of public health relevance, and thus the risk of disease seems not to be related with occurrence in raw meat but rather with improper hygiene during food preparation and storage. Infection is usually transmitted to the cooked product by a human carrier and increases via subsequent temperature abuse. Animal strains are not usually associated with *Staph. aureus* food poisoning incidents.
Toxoplasma gondii	Reports of infection in free- range chickens (Dubey, 2010) show a risk of transmission to humans.
Yersinia enterocolitica	Very few human cases of infection are reported annually and infection is usually associated with consumption of pig meat or pig meat products.

Details on general characteristics and characteristics of infection in humans of the pathogens discussed in the following sections are mainly taken from the following sources:

- Public Health England website (http://www.hpa.org.uk/)
- Disease Control and Prevention (CDC) website (http://www.cdc.gov)
- FDA (2012) *Bad bug book: Foodborne pathogenic microorganisms and natural toxins handbook*
- Foodsafety.gov.nz industry elibray (http://www.foodsafety.govt.nz/elibrary/)
- FSANZ (2013) *Agents of Foodborne Illness*
- ICMSF (1996) Microorganisms in food 5: Microbiological specifications of food pathogens.

19.1 *Campylobacter* spp.

19.1.1 Occurrence and characteristics of infection in humans

Campylobacter was first confirmed to cause human illness in 1972, and by 1986 it became recognised as the most commonly reported gastrointestinal pathogen in the UK, ahead of salmonella (Figure 46). Campylobacter infection is thought to be very under reported and it is estimated that there were approximately 750,000 campylobacter cases in the UK (Defra, 2013). *C. jejuni* accounts for approximately 90% of human infection (Defra, 2013). Other *Campylobacter* spp., such as *C. coli* and *C. fetus*, also cause foodborne diseases in humans.

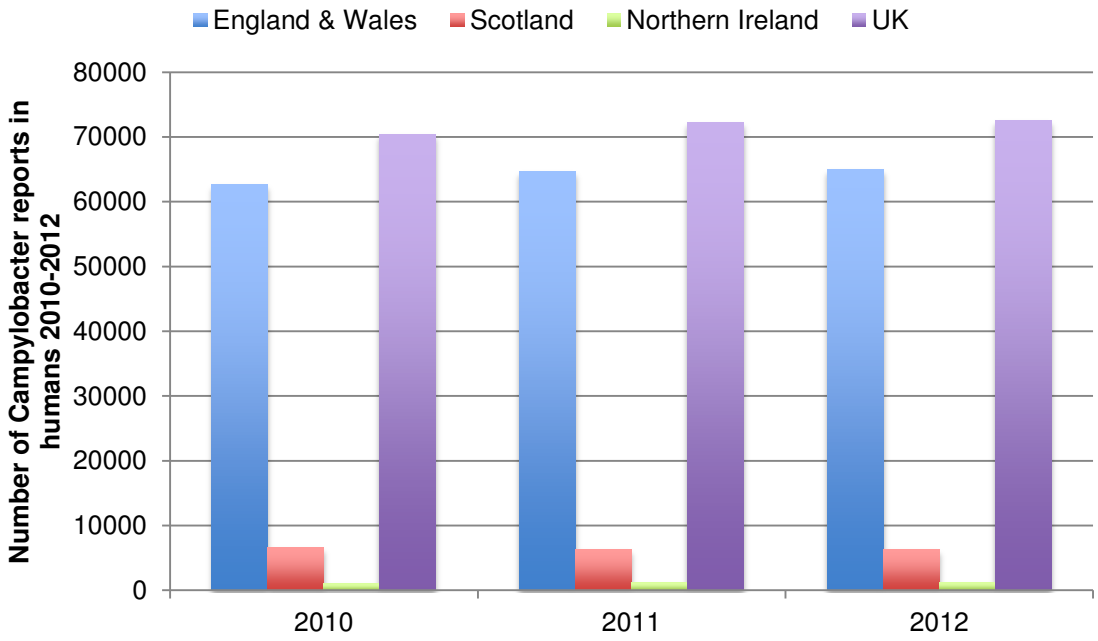


Figure 46. Number of reports of campylobacter infections in humans in the UK between 2010-2012 (Defra, 2013)

Transmission to humans is through the faecal-oral route, usually by the consumption of contaminated foods. *Campylobacter* spp. are one of the main human pathogens associated with poultry and poultry products (WHO, 2009; EFSA, 2012). In 2012 there were eight campylobacter outbreaks reported, six of which were associated with the consumption of chicken liver and chicken liver parfait. It has been estimated that the handling, preparation and consumption of broiler meat may account for 20% to 30% of human cases of campylobacteriosis, while 50% to 80% may be attributed to the chicken reservoir as a whole (EFSA, 2010a).

The infectious disease caused by bacteria of the genus *Campylobacter* is called Campylobacteriosis. Most people who become ill with campylobacteriosis get diarrhoea, cramping, abdominal pain, and fever within two to five days after exposure to the organism. The diarrhoea may be bloody and can be accompanied by nausea and vomiting. The illness typically lasts about one week. Some infected persons do not have any symptoms. In persons with compromised immune systems, campylobacter occasionally spreads to the bloodstream and causes a serious life-threatening infection.

The infective dose for campylobacteriosis is reported to be potentially low (<500 bacteria).

19.1.2 Organism characteristics

C. jejuni is a non-spore forming, Gram-negative rod with a curved to S shaped morphology.

C. jejuni has an optimum growth temperature between 37°C to 42°C, the approximate body temperature of a bird (41°C to 42°C), and seems to be well adapted to birds. Its minimum growth temperature is reported to be around 30°C. Although unable to grow below 30°C, *Campylobacter* spp. survive at temperatures as low as 4°C under moist conditions.

Members of the Campylobacter genus are microaerophilic; i.e., they grow at lower than atmospheric oxygen concentrations. Most grow optimally at oxygen concentrations from 3% to 5%. *C. jejuni* are susceptible to drying, heating, freezing, disinfectants, and acidic conditions.

19.1.3 Prevalence in birds

A survey carried out by the Food Standards Agency (FSA) of Campylobacter in chicken on retail sale in the UK between May 2007 and September 2008, reported that Campylobacter was present in 65% of the fresh chicken samples tested (FSA, 2009). An EU baseline survey carried out in 2008 (EFSA, 2010b) showed the UK estimated prevalence for Campylobacter in broiler batches (caecal contents) was 75% and on broiler carcasses (skin samples) 86%. These results were above the weighted EU mean prevalence's of 71% and 77% respectively. There was a wide range of Campylobacter prevalence across Members States varying from 4.9% to 100.0% on broiler carcasses and from 2.0% to 100.0% in broiler batches. The counts of Campylobacter on broiler carcasses varied widely between samples. In the UK 42% of samples contained less that 100 Campylobacter per gram (cfu/g) and 27% contained more than 1,000 Campylobacter per gram (cfu/g).

Due its risk to public health and high prevalence in poultry meat the FSA have developed a Campylobacter Risk Management Programme to achieve its strategic aim to reduce foodborne illness. As part of this program there is a UK target for reduction of Campylobacter. This is a reduction in the percentage of chickens produced in UK poultry slaughterhouses that have the highest level of contamination, i.e. those with more than 3 $\log_{10}$ cfu g^{-1}, from a baseline of 27% in 2008 to 10% by 2015, measured post-chill (FSA, 2010).

The principal reservoir of pathogenic *Campylobacter* spp. is the alimentary tract of wild and domesticated mammals and birds (WHO, 2009). As a common inhabitant of the gastrointestinal tract of warm-blooded animals, *Campylobacter* spp. can be expected to contaminate meat during slaughter and evisceration as a result of faecal contamination. The more faecal material that is spread, the more campylobacter there will be on the meat (WHO, 2009). Campylobacteriosis is not considered to be pathogenic in poultry and so infected animals do not show any signs of disease (The Poultry Site, 2000).

It is generally believed that the contamination of meat with *Campylobacter* spp. is predominately on the surface. However, one studies has shown that *Campylobacter* spp. may also be present in internal tissues of chicken legs, though at very low concentrations (Scherer *et al*., 2006). In addition, *Campylobacter* spp. can be found

in the thoraco-abdominal cavity of broilers despite careful aseptic evisceration with no apparent leakage from the alimentary tract (Berrang *et al*., 2002).

Most studies have identified the handling of raw poultry and the consumption of poultry products as important risk factors, accounting for a variable percentage of cases. In addition, cross contamination of *Campylobacter* spp. from raw chicken to prepared food has been identified as a risk factor.

The importance of poultry as a risk factor for human cases has been demonstrated in countries where interventions have been implemented in the broiler production chain or where poultry has been withdrawn from the market, and where a decline in human cases has followed. For example, in Belgium, due to the dioxin crisis in 1999, where all poultry meat and eggs were withdrawn from the market, the estimated reduction of campylobacteriosis cases following this event was 40% within the crisis period (Vellinga & Van Lock, 2002). Another example is in Iceland, where the introduction of fresh poultry meat on the market in the 1990s was followed by a dramatic increase in the incidence of human campylobacteriosis. By introducing strict control measures during 2000 (including monitoring of all flocks and freezing of contaminated carcasses) the annual human incidence was reduced by 70%. This clearly indicates that poultry had been a major determinant for human campylobacteriosis in Iceland in the late 1990s (Stern *et al.,* 2003).

For pathogens like *Campylobacter* spp. that are carried asymptomatically in the alimentary tract of the bird, the control of faecal contamination of carcasses is critical, especially during the evisceration stage. Levels of *Campylobacter* spp. on carcass surfaces are likely to be reduced during scalding, washing, mechanical water chilling and freezing of carcasses, with a further decline possible during frozen storage. However, taken together, these processes do not result in total elimination. An important factor in the persistence of the organisms is their tendency to become attached to or entrapped in the skin surface (Notermans & Kampelmacher, 1974; Thomas & McMeekin, 1980). These phenomena appear to offer a degree of protection from environmental stresses encountered during heating, chilling and exposure to chlorinated water. They also limit the removal of microbial contaminants during carcass washing (WHO, 2009).

Unlike other pathogens of concern, *Campylobacter* spp. appear unable to multiply in the processing plant since the minimum growth temperature is 30 to 35°C and the optimum is 42°C. In addition, growth outside the alimentary tract requires a reduced concentration of atmospheric oxygen and is favoured by 10% carbon dioxide (WHO, 2009). In some countries, carcasses may be sold uneviscerated or only partially-eviscerated (effilé), or evisceration may be delayed to allow a period of storage at up to 4°C for meat-flavour development. While *Campylobacter* spp. may survive the storage period, growth is highly unlikely under the conditions that occur (WHO, 2009). However, the presence in uneviscerated organs may be important (see Appendix L). In a study conducted to estimate the prevalence of *C. jejuni* during processing, 85% (60) and 89% (64) of livers and gizzards were positive for *C. jejuni* respectively.

19.1.4 Assessment of risk

Campylobacter spp. are often transferred from the intestines to the meat during evisceration. They can also be present in the giblets, especially the liver. It is clear

from the wealth of published data and risk assessments that *Campylobacter* spp. are of high public health relevance with regard to poultry meat.

19.2 *Clostridium perfringens*

19.2.1 Occurrence and characteristics of infection in humans

Cl. perfringens was the second most common cause of foodborne outbreaks linked to consumption of poultry meat in England and Wales between 1992-2010 (HPA, 2011a) and the third most common cause of foodborne outbreaks in England and Wales and cases of illness in the US (HPA, 2011b; Scallan *et al.*, 2011).

Persons infected with *Cl. perfringens* develop diarrhoea and abdominal cramps within 6–24 h (typically 8–12 h). The illness usually begins suddenly and lasts for less than 24 h. Persons infected with *Cl. perfringens* usually do not have fever or vomiting. The illness is not passed from one person to another. The very young and elderly are most at risk of *Cl. perfringens* infection and can experience more severe symptoms that may last for 1–2 weeks. Complications, such as dehydration, may occur in severe cases.

Symptoms are caused by ingestion of large numbers ($>10^6$) vegetative cells or $>10^6$ spores/g of food. Toxin production in the digestive tract (or in vitro) is associated with sporulation. This disease is characterized as a food infection; only one episode has ever implied the possibility of intoxication (i.e. disease from preformed toxin).

19.2.2 Organism characteristics

Cl. perfringens is an anaerobic (but aero tolerant) Gram-positive, spore forming rod that produces enterotoxin. There are five types of C. perfringens based on toxin type (A, B, C, D, E). Most C. perfringens food poisoning cases reported in developed countries are caused by type A strains.

Cl. perfringens has an optimum growth temperature between 43°C and 47°C. Its minimum growth temperature is reported to be around 10 to 12°C. Its spores are heat-resistant.

Growth is optimal under anaerobic conditions, but small amounts of oxygen can be tolerated.

19.2.3 Prevalence in poultry

Cl. perfringens is known to be a normal inhabitant of the intestinal tract of chickens as well as a potential pathogen causing necrotic enteritis (Long, 1973; Svobodová *et al.*, 2007). This condition may quickly lead to the death of the bird, prior to which symptoms like depression, ruffled feathers, laying close to heat source, limping, distended crop and laying in lateral recumbency can be observed (Helmboldt & Bryant, 1971). Death from necrotic enteritis can take place within 1-2 h and mortality rate is up to 50% (Timbermont *et al.*, 2011). A mild form of necrotic enteritis might not give any signs in behaviour of the bird and may not lead to death, but still lesions at the small intestine are macroscopically detectable (Kaldhusdal & Hofshagen, 1992). *Cl. perfringens* might also cause cholagiohepatatis and this condition does not show any ante-mortem clinical signs (Immerseel *et al.*, 2004). Løvland & Kaldhusal (1999) found covariance between number of condemnations due to hepatitis and the incidence of diagnosed necrotic enteritis in broilers from south-eastern Norway in years 1978-1998. They further investigated bacteriologically and

histologically 90 livers (45 for each type of examination) from condemned chickens. Out of 45 livers, 24 contained presumptive *Cl. perfringens* (anaerobic cultivation 18-24 h on blood agar and visual detection of haemolytic colonies). Histological examination indicated that 33 of the 45 livers examined contained lesions that could be caused by *Cl. perfringens*. Similarly, Hutchison & Riddell (1990) found that 9 out of 13 hepatitic livers from broilers studied in a Canadian plant contained *Cl. perfringens*. Herenda & Jakel (1994) examined four livers featuring hepatitis pooled out of large study on poultry condemnation. Two of these were positive for *Cl. perfringens*. We were unable to find any recent data on the prevalence of *Cl. perfringens* in UK poultry meat.

19.2.4 Assessment of risk

Although there does appear to be an association between *Cl. perfringens* and hepatitic livers, we would agree with EFSA (2012) and Horigan *et al.* (2013) in considering *Cl. perfringens* to be a low risk. *Cl. perfringens* is considered to be ubiquitous bacteria and can be found in a variety of foods as well as in the environment. Its vegetative form need temperatures above those used for refrigeration to grow to levels of concentration of public health relevance, and thus the risk of disease seems not to be related with occurrence in raw meat (such as poultry) but rather with improper hygiene and storage. *Cl. perfringens* infection often occurs when foods are prepared in large quantities and kept warm for a long time before serving. Outbreaks often happen in institutions, such as hospitals, school cafeterias, prisons, and nursing homes, or at events with catered food. There is a possibly higher risk of contaminated livers entering the food chain via partially-eviscerated poultry due to hepatitis livers not being identified during post-mortem inspection. However, such livers would be noticeable to caterers and consumers and it is unlikely that they would be ingested. Nevertheless we would recommend that further study is carried out to assess the risk.

19.3 Pathogenic *Escherichia coli*

19.3.1 Occurrence and characteristics of infection in humans

E. coli bacteria normally live in the intestines of humans and animals. *E. coli* consists of a diverse group of bacteria, of which only some are pathogenic. Pathogenic *E. coli* strains are categorized into pathotypes. The six pathotypes are associated with diarrhoea and collectively are referred to as diarrheagenic *E. coli.*

- Shiga toxin-producing *E. coli* (STEC)—STEC may also be referred to as Verocytotoxin-producing *E. coli* (VTEC) or enterohemorrhagic *E. coli* (EHEC)
- Enterotoxigenic *E. coli* (ETEC)
- Enteropathogenic *E. coli* (EPEC)
- Enteroaggregative *E. coli* (EAEC)
- Enteroinvasive *E. coli* (EIEC)
- Diffusely adherent *E. coli* (DAEC)

The most commonly identified VTEC is *E. coli* O157:H7, although other types have also been identified as important sources of outbreaks.

The symptoms of VTEC infections vary for each person but often include severe stomach cramps, diarrhoea (often bloody), and vomiting. If there is fever, it usually is not very high (less than 38.5˚C). Most people get better within 5–7 days. Some infections are very mild, but others are severe or even life-threatening.

19.3.2 Organism characteristics

E. coli are motile, Gram-negative, rod shaped bacteria and are members of the family Enterobacteriaceae.

Pathogenic strains of *E. coli* have an optimum growth temperature between 35℃ to 40℃. Minimum growth temperature is reported to be around 6 to 7℃.

E. coli are facultative anaerobic organisms so do not require oxygen for growth. However, they grow better in aerobic conditions.

19.3.3 Prevalence in birds

E. coli infections in chickens cause a number of health conditions such as airsacculitis, cellulitis, naval infection, salpningitis, hepatitis, septicaemia, inflammation of joints, bone marrow and bone necrosis, Coligranuloma (featuring granulomas in intestines, mesentery and liver), inflammation of sternal bursa (Dinev, 2010; Herenda & Jakel, 1994; Hunter, 2006; Dozois *et al.*, 1994). Nevertheless, many studies have failed to isolate toxin infectious strains of this organism in poultry (Beutin *et al.*, 1993; Read *et al.*, 1990; Chapman *et al.*, 1997). Poultry is not considered a main reservoir of toxin infectious strains of *E. coli* (EFSA, 2007; Doyle *et al.*, 2006). Poultry infection with *E. coli* VTEC does not show gastrointestinal symptoms (Dipineto *et al.*, 2006). Schoeni & Doyle (1994) found that artificial pre-oral inoculation of one day-old chicks with *E. coli* O157:H7 after 10 months resulted in colonization of birds' caeca, colon and cloaca but was not detected in gizzard, spleen, kidneys, liver, heart and small intestine. This indicates that organism is more likely to be transferred on the meat surface through contamination during processing than motility within body of infected animal.

Some research suggests that avian pathogenic *E. coli* (APEC) may be a human extra intestinal pathogen (Rodriguez-Siek *et al.*, 2005; Johnson *et al.*, 2007; Mellata, 2013). However, a clear link with foodborne zoonoticity of APEC to humans has not yet been established. *E. coli* β-glucuronidase positive is one of the audited criteria in French plants following Label Rouge quality system. The acceptable level is up to 5000 cfu/g.

19.3.4 Assessment of risk

In the scientific literature there are no published data on the prevalence of VTEC in poultry meat in Europe or specifically the UK, and there are no published data identifying poultry meat as a source of human infection with VTEC. EFSA (2012) assessed that VTEC falls within the low-risk category. We would agree with that assessment.

19.4 *Listeria* spp.

19.4.1 Occurrence and characteristics of infection in humans

Listeria is a psychotropic pathogen and, as such, is capable of growth in cold environments. *L. monocytogenes* is widely distributed in the environment. In animals, listeriosis is mainly a disease of farmed ruminants, with cattle and sheep

considered the most important species. There were 183 cases in the UK in 2012, an increase of 11.6% when compared with 2011 (Figure 47). Schwartz *et al.* (1988) estimated that 20% of human listeriosis risk in US could be connected to consumption of undercooked chicken and uncooked hot-dogs.

Symptoms of listeriosis vary with the infected person. In humans other than pregnant women, the symptoms can include headache, stiff neck, confusion, loss of balance, and convulsions in addition to fever and muscle aches. Pregnant women typically experience fever and other non-specific symptoms, such as fatigue and aches. However, infections during pregnancy can lead to miscarriage, stillbirth, premature delivery, or life-threatening infection of the new-born.

Gastroenteritis caused by *L. monocytogenes* has a relatively short incubation period, from a few hours to 2 or 3 days. The severe, invasive form of the illness can have a very long incubation period, estimated to vary from 3 days to 3 months.

The infective dose of *L. monocytogenes* is undetermined, but is believed to vary with the strain and susceptibility of the host, and the food matrix involved may affect the dose-response relationship.

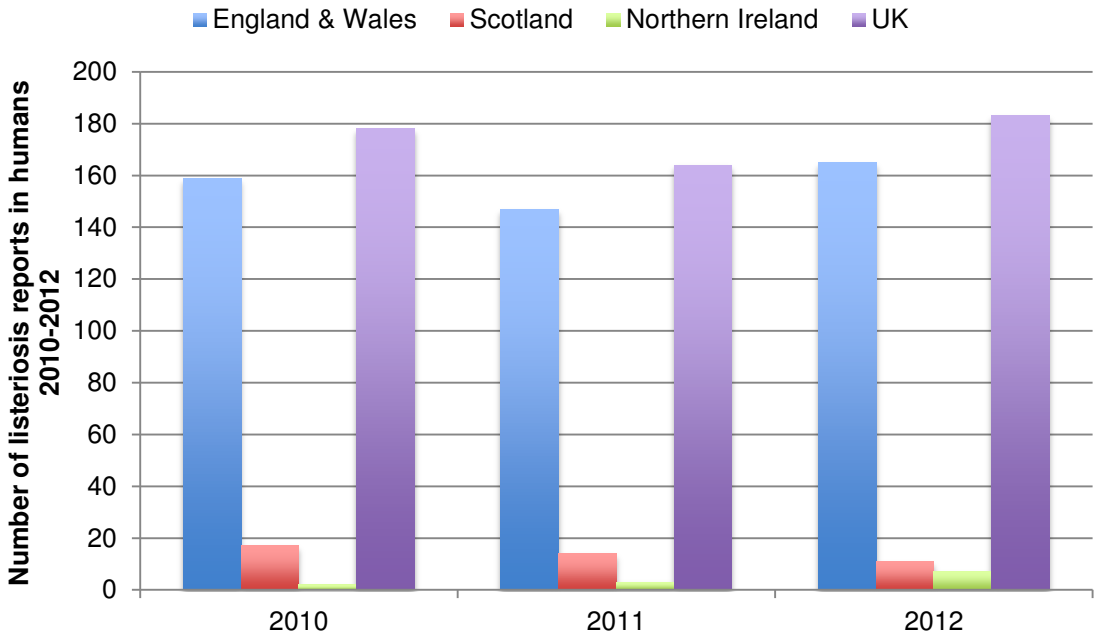


Figure 47. Number of reports of listeriosis in humans in the UK between 2010-2012 (Defra, 2013)

19.4.2 Organism characteristics

L. monocytogenes is a Gram-positive, rod-shaped, facultative bacterium, motile by means of flagella. *L. monocytogenes* has an optimum growth temperature between 30°C and 37°C, and has been reported to grow at temperatures as low as -1°C. However, there is published evidence that it will not in fact grow on either carcass, primals or minced meat at temperatures ≤4°C, particularly if vacuum packaged or held in 100% CO_2 atmosphere, irrespective of animal species (Johnson *et al.*, 1988; Duffy *et al.*, 2000; Sheridan *et al.*, 1995).

Grows optimally under microaerophilic conditions, but also grows well both aerobically and anaerobically.

19.4.3 Prevalence in birds

Listeriosis is a rare disease in poultry causing such conditions as septicaemia, encephalitis, myocarditis, pericarditis, pneumonia, hepatitis, and splenitis (MERCK, 2013; Dhama *et al.*, 2013; Crespo *et al.*, 2013). Dhama *et al.* (2013) considered that *L. monocytogenes* in poultry is likely to be an opportunistic pathogen, as in many cases listeriosis appears alongside other infections.

The prevalence of *L. monocytogenes* in poultry and its meat has been reported to be quite high by some international studies. For example, Chemaly *et al.* (2008) found that 46 out of 145 French broiler flocks were positive for *L. monocytogenes*. In a retail survey on the prevalence of zoonotic pathogens in poultry meat in Ontario (Canada), Cook *et al.* (2012) found that *L. monocytogenes* was present on 34% of chicken breast with skin and 15% of chicken breast without skin. Data on the prevalence of *Listeria* spp. in UK poultry has not been found (Horigan *et al*. (2013) also recently highlighted this data gap).

19.4.4 Assessment of risk

With meats, human listeriosis is normally associated with post-processing contamination followed by growth during prolonged storage at refrigeration temperatures of cooked, ready-to-eat products that receive no further heating. However, we would agree with Horigan *et al*. (2013) that "*the lack of knowledge on how listeria could contaminate* (poultry meat) *must be considered as a data gap as the mechanism whereby listeria contaminates foodstuffs is not fully understood*". There is no data available on whether poultry carcasses (both fully eviscerated and partially-eviscerated) would be contaminated with listeria from processing machinery or the bird itself and whether such contamination could be significant in relation to public health. There is some evidence that the concentration of listeria is likely to decrease at the evisceration stage, when the intestines, containing the majority of listeria infection are removed (Horigan *et al*., 2013). A slight reduction in pathogen concentration is likely to occur during any frozen storage for 3-6 months (Horigan *et al*., 2013).

If transport and storage is in compliance with the Food Hygiene Regulations (2006) are undertaken then temperatures would be below 4°C and only limited growth (if any) in poultry carcasses would be expected.

19.5 *Salmonella* spp. (non-typhoidal)

19.5.1 Occurrence and characteristics of infection in humans

In 2010 out of a total of 99,020 confirmed cases of human salmonellosis in the EU the most frequently isolated salmonella were: *S*. Enteritidis (45.0%) and *S*. Typhimurium (22.4%) (EFSA, 2012). In 2012, 8,798 cases of laboratory confirmed salmonellosis were reported in the UK. For every laboratory confirmed report of disease made to national surveillance schemes, there are estimated to be 4.7 unreported cases. This means the total number of cases in the UK in 2012 was approximately 50,000 (Defra, 2013). *S.* Enteritidis accounted for 27.9% of cases in the UK in 2012, whilst *S*. Typhimurium accounted for 23.8% of cases (Defra, 2013).

Inadequate cooking has been cited as a contributing factor in 67% of Salmonella related outbreaks (Murphy *et al.*, 2004).

The incubation period is 12 to 72 h depending on the infectious dose, the salmonella serotype, and specific host factors.

The infectious dose of salmonella can vary, depending on the bacterial strain ingested as well as on the immuno-competence of individuals. The infectious dose of salmonella is generally considered to be relatively high, in the region of 10^4 cfu for most food types. However, data from outbreaks of foodborne disease indicate that infections can be caused by ingestion of as few as 10 to 45 cells in some foods (D'Aoust *et al*., 1985; Lehmacher *et al*., 1995) and that the infectious dose is lower when present in food with a high fat or protein content.

Most patients develop a gastrointestinal illness with acute diarrhoea as the main symptom. Other common symptoms include abdominal pain or cramps, fever, chills, nausea, vomiting, pain in the joints, headache, myalgia, and general malaise. Infection is usually self-limiting although complications relating to bloodstream infections can occur.

19.5.2 Organism characteristics

Salmonella is a motile, non-spore forming, Gram-negative, rod-shaped bacterium in the family Enterobacteriaceae. The genus *Salmonella* is divided into two species: *S. enterica* (comprising six subspecies) and *S. bongori*.

The temperature range for growth of *Salmonella* spp. is 5.2 to 46.2°C, with the optimal temperature being 35 to 43°C. Although freezing can be detrimental to *Salmonella* spp. survival, it does not guarantee destruction of the organism.

Salmonella spp. are classed as facultative anaerobic organisms as they do not require oxygen for growth

19.5.3 Prevalence in poultry

Salmonella is widespread in nature and it is one of the primary pathogens associated with foodborne illness because of their ability to colonize the gastrointestinal tract of poultry and other livestock (Turner *et al*., 1998). Salmonellosis in poultry is acute in young birds (less than 1 month old). However, in adult birds *Salmonella* spp. usually colonize the intestines and the animals do not show symptoms of infection, but become carriers of the pathogen (Quist, 1963). An exception is *S. gallinarum,* which causes fowl typhoid in all animals regardless of age. This *Salmonella* serotype is however an uncommon cause of Salmonellosis in other animals except poultry (Kaiser *et al*., 2000).

Recent surveys have reported the prevalence of Salmonella in UK chickens at retail as variously 4.0% (Meldrum and Wilson, 2007), 5.6% (Little *et al*., 2008), and 6.6% (FSA, 2009). Salmonella prevalence reported in other species are 29.9% for duck, 5.6% for turkey, and 8.6% for other poultry (Little *et al*., 2008).

The prevalence of salmonella in UK broiler flocks has been significantly reduced in recent years due to the introduction of a range of controls as a result of the introduction of microbiological criteria in legislation and EU and UK targets for reduction (Jorgensen & Willis, 2014). As reported in the AHVLA annual report on Salmonella in Livestock Production in GB (AHVLA, 2013) an estimated 31,175 broiler flocks were tested according to the requirements of the *Salmonella* in GB during 2012, showing an estimated prevalence of *Salmonella* positive broiler flocks in GB from statutory testing of 1.99% (619/31,175). This compares with an estimated prevalence of 1.56% in 2011, 1.58% in 2010 and 1.34% in 2009. The

estimated prevalence of the target *Salmonella* serovars (*S*. Enteritidis, *S*. Typhimurium and monophasic strains of *S*. Typhimurium) in broiler flocks in GB was 0.01% (4/31,175) in 2012. A very low prevalence has been observed since the implementation of the Salmonella National Control Programme (0.01% in 2011, 0.03% in 2010 and 0.04% in 2009). No flock tested positive for *S*. Enteritidis in 2012. The prevalence for all *Salmonella* serovars in fattening turkeys during 2012 was calculated as 17.1% (550/3,222). The prevalence for regulated serovars in fattening flocks in 2012 was 0.03% (1/3,222). Data for other poultry is sparse since there are no statutory monitoring requirements for *Salmonella* in either ducks, geese or guinea fowl. AHVLA report that there were no submissions from guinea fowl in 2012, and no reports of *Salmonella* from geese during 2012.

The majority of cases of human salmonellosis are caused by either *S.* Enteritidis or Typhimurium (van Duijkeren *et al*., 2002). Artificial infection of birds with *S.* Enteritidis has been shown to cause acute septicaemia in older birds (1 year old) as well as suppurative peritonitis, abdominal adhesions and foci in liver and kidneys, but had no effect on the health of 20 week old birds (Humphrey *et al*., 1991). Thus, it can be assumed that commercial broilers and chickens of slow growing breeds, which are slaughtered at 5 to 7 weeks and approximately 12 weeks of age respectively, are unlikely to show any symptoms of infection with *S*. Enteritidis. Spent hens may be slaughtered after 72 weeks of life, thus it is likely that in these birds infection with *S.* Enteritidis could be detected during ante and post mortem inspection.

Poultry may show pathological signs of salmonella infection. For example, Rampling *et al.* (1989) found that 58% of 81 carcasses rejected for pericarditis contained *S.* Enteritidis PT4. This link between pericarditis and *S.* Enteritidis is contradicted by another study where inoculations were made into the crop of four week old broilers of *S.* Enteritidis PT4 and no pericarditis was observed (Desmidt *et al*., 1997). O'Brien comments that only a small number of infected birds may develop *S.* Enteritidis associated pericarditis (O'Brien, 1990). Both *S.* Enteritidis and Typhimurium after ingestion by poultry can migrate from the digestive tract to other organs such as liver, spleen and ovaries (Humphrey *et al*., 1991; Lee *et al*., 1983). In 2011, the prevalence of *S.* Enteritidis and Typhimurium in different British poultry production sectors was reported to be at the level of 0.01 to 0.17% (National Farmer's Union, 2011).

Chickens frequently carry *Salmonella* spp. (Todd, 1980) and carcass contamination increases during processing (Lillard, 1988). After colonization of the gastrointestinal tract, the highest populations of salmonella are found in the cecum, cloaca, ileum, and to a lesser extent the crop (Barrow *et al*., 1988). In a study conducted by Molla & Mesfin (2003) to estimate the prevalence and distribution of *Salmonella* spp. in raw chicken meat, the liver, gizzard and heart of 21.1% of the total number products sampled (80/378) were positive for *Salmonella* spp.

Reducing the frequency of salmonella in broiler flocks is a challenge for both public health and industry sustainability. Newly hatched broilers are highly susceptible to colonization with *Salmonella* spp. and are more susceptible than older birds. This is thought to be caused by differences in the intestinal microflora (Schleifer *et al*., 1984; Bailey *et al*., 1987; Blankenship *et al*., 1993). Salmonella contamination of day-old broiler flocks delivered to grow-out farms has been shown to be a precursor of the

flocks' contamination during rearing and processing stages (Bains & MacKenzie, 1974; Bhatia & McNabb, 1980; Higgins *et al.*, 1981; Goren *et al.*, 1988; Christensen *et al.*, 1997; Byrd *et al.*, 1999; Rose *et al.*, 1999; Bailey *et al.*, 2001; Cardinale *et al.*, 2004).

19.5.4 Assessment of risk

It is clear from the wealth of published data and risk assessments that *Salmonella* spp. are of high public health relevance with regard to poultry meat. However, there is evidence that the introduction of microbiological criteria in legislation, EU targets for reducing Salmonella in broiler flocks and the UK Salmonella National Control Programme (NCP) have contributed to a significant decline in flock prevalence for regulated serovars in broilers and turkeys to 0.01 and 0.03%, respectively. However, the prevalence of salmonella in other poultry is unclear.

19.6 *Toxoplasma gondii*

19.6.1 Occurrence and characteristics of infection in humans

T. gondii is a single-celled parasite that causes a disease known as toxoplasmosis. Transmission of infection is by ingestion of either oocysts as a result of environmental contamination of tissues cysts in raw or undercooked meat. Cats are the definitive host for the organism although many warm-blooded animal species can be infected as intermediate hosts.

Infection with *T. gondii* in healthy humans does not show any symptoms, thus cases of foodborne transmission are difficult to determine. It is estimated that only 10-20% of *T. gondii* infections are symptomatic (Advisory Committee on the Microbiological Safety of Food for Food Standards Agency, 2012). In humans whose immune system has been compromised symptoms, such as headache, seizures, nausea and coordination problems can be observed. Women infected during pregnancy may transmit the parasite to the foetus. Depending on the stage of the development, the foetus may become severely damaged, which may result in death or problems in further development, such as: eye disease or even loss of sight, mental disability or seizures (Centers for Disease Control and Prevention, 2013a). According to US figures, 22.5% of the US population and even up to 95% of other world populations may be infected with *T. gondii* (CDC, 2013). In the UK, numbers range from 11 to 40% depending on the geographical location (Advisory Committee on the Microbiological Safety of Food for Food Standards Agency, 2012). A total of 327 laboratory confirmed cases of toxoplasmosis were reported in the UK during 2012 (Defra, 2013).

The number of faecal oocysts or tissue cysts required to cause *T. gondii* infection in humans has not been established.

19.6.2 Organism characteristics

T. gondii is a single-celled parasite. *T. gondii* tissue cysts remain viable in infected meat stored at refrigeration temperatures of 4°C for up to 19 days. Freezing at -21°C has been shown to kill unsporulated and sporulated oocysts.

19.6.3 Prevalence in birds

Food is a recognized reservoir of *T. gondii* and undercooked meat has been found to be an important source, accounting for 30-60% of infection cases in pregnant

women (Advisory Committee on the Microbiological Safety of Food for Food Standards Agency, 2012).

Data on prevalence of *T. gondii* in UK poultry has not been found, it is know that an investigation of livestock in UK for presence of the parasite has been recommended (Advisory Committee on the Microbiological Safety of Food for Food Standards Agency, 2012).

Yan *et al.* (2010) reported results of artificial infection of chickens with *T. gondii*. They found that infected chickens did not show any clinical signs of illness although the microorganism could be found in heart, liver, lung, brain, eyes and spleen (Yan *et al.*, 2010). Prevalence of *T. gondii* in north-west Chinese free-range and caged chickens was also investigated. It was found that 10.2% of free-range and 6.23% of caged chickens were positive for *T. gondii* (Cong *et al.*, 2012). Similarly in southern China 11.4% of free-range and 4.1% caged (Yan *et al.*, 2009) and in north-east China 11.2% of free-range and 4.7% caged chickens showed prevalence for this organism (Yang *et al.*, 2012).

19.6.4 Assessment of risk

Poultry meat that is consumed is almost always well cooked, so, in the absence of cross-contamination, the risk of toxoplasmosis derived from the consumption of this type of meat can be considered to be low, except in situations, such as barbequing or consumption of meat preparations, in which undercooking is more likely. Based on the data presented and the discussions above, the BIOHAZ Panel assessed the risk of *T. gondii* in poultry meat to be, at the present time, low. We would concur with that assessment.

19.7 Conclusions

We would concur with other assessments that *L. monocytogenes* and toxins of *B. cereus*, *Cl. botulinum*, *Cl. perfringens* and *S. aureus* can be considered to be hazards for which the public health risk is mainly controlled after post-carcass chill (EFSA, 2012).

In common with other reviews and risk assessments (MAF RA (M&S), 2000; EFSA, 2012; Horigan *et al.*, 2013) we have found little evidence in the literature to suggest that pathology in birds and associated disease is of any significant importance compared with enteric pathogens such as *Campylobacter* and *Salmonella* spp.

We would also agree with other reviews and risk assessments (Bremner & Johnston, 1996; Löhren, 2012; EFSA, 2012; Horigan *et al.*, 2013) that the two most important zoonotic bacteria commonly implicated in foodborne illness associated with poultry meat are *Campylobacter* spp. and *Salmonella* spp. Generally, both organisms are carried in the intestines of poultry without causing clinical disease (although there may be an association between *S.* Enteritis and pericarditis).

The principle source of these hazards would appear to be faecal spillage from the intestines during evisceration. There is evidence that evisceration with automated machines can rupture the intestines, causing faecal leakage, and thus contamination, to occur. Thus would suggest that providing no faecal leakage or rupture of the intestine occurs during partial-evisceration, the partial-evisceration process may be expected reduce the risk of these hazards. However, no evidence has been found to support this supposition.

Both of these pathogens are recognised as significant risks to public health by the FSA and poultry industry and subject to national control programmes (UK Salmonella National Control Programme (NCP) and Campylobacter Risk Management Programme) to reduce their prevalence in UK poultry flocks. Birds destined for partially-eviscerated production will be subject to the same controls and benefit from these controls.

20 Appendix L: Assessment of the Microbiological Risks Associated with Poultry Organs

The microbiological status of processed poultry carcasses has been reported to be dependent on several key factors such as the level of contamination in live birds, numbers and genera of pathogenic or indicator organisms introduced at pre-harvest phases, and the extent of occurrence of contamination and cross-contamination during processing (Abu-Ruwaida *et al*., 1994).

It has been generally recognised that flesh of a healthy live bird is essentially sterile; however, during processing, bacteria on the skin surface may contaminate the flesh and skin membrane through severed blood vessels or skin cuts and tears (Avens & Miller, 1973). It has been suggested that most bacterial growth is confined to the skin surface of dressed and eviscerated poultry and that very few bacteria are present in the adjoining flesh (Frazier, 1967; Sharf, 1966). However, there have been some recent studies that have shown that *Campylobacter* spp. may also be present in internal tissues of chicken legs, though at very low concentrations (WHO, 2009). In addition, *Campylobacter* spp. can be found in the thoraco-abdominal cavity of broilers despite careful aseptic evisceration with no apparent leakage from the alimentary tract (Berrang *et al*., 2002).

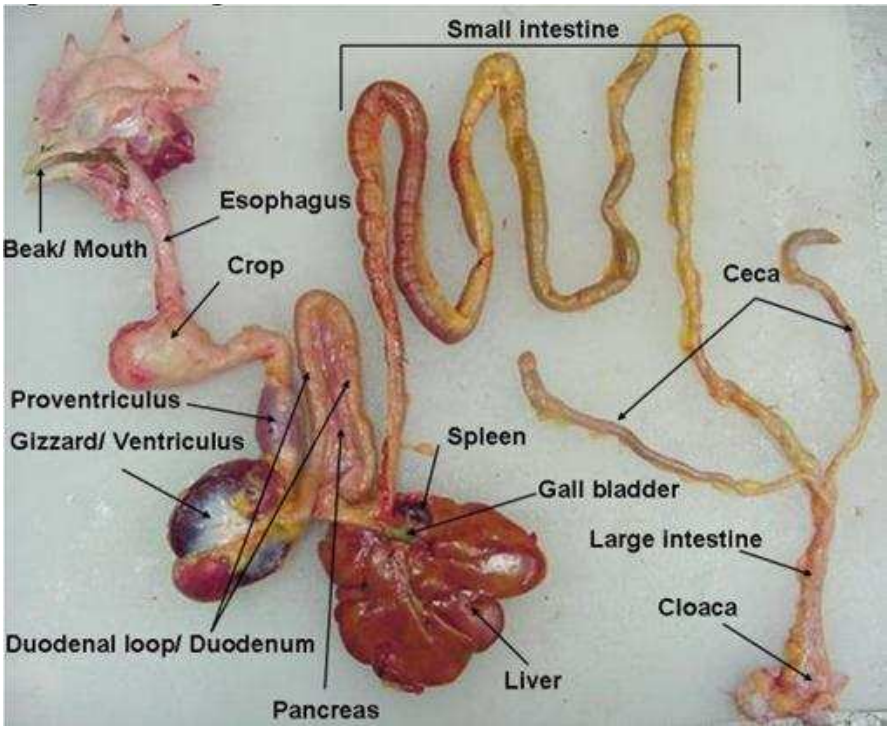


Figure 48. Digestive system of broiler

In general, most studies and risk assessments have identified the intestines of poultry as a major source of pathogenic hazards, and breakage during evisceration (or preparation before cooking in the case of NYD) causing faecal contamination as an important risk to public health. In order to assess the microbiological risk associated with partially-eviscerated poultry, we reviewed the microbiology of the

organs associated partially-eviscerated chicken. The following organs (in alphabetical order) remain in partially-eviscerated poultry:

1. Crop
2. Gizzard
3. Heart
4. Kidneys
5. Liver
6. Proventriculus

In addition, since the feet often remain on partially-eviscerated poultry specific hazards and risks associated with the feet were also reviewed.

Figure 48 and Figure 49 show images of the digestive system of a domestic fowl and Figure 50 images of individual organs found in partially-eviscerated poultry carcass.

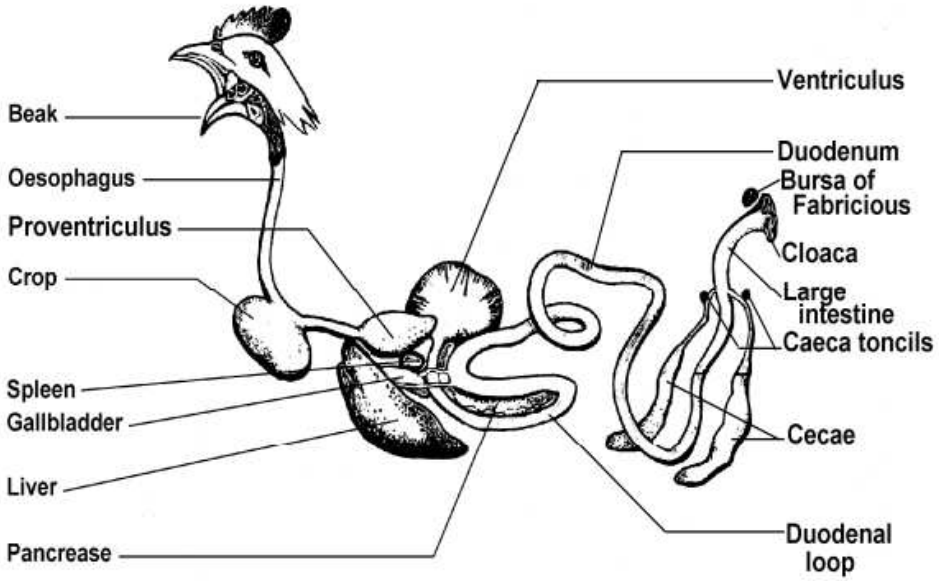


Figure 49. The digestive tract of a domestic fowl

Figure 50. From left to right, broiler heart, liver, gizzard with Proventriculus, lungs, all organs that remain in the cavity of partially-eviscerated poultry carcasses

20.1 Crop

The crop serves as a storage organ that partially regulates the entry of the ingested food into the gizzard. This allows the chicken to eat its daily ration in a short period and digest it later. Considerable microbial growth occurs in the crop, which might contribute to feed digestion and is therefore beneficial to the bird (Champ *et al.*, 1983). The time feed is in the crop depends on a number of factors including the amount, consistency, moisture content, and access to feed. These factors also influence the microbial growth found in this organ. Some of the bacterial species isolated from the crop of chickens include *E. coli*, enterococci, staphylococci, lactobacilli, *Campylobacter* spp., and *Salmonella* spp. (Frei *et al.*, 2001). However many of these are transient species and after the first week the dominant species found in the crop is Lactobacilli (Barnes *et al.*, 1972; Mead, 1997; Mead & Adams, 1975; van der Wielen *et al.*, 2002; van der Wielen *et al.*, 2000). On the epithelial surface of the crop the *Lactobacillus* spp. form a layer of cells up to three deep which restricts the available crop epithelium surface for colonization by pathogenic species (Fuller, 1973). Shortly after feeding, the pH of the crop decreases to approximately 5.0 due to the bacterial production of lactic acid. This reduced pH may contribute to digestion via the hydrolysis of stored feed, but also may have a bacteriostatic or bactericidal activity against bacteria sensitive to this pH, and consequently may protect the chicken from ingested pathogenic bacteria (Mead, 1997). Thus, the crop also has an influence on the microbial ecology of the entire gastrointestinal tract (Maisonnier *et al.*, 2003).

The crop as been identified has a source of *Salmonella* spp. and *Campylobacter* spp. on contaminated carcasses and was cited by Windham *et al*. (2005) as more likely to rupture than the ceca during commercial evisceration.

Epidemiologic studies (Byrd *et al.*, 1998; Berrang *et al.*, 2000; Jeffrey *et al.*, 2001) have identified the crop as an important reservoir for campylobacter. They also suggest that there is a good correlation between the presence of *Campylobacter* spp. in the intestine and in the crop (Table 25). In a survey conducted in the US, Jeffrey *et al.* (2001) found that "*if the intestine was positive for Campylobacter, the odds of finding a positive crop culture was 8.6 times greater, and the odds of finding a positive skin culture was 35 times greater than if the intestinal culture was negative for Campylobacter*". Also Byrd *et al.* (1998) reported a correlation of there being a 5.5 times greater chance of crops being positive for chickens with positive intestinal samples. A small survey of 18 carcasses by Berrang *et al.* (2000) measured higher counts of *Campylobacter* spp. (4.5 to 5.0 $\log_{10}$ cfu g^{-1}) from the crop per gram than from the skin. They concluded that "*if compromised, this may increase the numbers on the surface of the carcass*". However, since the crop contained fewer campylobacter than the ceca or colon, they concluded that "*crop breakage would contribute less to the spread of Campylobacter than would ceca or colon breakage*". Jeffrey *et al.* (2001) reported that the recovery of *Campylobacter* spp. from the crop "*may be improved by sampling the crop contents along with the crop*". The crop has also been shown to be a potential source of salmonella contamination on processed carcasses (Hargis *et al.*, 1995); the study found 52% of broiler crops were positive for *Salmonella* spp.

Table 25. Prevalence of pathogens associated with the crop of poultry

Organ	Microorganism	N =	Prevalence (%)	Country	Reference
Crop	Campylobacter	202	48	US	Jeffrey *et al.*, 2001
Crop	Campylobacter	18	100	US	Berrang *et al.*, 2000
Crop	Campylobacter	359	62	US	Byrd *et al.*, 1998

Data suggest that prolonged feed withdrawal is associated with an increase in crop contamination by *Campylobacter* spp. (Byrd *et al.*, 1998) and Salmonella spp. (Rameriz *et al.*, 1997).

20.2 Feet

During initial studies the feet were identified as source of possible pathogen contamination not present in conventionally produced fully eviscerated poultry. In the French traditional method of trussing effilé carcasses (Figure 1 to Figure 5) the feet are packed tight to the body and any contamination on the feet deposited onto the skin of the carcass. This was observed in our studies and with some French produced poultry.

There is very limited information available on the general microbiological quality of poultry feet. A few studies (Kotula & Pandya, 1995; Göksoy *et al.*, 2004; Lopes *et al.*, 2007; Santos *et al.*, 2011) have shown significantly higher counts on the feet than other parts of the carcass, including the presence of pathogens such as *Salmonella* spp. (Santos *et al.*, 2011).

20.3 Gizzard

A study conducted by Smith & Berrang (2006) determined the following microbial counts (Table 26) for total aerobic bacteria, coliforms, *E. coli* and *Campylobacter* spp. in the crop and gizzard.

Table 26. Mean counts (log_{10} cfu g^{-1}) of crop and gizzard analysed for ACC, coliforms, *E. coli* and *Campylobacter* (adapted from Smith & Berrang, 2006)

Indicator organism and pathogen	Crop (log_{10} cfu g^{-1})	Gizzard (log_{10} cfu g^{-1})
Total aerobic bacteria	5.6	2.9
Coliforms	4.2	2.3
Escherichia coli	3.9	2.2
Campylobacter spp.	4.6	2.2

Although the gizzard was found to contain more materials that the crop, the ingesta from the crop had higher counts of bacteria and a higher incidence of contamination than the gizzard. Smith & Berrang (2006) attributed the difference in counts between the crop and gizzard to a difference in pH between the two organs. Immediately prior to entering the gizzard, ingesta passes through the proventriculus, which secrets HCl for digestive purposes; the approximately pH of this acid secretion is 2.0 (Duke, 1994).

20.4 Intestines

Most studies cite the intestine of the bird as the main reservoir of the principal food poisoning bacteria, *Salmonella* and *Campylobacter* spp., of poultry meat (Mead, 1974; Mead & Scott, 1997; Allos, 2001; Löhren, 2012; EFSA, 2012). For example, it has been reported that after colonization of the gastrointestinal tract, the highest populations of salmonella are to be found in the cecum, cloaca, ileum, and to a lesser extent the crop (Barrow *et al*., 1988).

It is generally agreed that the spread of these organisms during processing depends upon the extent to which faecal contamination can be controlled (Mead, 1974; Corry & Atabay, 2001). Bacterial contamination of the external surface of processed poultry carcasses can originate from contact with ingesta or faeces excreted from the alimentary tract during growing, transportation, or processing (Oosterom *et al*., 1983; Genigeorgis *et al*., 1986; Izat *et al*., 1988; Hargis *et al*., 1995; Stern *et al*., 1995; Byrd *et al*., 1998; Berrang *et al*., 2002). It is widely recognised that evisceration with automated machines can rupture the intestines, causing faecal leakage, and thus contamination, to occur. Faecal contamination of the inner and outer surfaces of the carcass during evisceration is an important mode of contamination.

Frequency of carcass contamination depends upon the amount of material present in the digestive tract, the condition of the digesta (partially digested food and faeces) remaining in the intestines (watery or firm), the integrity of the intestines, and the efficiency of the eviscerating equipment and plant personnel (Northcutt, 2001).

In general, it is common to withdraw feed prior to transport and processing, since it reduces the amount of ingesta in the gastrointestinal tract and reduces the incidence of torn or ruptured gastrointestinal tracts, therefore decreasing the likelihood of carcass contamination (Bilgili, 1988). However, intestinal strength of broilers has been found to be approximately 10% lower when broilers were without feed for 14 or more hours before processing as compared to full-fed broilers (Northcutt, 2000; Bilgili & Hess, 1997; Buhr *et al*., 1998).

20.5 Heart

In a study conducted to determine the prevalence of *L. monocytogenes* in chicken offal, out of 72 chicken hearts collected from different markets in Malaysia 20.83% (15) were positive for *L. monocytogenes*, as compared to chicken gizzard (33.33%) and liver (25.00%) (Kuan *et al*., 2013). Also in a New Zealand study conducted by Wong *et al*. (2011) 86% of hearts tested positive for the presence of *Campylobacter* spp. as compared to 97% of gizzards and 99% of livers. The prevalence of Salmonella reported by Molla & Mesfin (2003) indicate that 23.7% (14/59) of poultry hearts tested positive for *Salmonella* spp. as compared to 41% of gizzards (23/56) and 35% of livers (19/55).

20.6 Liver

Poultry livers carry a high risk of *Campylobacter* spp. contamination, as the bacteria can be present throughout the liver. Studies have reported that livers can be both internally and externally contaminated with campylobacter (Whyte *et al*., 2006; Merrit *et al*., 2011). Ingestion of undercooked chicken livers infected with *C. jejuni* has

been reported to be a cause of intestinal campylobacteriosis in human (Mouton *et al.*, 1982).

In England and Wales, 25 out of 114 campylobacter outbreaks (21.9%) that were notified to the Public Health England (PHE), the responsible public health authority, were assigned to the consumption of poultry liver (Little *et al.*, 2010). The data show an increasing number of Foodborne outbreaks of campylobacteriosis associated with poultry from 2007 to 2010 (Figure 51).

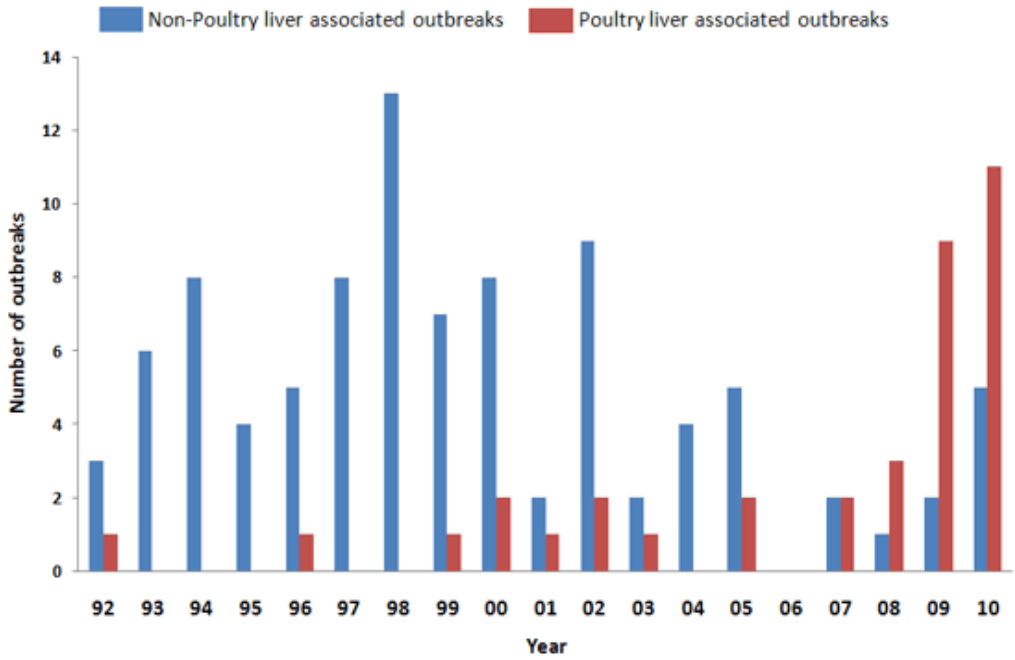


Figure 51. Foodborne outbreaks of campylobacteriosis by year, extracted from Health Protection Report (HPA, 2010)

20.7 Lungs

Bacteria may be found in the respiratory tract of healthy birds, principally in the nasal cavity, trachea, and lungs, include *Streptococcus*, *Staphylococcus*, *Corynebacterium*, *Lactobacillus*, *Escherichia*, and *Bacillus* species (Smibert *et al.*, 1958).

Microbial pathogens, such as *Campylobacter* spp., are present in the environment within many growing houses. This bacterium can be found airborne in the dust in the growing houses during catching and transport (Stagg & Crook, 1995; Kwon *et al.*, 1999). It may therefore be possible for airborne *Campylobacter* spp. to infiltrate the respiratory tract of broilers during grow-out, catching, transport and hanging. The respiratory tract of a broiler includes airsacs that are large in volume relative to the lungs. The airsacs are unavoidably torn during evisceration of carcass even without leakage of alimentary tract contents (Berrang, *et al.*, 2003). Table 27 shows levels of *Campylobacter* spp., *E. coli*, coliforms and ACC recovered from rinse of respiratory track of broilers.

Table 27. Mean $\log_{10}$ colony-forming units per millilitre recovered from 60 ml rinse of the respiratory tract of broiler carcasses before and after a commercial scald (n=30) (adapted from Berrang *et al.*, 2003)

Sample site	*Campylobacter* spp.	*Escherichia coli*	Coliform	Total Aerobic
Pre-scald	0.7 ± 0.3 ($^{14}/_{30}$)	1.2 ± 0.9 ($^{10}/_{30}$)	1.2 ± 0.9 ($^{13}/_{30}$)	3.0 ± 0.6
Post-scald	1.0 ± 0.4 ($^{14}/_{30}$)	2.7 ± 0.5 ($^{22}/_{30}$)	3.0 ± 0.5 ($^{24}/_{30}$)	4.1 ± 0.5

20.8 Kidney

There is very limited information available on the general microbiology of poultry kidney. To the best of our knowledge, the main report on the microbiology of poultry kidney relates to prevalence of specific pathogens. In a study conducted by Ramya *et al*. (2012) 30% (3/10) of poultry kidney were positive for *Salmonella* spp. As stated by Merck (2013) microbial infection of poultry kidney is very rare as compared to other organs. Although the reason for the low prevalence of microorganism present on the kidney was not mentioned, it is assumed that the kidney tissue may be unfavourable for microbial survival or growth.

20.9 Proventriculus (stomach)

The proventriculus in poultry is a glandular organ that corresponds to the stomach of mammals. It produces a gastric juice containing hydrochloric acid and proteolytic enzymes. However, it differs from the mammalian stomach in that little mixing or holding of food occurs in it. From the proventriculus, the food moves to the ventriculus (or gizzard), a muscular organ where the food is ground and mixed with the gastric juice.

It has been shown that, similar to the crop, the low pH within the gizzard defines the microbial population in distal portions of the gastrointestinal tract (Bjerrum *et al.*, 2005). In terms of the microbial population that it harbours, a search of the literature shows that little is known. Lee *et al.* (1993) suggests that the harsh environmental conditions found in the crop and proventriculus means that the vast majority of the culturable microbes found are transient. However, they do point out that the discovery of resident microbes in the stomach of humans indicates that these regions of the chicken intestine may also have a resident population of microorganisms with an, as of yet, unknown role in the microbial ecology of the gastrointestinal tract.

20.10 Conclusions

In general, most studies and risk assessments have identified the intestines of poultry as a major source of pathogenic hazards, and breakage during evisceration (or preparation before cooking in the case of NYD) causing faecal contamination as an important risk to public health.

It is clear from the literature that the organs left in the cavity of a partly-eviscerated poultry carcass are likely to harbour pathogenic microorganisms and the liver especially has already been associated with food poisoning outbreaks. No data has been located on the growth or survival of pathogens during the time the organs would remain within the partially-eviscerated carcass,

There is no published evidence to suggest that any pathogens present in the organs will diffuse into the muscles of the carcass. However, there will be some risk of contamination when the carcass is fully eviscerated.

21 Glossary

ACC	Aerobic Colony Count
AHVLA	Animal Health and Veterinary Laboratories Agency
bph	Birds per hour
CCP	Critical Control Point
CDC	Centers for Disease Control and Prevention
cfu	Colony forming unit
EC	European Commission
EFSA	European Food Safety Authority
ESBL	Extended-Spectrum Beta-Lactamases
FAO	Food and Agriculture Organization of the United Nations
FBO	Food Business Operators
FCI	Food Chain Information
FDA	US Food and Drug Administration
FSA	Food Standards Agency
FSANZ	Food Standards Australia New Zealand
GB	Great Britain
HACCP	Hazard analysis and critical control points
HPA	Health Protection Agency
ICMSF	International Commission on Microbiological Specifications for Foods
Innova	FSA database recording AM and PM information
MAP	Modified Atmosphere Packaging
MAFF	Ministry of Agriculture, Fisheries and Food
MAF RA (M&S)	Ministry of Agriculture Regulatory Authority (Meat and Seafood), New Zealand
MLCSL	Meat and Livestock Commercial Services Ltd
MRSA	Meticillin-resistant *Staphylococcus aureus*
NACMCF	National Advisory Committee on Microbiological Criteria for Foods
NYD	New York Dressed
OMAF	Ontario Ministry of Agriculture and Food
OVs	Official Veterinarians
QA	Quality Assurance
SD	Standard Deviation
UDP	Undrawn Dressed Poultry
UK	United Kingdom
WHO	World Health Organisation

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