

DG Health and  
Food Safety

OVERVIEW REPORT

# Mitigation Measures in Place for *Campylobacter spp.* in Poultry

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**OVERVIEW REPORT ON THE MITIGATION MEASURES IN PLACE FOR  
CAMPYLOBACTER SPP. IN POULTRY**

## ***Executive Summary***

*Campylobacteriosis is the most frequently reported food borne illness in the European Union. Not only is it a persistent problem but its incidence is steadily increasing. Given the strong link of outbreaks with the poultry production chain, measures aimed at reduction of Campylobacter in poultry are significant in reducing occurrence of the disease. This report provides an overview of such mitigating measures in place, based on fact-finding missions carried out in three Member States and on information provided by the EFTA Surveillance Authority on two missions to EFTA states. The main findings are summarised below.*

*The implementation of targeted sampling/monitoring plans at the different steps of the poultry production chain provide valuable information on the prevalence of Campylobacter along the food chain, and of the effectiveness of any measures taken.*

*Different measures have been put in place by the Member States concerned, including: the issuance of national legislation targeting the prevalence of pathogens in specific poultry products; the adoption of a voluntary process hygiene criterion at slaughterhouse level along with a compulsory warning message on the product labels; and the implementation of specific control programmes aiming to reduce Campylobacter prevalence in poultry, in close collaboration with the poultry industry. However, implementation of these mitigating measures has not always produced the hoped-for results.*

*Mitigation of the levels of Campylobacter at farm level can be achieved with strict biosecurity measures. However, it is not feasible to completely eliminate it especially during summer months. Acceptable results can be further achieved through interventions at farm level that lead to lower levels of contamination of carcasses, e.g. complete flock depopulation instead of thinning, enhanced biosecurity at poultry house level, improved husbandry methods, awareness-raising actions and providing incentives to producers. Some of these interventions are very difficult to apply consistently, taking into account current commercial practices.*

*The variation in prevalence and numbers of Campylobacter spp. between farms highlights the need for further interventions at slaughterhouse level. Such interventions can be integrated in existing hygiene protocols and procedures, or can be innovative.*

*Mitigation of Campylobacter spp. in poultry meat has also been a priority in the EFTA states visited. The main measures implemented involved the freezing or heat treatment of meat from Campylobacter-positive broiler flocks, either on the basis of legislation or of a voluntary plan, the implementation of specific national control programmes in close collaboration with the industry, and the implementation of measures targeting poultry primary production. Competent authorities and the industry consider the national action plan as the driving force to control colonisation of broiler flocks with Campylobacter.*

*Enhanced biosecurity measures implemented in broiler farms, together with good practices in farming systems such as efficient cleaning and disinfection, control of movement of people and equipment, limited partial depopulation, and education of farmers and their staff contribute to a low Campylobacter prevalence in poultry flocks. As a result, industry and competent authorities alike consider cross-contamination during the slaughtering process a minor risk, provided hygiene requirements are respected. Based on current trends, competent authorities of the EFTA states visited consider their action plan effective in reducing Campylobacter prevalence in poultry products.*

*It is important to note that the poultry production systems in the Member States visited differ considerably from those in the EFTA states visited.*

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**ABBREVIATIONS AND DEFINITIONS USED IN THIS REPORT**

<b>Abbreviation</b>	<b>Explanation</b>
AMR	Antimicrobial Resistance
CA / CCA	Competent Authority / Central Competent Authority
<i>C. coli</i>	<i>Campylobacter coli</i>
<i>C. jejuni</i>	<i>Campylobacter jejuni</i>
DNA	Deoxyribonucleic Acid
EC	European Community
EFSA	European Food Safety Authority
EFTA	European Free Trade Association
EU	European Union
EURL	European Union Reference Laboratory
FBO	Food Business Operator
FCI	Food Chain Information
HACCP	Hazard Analysis Critical Control Points
IID	Infectious Intestinal Diseases
ISO	International Organization for Standardization
MS	Member State/s
NMKL	Nordic Committee on Food Analysis
NRL	National Reference Laboratory
PCR	Polymerase Chain Reaction
PHC	Process Hygiene Criterion
RASFF	Rapid Alert System for Food and Feed
ST	Sequence Typing
VIDAS	Vitek Immunodiagnostic Assay System

## 1 INTRODUCTION

Currently there is no specific EU legislation for official controls on *Campylobacter* spp. A specific microbiological criterion (process hygiene criterion at slaughterhouse level) was adopted into EU law in August 2017 amending Regulation (EC) No 2073/2005. General requirements on the monitoring of zoonoses and zoonotic agents, including *Campylobacter* spp., are described in the zoonosis Directive 2003/99/EC of the European Parliament and of the Council on the monitoring of zoonoses and zoonotic agents, amending Council Decision 90/424/EEC and repealing Council Directive 92/117/EEC<sup>1</sup>. Full legal references to EU legal instruments quoted in this report are provided in Annex I and refer, where applicable, to the last amended version.

This overview report provides a summary of the outcome of a Directorate-General for Health and Food Safety project carried out between 2015 and 2016 on *Campylobacter* in poultry. The project comprised fact-finding missions in three MS where tackling of *Campylobacter* has been a priority for the competent authorities (CA) over recent years. These fact-finding missions were performed with the agreement of the CAs. The EFTA Surveillance Authority carried out missions in two EFTA states at the same period.

The information gathered during the missions is summarised in this overall report which describes the measures implemented in the countries visited in order to tackle *Campylobacter* and the main conclusions noted. When other sources of information are used these are referenced as footnotes in the report.

It has to be pointed out that the poultry production systems and situation in the MS visited is not comparable to the ones of the EFTA states visited:

- In the MS, they usually include big farms with several poultry houses, with different levels of integration, and normally practice indoor farming (from 72-95% depending on the country). Limited official data exist at the moment on the level of prevalence of *Campylobacter* at farm level in the EU;
- In the EFTA states visited, the farming system is characterised by small and/or medium-sized family farms. In most cases, these farms consist of single poultry houses. Flock-prevalence of *Campylobacter* is kept at low levels.

## 2 OBJECTIVES

The objectives of this short series were to gather and identify any measures/actions put in place in those countries (e.g. by CAs, stakeholders) for preventing/reducing or eliminating *Campylobacter* risk in the production and distribution of poultry meat as well as to identify any good practice that could contribute to this goal.

## 3 BACKGROUND INFORMATION

The public health burden caused by campylobacteriosis is of major concern and discussions on how to better address the risk linked to this pathogen are taking place at EU level.

***Campylobacteriosis is the most frequently reported food-borne illness in the European Union (EU) since 2005***<sup>2</sup>.

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<sup>1</sup> OJ L 325, 12.12.2003, p. 31 - 40

Campylobacteriosis is a bacterial diarrheal disease, with a high incidence in the EU population and has become a persistent problem. While there is clear evidence of decrease in the incidence of *Salmonella* in humans (a drop of 50% in cases compared to 10 years ago), the reported cases of *Campylobacter* are steadily increasing. The number of reported confirmed cases of human Campylobacteriosis, in 2015, was 229,213 with an EU notification rate of 65.5 per 100,000 population. However, the true number of cases of illness is likely to be 10 to 100 times higher than the reported number, as there is a considerable under-detection and under-reporting (due to gaps in the notification systems, lack of symptoms, lack of hospitalisations, etc.). This provides an actual number of cases believed to be around 9 million each year (1 in 50 EU citizens suffers from an incident of campylobacteriosis annually). Considering the high number of human cases, the severity in terms of reported case fatality is low (0.03 %).

The cost of campylobacteriosis to public health systems and to lost productivity in the EU is estimated to be around €2.4 billion a year<sup>3</sup>. In addition, the emergence of resistance to antimicrobial agents of some strains of *Campylobacter* spp. is of great concern.

***Evidence suggests that much of the campylobacteriosis disease burden is associated with the presence of Campylobacter in poultry production and its supply chain.***

*Campylobacter* is part of the natural gut microflora of most food-producing animals. It is a commensal organism in many avian species, such as chickens, in which it remains asymptomatic and lifelong with a small decline in older birds. It is known to be widespread in the EU broiler production sector but prevalence rates vary considerably across Member States (MS).

According to an EU-wide baseline survey<sup>4</sup> that was carried out at slaughterhouse level in 2008, the prevalence of *Campylobacter*-colonised broiler batches was 71.2% and that of *Campylobacter*-contaminated broiler carcasses was 75.8%.

Typically, each contaminated poultry carcass can carry 100 to 100,000 *Campylobacter* cells. Given the fact that up to 500 *Campylobacter* cells can cause infection to human, poultry meat poses a significant risk for consumers, particularly when it is mishandled during preparation or undercooked. Poultry meat may directly account for 20% to 30% of human cases of Campylobacteriosis, while 50% to 80% may be attributed to the poultry reservoir as a whole (i.e. contact with live birds and/or via the environment in areas with high poultry concentration). Over 80% and approximately 10% of the human cases are caused by *Campylobacter jejuni* (*C. jejuni*) and *Campylobacter coli* (*C. coli*), respectively.

***In order to implement an intervention policy, the main risk factors contributing to human infections from Campylobacter must be recognised<sup>5</sup>:***

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<sup>2</sup> The European Union summary report on trends and sources of zoonoses, zoonotic agents and food-borne outbreaks in 2015: <https://www.efsa.europa.eu/en/efsajournal/pub/4634>

<sup>3</sup> EFSA explains zoonotic diseases: <http://www.efsa.europa.eu/en/topics/factsheets/factsheetCampylobacter>

<sup>4</sup> Analysis of the baseline survey on the prevalence of *Campylobacter* in broiler batches and of *Campylobacter* and *Salmonella* on broiler carcasses in the EU, 2008: <http://www.efsa.europa.eu/en/efsajournal/pub/1503.htm>

- The risk of colonisation of live broilers by *Campylobacter*.

Contamination of farms with *Campylobacter* "comes always from outside" (other animals, people, water, manure, etc.). Day old chicks are *Campylobacter* free (no vertical transmission has been documented) and colonisation starts after the first 2-3 weeks of age. Once *Campylobacter* is introduced into the poultry house, the organisms spread very quickly, often reaching a prevalence of 100% within a few days. Additionally, the number of these bacteria in the gut, faecal material and in litter can be extremely high with counts as high as 9.0 log<sub>10</sub> (10<sup>9</sup>) colony forming units per gram.

- The risk of contamination of carcasses during processing (slaughterhouses).

This is related to the existence of positive poultry flocks and the conditions and/or the practices followed in the slaughterhouse. The risk of contamination of carcasses with *Campylobacter* and for high *Campylobacter* counts on carcasses varies significantly among slaughterhouses (certain slaughterhouses are more capable than others in preventing and/or in controlling the contamination by *Campylobacter*<sup>6</sup>). These differences may be linked to different slaughtering practices, the impact of specific process operations (e.g. scalding, defeathering, evisceration, washing and chilling) and the hygiene design of the equipment<sup>7</sup> used.

- The risk of cross-contamination (e.g. from raw to cooked products) during food preparation at professional catering and domestic kitchens.

Undercooking of chicken is of less importance as contamination is usually on the surface and the survival of the pathogen during cooking is rare.

Consumers can diminish the risk of falling ill from potentially contaminated food by following good personal hygiene and food handling practices. The main risk factors are related to the inadequate refrigeration of food, the poor washing of hands and surfaces such as cutting boards and dishes, the close contact of raw meats with other foods and the cooking of food to inadequate temperatures.

## 4 OVERVIEW OF MAIN FINDINGS AND CONCLUSIONS

### 4.1 LEGISLATION AND NATIONAL MEASURES

During these missions, up-to-date information was gathered on existing national legislation and national measures adopted in the MS and EFTA states visited concerning *Campylobacter*:

- In one MS, a 2009 national law set a compulsory process hygiene criterion (PHC) in minced meat and meat preparations based on poultry meat intended to be eaten after heat treatment. This criterion requires testing of five (n) samples of products at the end of the production line. When at least one sample exceeds the limit of 100 cfu/g, food business operators (FBOs) should take corrective actions

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<sup>5</sup> EFSA 2011, Scientific Opinion on *Campylobacter* in broiler meat production: control options and performance objectives and/or targets at different stages of the food chain: <http://www.efsa.europa.eu/en/efsajournal/pub/2105.htm>

<sup>6</sup> EFSA 2010b, Analysis of the baseline survey on the prevalence of *Campylobacter* in broiler batches and of *Campylobacter* and *Salmonella* on broiler carcasses, in the EU, 2008 - Part B: <http://www.efsa.europa.eu/en/efsajournal/pub/1522>

<sup>7</sup> EFSA 2005, Opinion of the Scientific Panel on biological hazards (BIOHAZ) related to *Campylobacter* in animals and foodstuffs: <http://www.efsa.europa.eu/en/efsajournal/pub/173>

for rectifying the situation (i.e. improve production hygiene and selection of raw materials).

- In another MS, FBOs have implemented a voluntary PHC at slaughterhouses. The PHC requires testing of five (n) individual breast skin samples post chill. The sample results are unsatisfactory when more than 3 (c) values are between 1,000 (m) and 10,000 cfu/g (M) and/or one sample is above 10,000 cfu/g. The PHC sampling plan is combined with samples taken from the appendix of 10 birds from the same flock.
- In the third MS, joint initiatives between the CA and the industry are implemented, based on a CCA strategy to reduce *Campylobacter* on poultry meat as part of a five year plan. These initiatives include specific interventions, initially focused on primary production (enhanced biosecurity) and later at slaughterhouse and retail points. The CCA introduced a limited number of incentives and rules, permitting flexibility for industry actions.
- In one EFTA state, national legislation for domestic production specifically targets *Campylobacter* and requires freezing for at least two weeks or heat-treatment of all meat from *Campylobacter*-positive broilers flocks before their distribution, under the responsibility of the FBO. The national control programme for *Campylobacter* in poultry, mandatory since 2002, has been established jointly by the CA and the poultry industry. The programme aims at preventing the distribution of chilled poultry meat positive for *Campylobacter* and defines interventions jointly agreed upon by the CAs and poultry industry, mainly targeting primary production (enhanced biosecurity). Under this programme, FBOs intending to distribute chilled poultry products are required to sample every flock on the farm throughout the year by taking one aggregate sample of ten fresh faeces from each poultry flock within five days preceding slaughter, and every slaughter batch at the slaughterhouse between 1 April and 31 October, by taking a pooled sample of the appendix of ten chicken carcasses/ ten neck skin samples for turkeys.
- In the other EFTA state, a voluntary surveillance programme, jointly financed by the CA and the industry with specific mitigation measures targeting *Campylobacter* spp. in broilers slaughtered before the age of 51 days has been in place since 2001. Mitigation measures in place are mainly implemented in the poultry primary production (enhanced biosecurity). Farmers sample every broiler flock within five days preceding slaughter for detection of *Campylobacter* spp. from May to October. The samples consist of ten swabs of fresh faeces pooled in an aggregate sample. Meat from broiler flocks found positive for *Campylobacter* is subject to freezing at -18 °C for at least 3 weeks or to heat-treatment.

The specific national measures adopted by the MS visited are focused mainly on actions at slaughterhouse and/or post-slaughterhouse level. When a process hygiene criterion, under national legislation or on a voluntary basis, is applied, it refers to a specific point of the poultry production chain. It aims to stimulate the poultry processing industry to monitor the contamination level and to seek appropriate corrective actions.

In the EFTA states visited, national measures mainly target primary production.

## 4.2 MITIGATION MEASURES IN PLACE

### Measures at farm level

The colonisation of live broilers by *Campylobacter* is related to specific risk factors in primary production<sup>8</sup>. These risk factors include the age of birds, poor biosecurity conditions and the partial depopulation of flocks for slaughter, the slaughter season (with higher risks in the summer), the farming of multiple species and the farming method used (a broader list of these risks factors are presented in Annex II)

The CAs/FBOs have given special emphasis on biosecurity and husbandry conditions, in order to reduce the *Campylobacter* prevalence at farm level. They explained that, in their view, simple actions, already established in EU legislation on food hygiene and animal health, are important and should be taken into account in order to reduce the prevalence of *Campylobacter* spp. in poultry fattening farm.

As regards biosecurity these include:

- choice of site/premises design;
- hygiene and tidiness;
- entry procedures for poultry houses;
- pest control;
- cleaning and disinfection, and
- waste disposal.

**Picture 1 & 2** Single barrier house entry systems



The majority of the CAs met stated that, based on their experience, no specific mitigation measures, exclusively targeting *Campylobacter*, have been successfully implemented at farm level until now.

However, the CAs also detailed **good practices** that, in their view, could prevent the introduction and spread of *Campylobacter* spp. within and between poultry farms:

- Enhanced biosecurity measures that, when applied consistently over time, limit the sources of introduction of *Campylobacter* into the houses. These measures could comprise (*inter alia*):

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<sup>8</sup> See footnote number 4

- Stricter entry procedures, such as the implementation of a double barrier system. Under this practice, personnel entering a poultry house have to cross two 50 cm-high barriers, change into house specific shoes/cloths and wash and disinfect hands between houses.

**Picture 3.**

Double barrier house entry system



- Limiting to an absolute minimum the introduction of supplies, equipment and litter into a house, during the fattening period. Everything moves in before birds arrive and stays there until the house is depopulated. In cases where dead birds had to be removed and disposed of, only dedicated containers were used in or outside the poultry house or special hatches were used to remove the corpses without personnel having to enter/exit the house. Adequate quantities of feed and other supplies are appropriately stored inside the house before the housing of the new flock and are intended to last until the end of the flock cycle.
- Use of fly nets (especially during the summer months). Fly nets are considered to have an impact in limiting the introduction of *Campylobacter* in poultry houses. This applies especially in mixed farms where other animals such as cows are reared in close proximity to poultry houses and when other breaches of biosecurity have been excluded.
- Coverage of the ventilation/air inlets of poultry houses with an insect proof mesh (mesh size 3 mm, wire diameter 0.94 mm).

Information provided by the EFTA Surveillance Authority:

Some farmers in the EFTA states visited highlighted the importance of catching practices for limiting the introduction of *Campylobacter* by reducing movements of people, equipment and crates into the houses. For example, in some farms, catching was organised with two teams, and birds were slid outside through an opening protected by a flap. This practice reduced personnel movement in and out of poultry houses and transportation crates were never brought inside. In other farms, the flock was physically separated in two groups inside the poultry house from day one to facilitate catching when partial depopulation was practiced.

- Improved husbandry systems aimed at limiting the spread of *Campylobacter* within a flock (after introduction in a house) or within a farm:
  - Automatic adjustment of poultry house humidity and maintenance of it between 60-70% (for broilers). In some cases, indirect heating employing biomass was used inside the sheds. The control of the humidity level

produces a less favourable environment for the survival of *Campylobacter* (dry litter).

- Storage and covering of the poultry litter at a distance from a poultry house in order to avoid the contamination of other houses in proximity via insects, pests or the air. In addition, when it is used as a land fertiliser (for cultivation or green fertiliser) the litter is composted before being spread.

Information provided by the EFTA Surveillance Authority:

- Cleaning and disinfection of poultry houses and crates between flocks as a measure for mitigating *Campylobacter* and proper drying of houses following cleaning, and before continuing with disinfection. Use of low-pressure washers to avoid uncontrolled splashing. In a farm visited, floors were heated allowing shortening of the drying period, down to a few hours, between cleaning and disinfection.
- UV disinfection and acidification of water.
- Use of disinfectants alternated with fumigation in the bird houses.

**Picture 4 & 5.** House fly nets



The CAs of the MS noted that, so far, categorisation of flocks into high and low risk or identification of a single possible cause of introducing *Campylobacter* into sheds had not been achieved. Their experience shows that even with strict biosecurity conditions and efforts made in avoiding any introduction of equipment and litter into the shed during the fattening period, *Campylobacter* contamination of flocks could not be avoided. Seasonal trends, with higher level in summer months, seem also to be very common.

The CAs pointed out that other important aspects to be considered are the training of farmers/farm personnel and the incentives offered to farmers:

- The farmers' attitude is very important and, in some cases, in-house training courses focused on measures to prevent the introduction and spread of *Campylobacter* spp. within poultry farms had been organised either by the CAs or by major processors. Web-based training programmes and biosecurity guides have also been used for this purpose.
- Providing incentives to farmers for more advanced biosecurity measures and improved management. The CAs explained that since the colonisation of birds

with *Campylobacter* does not represent an animal health/welfare issue and, therefore, it does not impact negatively on birds' growth or feed conversion rate, *Campylobacter* is not considered an important problem for many farmers in terms of animal production. FBOs met during the visits stated that in some cases, financial incentives are paid by the processors/poultry business operators to farmers based on some measurable criteria that indicate good management practices i.e. litter quality (dryness), less hock burns and pododermatitis in broilers.

The CAs noted that existing poultry production systems, as well as some **commercial practices, compromise the implementation of effective mitigation measures for *Campylobacter* at farm level.** Currently, some important measures/practices for tackling *Campylobacter* seem to be difficult to broadly implement in a practical way.

These are, in particular, the following:

- **Partial flock depopulation or thinning:** It is known that the "all in - all out" policy can limit the introduction of *Campylobacter* into farms<sup>9</sup>. In this regard, the CAs and FBOs highlighted that some of the main problems for tackling *Campylobacter* at farm level arise from the partial depopulation of houses. This very common practice consists of removing part of the flock before the end of the rearing period (5 to 7 days before) allowing the remaining birds to increase their weight.

European Food Safety Authority's (EFSA) research has shown that batches originating from partially depopulated flocks carried higher levels of *Campylobacter* due to the stress of the birds and breaches of biosecurity during thinning. Moreover, when the mission teams visited poultry farms that implemented complete flock depopulation it was noted that, in combination with enhanced biosecurity measures, the levels of *Campylobacter* spp. were significantly lower when birds were tested at the slaughterhouse.

The CAs and the FBOs in MS further explained that it would be difficult to apply complete flock depopulation of poultry houses at once as this practice would require huge investments in building new houses. In one MS, the CAs explained that it would be necessary to increase the number of houses by 20-25%, which is not practical, or to reduce the number of birds fattened per house: it was calculated that the number of broilers per house should be reduced by 30-35%.

- **Production systems, procedures followed between the housing of different flocks:** The cleaning and disinfection of houses after depopulation is crucial in order to guarantee that a broiler house is *Campylobacter*-free before the stocking and therefore to avoid colonisation of the new flock. In older facilities, proper cleaning and disinfection might be difficult, requiring more effective procedures to be followed. Another issue that possibly adds to the difficulties of cleaning is that current cost models and intensive production systems require short empty periods (usually one week or less) between depopulation and the introduction of new birds. This:

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<sup>9</sup> See footnote number 4

- could hinder the ability to carry out additional cleaning and disinfection if needed,
- does not offer adequate time for the broiler house to dry before the repopulation (lack of humidity is important for the mitigation of *Campylobacter*),
- does not allow proper cleaning/disinfection of feeders and drinkers (disassembling - reassembling and treatment of all surfaces with a suitable antibacterial agent in line with manufacturer's instructions).

Swab tests for total bacterial count are used to verify the efficacy of cleaning and disinfection during empty periods but most of the time the results are only available after repopulation with a new flock.

- Catching of birds: considering that the personnel and materials entering the house must be *Campylobacter*-free, the catching procedures during partial or final depopulation are of great importance. Deficiencies during these procedures which may create problems for tackling *Campylobacter* include the poor hygiene level of catchers, the movement of catchers between different farms during the same day, difficulties to clean and disinfect modules and crates (either under the responsibility of farmers or the slaughterhouse) and poor hygiene of equipment used during catching (e.g. automatic catchers and forklifts).
- Maintenance of biosecurity conditions: The implementation of strict biosecurity conditions is difficult to maintain at all times. The most common set-up noted during the visits of the mission teams were indoor closed poultry houses with one simple barrier system at the point of entry. Changing of cloths and washing/disinfection of hands was done before passing this barrier. However, both the mission teams and the CAs agreed that some elements of personal behaviour by the farmer or conditions commonly met in poultry farms could have a negative effect in the maintenance of the biosecurity measures. Examples include:
  - the use of different shoes but of same clothing by the farmer for the different houses of the farm,
  - the lack of fly catchers in the entrance of the house,
  - the lack of change of liquid disinfectant or the use of disinfectant without previously cleaning one's shoes,
  - the lack of washbasins or not washing hands before entering the houses,
  - gaps beneath the barrier allowing outside to inside contamination,
  - the existence of vegetation in close proximity with the house,
  - the storage of the litter close to the farm houses, etc.

However, in their opinion most of these measures are difficult to broadly implement in a practical way due to the current commercial practices.

Concerning ***free range and organic farming*** the CAs met explained that since very few tests results (all based on limited retail sampling) are available for these types of production systems, the data available does not provide convincing evidence to support the theory that birds with access to range are more contaminated than birds reared using conventional farming systems. In one MS, some FBOs explained that, based on their

own sampling experience, high levels of *Campylobacter* spp. are found in free range broilers whereas in organic broilers levels are usually lower (possibly due to the older age of these birds at slaughter).

Concerning *other transmission routes attributed to chicken reservoir as a whole, other than broilers*, the results obtained from a surveillance project, carried out in 2015, in one MS, showed that the prevalence of *Campylobacter* at laying hen farms was 82%. In another MS, the mission team was informed that the caecal levels of *Campylobacter* spp. are significantly lower in fattening turkeys under standard indoor conditions at the time of slaughter compared to the levels in broilers (3-4 logs and 8-9 logs, respectively), a fact attributed to the older age of those birds at the time of slaughter.

The CAs provided *additional information* which showed that a decreasing prevalence of *Campylobacter* in end products usually follows a parallel decrease in prevalence in the number of flocks testing positive. This is one reason why they argue that:

Future research projects should primarily focus on decreasing the prevalence of positive flocks, as a result of which the number of infections in end products via other transmission routes (such as surface water and air) should also decrease.

The mission teams were informed in the MS visited about the progress of such ongoing research projects at farm level (see also Annex IV) in order to:

- Increase resistance of broilers to colonisation (use of additives in drinking water and/or feed (e.g. organic acids and phytochemicals), vaccination, and/or selective breeding, and/or

Reduce the concentration of *Campylobacter* in chicken intestines before slaughter (for example by treatment with bacteriophages or bacteriocins). The use of bacteriophages (naturally occurring viruses that specifically attack and kill bacteria) with the ability to kill *Campylobacter* can minimise the colonisation of chickens. However, the cost and consumer concern over feeding viruses to poultry may limit its acceptance as a viable option.

The mission teams were also informed by the CAs about:

- the development of autogenous vaccines for breeders or enzyme vaccines for broilers that will reduce the adhesion of *Campylobacter* on poultry's digestive tract,
- the use of probiotics in feed or feed additives that will decrease the virulence properties of *Campylobacter* spp. in order to reduce the adhesion of *Campylobacter*, and

The CAs of two MS explained that relevant studies had underlined the fact that *Campylobacter* undergoes genetic changes (due to its advanced system of DNA uptake) and acquires resistance and virulence factors. Therefore, several immunisation strategies (e.g. phage therapy, vaccination) cannot easily be applied as a mitigation measure at farm level.

Moreover, they noted that the disease in humans is related to the specific *Campylobacter* strain implicated and physiological differences between individuals. Campylobacteriosis might not always be caused by the ingestion of high numbers but also small numbers of high virulent strains of *Campylobacter* spp. It was also mentioned

that a containment approach for *Campylobacter* similar to that used for *Salmonella* will not work due to *Campylobacter's* prevalence in the environment.

Additional information provided by the EFTA Surveillance Authority:

In the EFTA states, the farms visited practiced an all-in all-out farming system with a period of one to two weeks between flocks, depending on the farm. The CAs noted that some of the smallest producers who had not adopted this system presented a higher risk of *Campylobacter* contamination, as did farms with a high number of houses/birds and farms carrying out partial depopulation.

In one EFTA state, in order to place chilled poultry meat on the market, producers need to ensure that flocks are free from *Campylobacter*, which is a compelling incentive for the industry to maintain its efforts in keeping a low *Campylobacter* prevalence in poultry and poultry meat along the food chain.

**Measures at processing level**

In order to explore good practices and production improvements at processing level, the following should be taken into consideration:

- the risk factors for *Campylobacter* during slaughter and processing, and
- the specific characteristics of the pathogen: sensitivity in dry conditions and freezing, growth only in low oxygen levels environment and in temperatures between 37 and 42°C, inability to multiply outside an animal host and in foods (for more information see Annex II).

Reducing *Campylobacter* spp. has been an objective for the CAs in the MS through the implementation of specific actions in processing establishments. These actions are considered very important by the CAs in order to commit and activate the FBOs, especially at slaughterhouse level, investigating specific mitigation measures for tackling *Campylobacter*. Collaboration with the FBOs supporting the own-check controls systems is therefore considered vital. The actions encountered at processing level during the missions were:

1. The verification of the implementation of a PHC by the FBOs at the different stages of the poultry chain (at slaughterhouses or at processing establishments) during official controls. In these instances, when the results from samples taken by the FBOs exceed the PHC, remedial measures should be considered, sometimes in coordination with the CAs. These measures mainly focus on hygiene conditions, on optimising the different process steps in slaughter line and on fine-tuning the equipment used.

The application of the PHC aims to control *Campylobacter* presence in specific poultry products. The fact that the poultry industry has been working with this criterion for some years now, has allowed them to have a better understating of *Campylobacter* and to develop tools/strategies in order to reduce the levels.

2. The implementation of new procedures, as part of the modernisation of official controls. One MS was about to launch a pilot programme focusing on the verification (during official controls) of key conditions in processing establishments together with the implementation of a PHC on *Campylobacter* spp. (neck skin samples) by the FBOs. Caecal samples would also be taken from birds arriving in the slaughterhouse in order to assess their contamination level. A modified Food

Chain Information (FCI) document would be produced when sampling is carried out at farm level. The verification of the whole sampling plan will ultimately be part of the official control.

3. The support of FBO own-check procedures aimed at restricting the level of *Campylobacter* contamination.

In MS, interventions at slaughterhouse level are considered necessary both by the CAs and FBOs since they consider it is not possible to eliminate *Campylobacter* spp. at farm level. In this regard, they are investigating the effect of specific interventions during the slaughter process, focusing on certain critical areas that are likely to have a significant influence on *Campylobacter* levels.

In this regard they described, *inter alia*, the following interventions:

- Transport and lairage conditions, with the aim of avoiding re-contamination and reducing recycling of colonising strains from positive to negative farms. In this regard, the cleaning and disinfection of crates, modules and transport vehicles should be effective, leading to visibly clean and disinfected equipment. Hot water and disinfectants in adequate concentrations should be used. The effectiveness of the procedure should be verified through periodic microbiological testing. The use of crates/modules made of non-corrodible material and easy to clean and disinfect are also considered useful. The proper storage of the crates after cleaning and disinfection, for example in areas different from those used for the reception of live poultry and for the cleaning of transportation trucks should be also ensured.

**Pictures 6 & 7.** Cleaning and disinfection of crates



- Control of the conditions in the hanging area, with the aim of minimising bird and air movement into the plant to reduce airborne *Campylobacter* (contamination from "dirty" to "clean" areas).
- Scalding using multiple scald tanks that offer better cleaning of the carcasses and reduce cross-contamination between the different batches as well as the use of a counter-flow of water (water flows against the incoming carcasses), the use of high water flow rate and the agitation of water to reduce the build-up of dry matter and bacteria. The maintenance of a higher temperature of the scald tank (above 55°C) and the replacement of the tank water regularly could have an additional positive benefit.

- Plucking (or defeathering), with proper setting (machinery should be adjusted to suit every load/bird size) and less intense plucking. The excessive pressure placed on carcasses can cause cross-contamination by releasing faecal matter from the cloaca. Plucking fingers should be cleaned effectively and checked daily. Damaged ones should be replaced. An adequate flow rate of water should be used to wash out feathers. Moreover, minimising of both water leakage and air movement into post pluck areas (aerosol control), which can be common problems in poultry slaughterhouses, are important to avoid the contamination of "clean" plant areas. In this regard, the use of specific ventilators to extract the air in the plucking/scalding area and to regulate the air flow was noted in one case.

**Picture 8.**

Plucking fingers



- Evisceration, which should operate effectively in order to avoid contamination of carcasses by intestinal content. It is recommended to set properly and adjust the equipment to the birds' size and to keep birds of similar size together (using flock uniformity practices as for example the sexing of poultry loads). Verification of effective evisceration before the inside/outside wash could be undertaken. For example, the visual monitoring of the number of evisceration failures (perforated or leaking intestines) as a percentage of birds slaughtered within each batch could highlight any problems linked to equipment. Especially for evisceration, the CAs and FBOs stated that some of the problems for tackling *Campylobacter* at slaughterhouse level arise during this step as the machines used are not able to minimise cross-contamination of bacteria through the spillage of gut contents and faeces. In their view the use of different equipment/adjustments could influence the level of contamination of poultry carcasses. The limited feed withdrawal (or the absence of it) during the first depopulation of the birds could further increase the gut spillage (before slaughter, feed is withdrawn from the flock in order to reduce defecation during transportation, to reduce faecal shedding during defeathering and to facilitate evisceration in the processing plant).
- Washing of carcasses using high pressure rinsing and multiple water washing steps. The proper alignment of inside/outside wash nozzles could ensure that water runs over whole carcasses internally and externally. All washers should be checked frequently at all steps of the process. Carcasses should not be allowed to become dry before chilling. Contamination of the carcasses could be higher with water immersion.
- Chilling, which should permit an effective and rapid cooling of poultry carcasses. A rapid drop in temperature is critical for reducing the establishment and adherence of *Campylobacter* on carcasses. During chilling, condensation or water

pooling should be avoided. The use of water sprays in chillers should be avoided as they dramatically increase humidity. UV lighting of carcasses exiting the chiller is also known to reduce the numbers of *Campylobacter* on the skin surface. An appropriate line speed should be used to allow proper chilling.

- Packaging of meat. The CA of one MS explained that a new type of packaging of poultry meat (i.e. roast in the bag packaging) is now widely used by the industry. This allows cooking the chicken without removing the wrapping thereby preventing consumers from having direct contact with the fresh poultry meat. Moreover, the use of modified atmosphere or leak proof packaging for whole poultry carcasses is also widely used with positive results. In a number of establishments visited it was noted that in order to avoid cross-contamination of the outer packaging FBOs had put in place a segregation between packing teams under which staff handling directly raw poultry are not permitted or able to touch packed products.

During the visits in the slaughterhouses the CAs explained that these interventions can contribute substantially in producing poultry carcasses with lower *Campylobacter* levels. They also stressed the importance of layout, design, construction and size of food premises in order to permit adequate hygiene practices and ensure protection against contamination. For example, they explained that a mechanical airflow system should prevent the air from flowing from contaminated areas (plucking and scalding areas) to clean ones (evisceration). Moreover, the layout and the construction of the slaughter line should not permit scalded poultry carcasses to linger in the scalding/plucking area before being transferred to the next clean area, as such a delay could lead to cross-contamination of the outer surface of the carcasses due to mist formation.

**Picture 9.**

Scaled poultry carcasses lingered in the scalding area



The mission teams acknowledged during the visits that certain of these interventions are already part of the existing system of hygiene design and procedures at slaughterhouses, which are based on current EU legislation e.g. proper evisceration, washing of carcasses, avoiding cross-contamination with clear separation of offal and carcasses on the line, proper cleaning disinfection and storage of modules and crates.

In one MS the FBOs presented a number of innovative practices and explained that they already are, or could be, incorporated in slaughterhouses in order to reduce *Campylobacter* spp. levels on poultry carcasses:

- A method that combines the effect of hot steam and ultrasound to reduce the bacterial load on poultry carcasses. A combination of this method with the use of electrolysed water in pilot scale has taken place and preliminary results were

presented to the mission team concerned. The combination of those two methods was found to have even better results compared to those from the individual methods.

- Rapid surface chilling (method that utilises the effect of a cryogenic gas nitrogen to shock chill the outer surface of the poultry carcase at -2 °C, which reduces the bacterial load on the skin). It was explained that this method has not yet been tested on an industrial scale but the preliminary results of a small-scale trial were promising.
- Secondary scalding (method whereby a poultry carcase is submerged in hot water at 82 C for one second, after primary scalding and plucking and before evisceration in order to reduce the bacterial load on the skin). The method has not yet been tested on an industrial scale but trial results presented were positive when the method was combined with no thinning at farm level.

According to the FBOs, the preliminary results of these innovative practices are quite promising although in some cases their use needs to be fully optimised. The FBOs highlighted that such methods should not be used as end-line solutions but should be part of processes in place.

Moreover, the CAs remarked that certain other aspects should be evaluated, as to the effect that these innovative practices might have on the overall appearance of the carcasses, their size and the space required for equipment to be installed, as well as their cost and their compatibility with the fulfilment of other EU hygiene requirements. Regarding the processes already in use, one CA noted that this information is not indicated on the labelling.

The CAs of the MS visited pointed out that the freezing of positive carcasses, which is known to reduce the levels of *Campylobacter* spp. on poultry carcasses, is not considered economically feasible for the type of EU market (requiring fresh whole poultry carcasses).

In one MS, the CAs explained that recent studies performed underline the fact that, due to its simpler genetic features, *Campylobacter* can respond and survive in different and hostile environments (e.g. oxidative stress, starvation, high acidity, heat shock, osmotic stress). In their view, the capability of *Campylobacter* to form biofilms on surfaces and the ability of some strains to successfully survive the slaughterhouse environment are also issues of concern.

#### Information provided by the EFTA Surveillance:

In the EFTA states visited, FBOs generally recognise that efficient mitigation measures for *Campylobacter* should target poultry primary production to reduce contamination of flocks arriving at the slaughterhouse. Considering the low *Campylobacter* prevalence in farm flocks, no specific measures for *Campylobacter* were in place at the slaughterhouse other than respect of general hygiene requirements.

Nevertheless, according to a FBO of one EFTA country, fogging of slaughter line and crates contributed to lowering the risk of *Campylobacter* contamination.

In the case of positive flocks on *Campylobacter* heat-treatment or freezing (for 14 days in one EFTA state, or at least 21 days in the other EFTA state) of meat is carried out in the EFTA states visited.

## Measures at retail level

In the MS the measures at retail level aim mainly to collect data about the *Campylobacter* spp. presence in fresh chicken meat (poultry carcasses) placed on the market through retail sampling programmes and, to a lesser extent, to inform properly operators working at this level of the risks associated with *Campylobacter* and of ways of reducing contamination of poultry meat they handle.

Retail surveys are carried out in all the MS visited with the collection of samples of poultry meat from retail outlets. In one MS, the CAs have been implementing such surveys since 2006.

In one MS the results of the *Campylobacter* tests performed were (at the time of the mission) published on the CA's website. The CA explained that this decision was taken in order to increase public awareness on *Campylobacter* while acting as a strong incentive for retailers, the meat industry and eventually farmers, to take actions to tackle *Campylobacter*.

Several initiatives have been undertaken by the CAs in order to raise awareness of those working in retail services:

- Production and circulation of information leaflets and tailored posters towards the operators working in the catering and food service sectors on the risks related to *Campylobacter* in poultry.
- Provision of specific guidelines, recipes and methods on safe preparation of food by the CAs in relation to products linked to *Campylobacter* outbreaks.

The CAs have also tried to find effective efficient ways to raise consumer awareness on the risks of bacterial contamination of food products. In particular, to inform consumers about the proper handling and cooking of chicken/poultry at home since most incidents are sporadic and occur at household level.

In this regard, they have taken the following actions:

- In one MS, since 2001, national legislation requires pre-packed poultry meat and meat preparations to bear a specific warning message, on which the following wording is legibly displayed in a separate box, in contrasting colours '*Important, don't give harmful bacteria a chance! That is why it is important to ensure that those bacteria do not end up in your food via the packaging, your hands or your kitchen equipment. Make sure the bacteria are killed by ensuring that this meat is fully cooked.*' Regarding this message, a study was performed in 2015, to measure the effect of the warning message on consumers. The study showed that 81% of consumers felt that the message was important and 22% of them intended to improve their food-handling behaviour after reading the message. A variety of publicity activities and specific campaigns (TV, radio, press, partnerships and social media) have been undertaken by the CAs in the MS in order to inform consumers about their role and the measures they can take at home. The CAs consider that messages need to be continuous as impact is short lived.

Usually, advices to consumers refer to the handling of fresh chicken and the avoidance of cross-contamination in general. According to the majority of CAs met the introduction of any messages to the public specifically on *Campylobacter* should take into consideration the potential for causing unnecessary alarm and fear among consumers regarding poultry meat.

In the implementation of such warning policies, the CAs' efforts are to work closely with retailers in delivering simple, clear and consistent messages to consumers on how to prepare and cook poultry in order to reduce the chance of getting ill. Some of the examples noted by the mission teams were:

- The '*Do not wash!*' message which was clearly displayed on the raw poultry packaging and/or on the shelves at retail level in one MS.
- The warning message under the title '*You can't see them, but they can make you sick!*' This nationwide campaign, which is subsidized by the CCA in one MS, can be seen on posters, online through interactive banners on popular websites, as well as on other media. It focuses on the five simple safety tips (regarding purchase, washing, separation, heating and cooling of foodstuff) that consumers themselves can adopt to reduce the number/risk of foodborne infections.

**Picture 10.**

Warning messages towards consumers



#### Information provided by the EFTA Surveillance Authority:

In the EFTA states visited, retail surveys have not been carried since 2006, as the benefits of surveillance at this level were considered not cost-effective compared to surveillance in flocks and at the slaughterhouse.

The CAs periodically publish consumer information on their website and/or social media to help consumers make better-informed choices. The CAs provided general information on *Campylobacter*, good kitchen hygiene and season-related advice to consumers.

In one EFTA state, some FBOs voluntarily inform consumers by adding on the label information on risks of cross-contamination and advice on proper handling/cooking of poultry meat at home.

### **4.3 ZOOSES MONITORING AND REPORTING**

*Campylobacter* remains the most commonly reported gastrointestinal foodborne pathogen in humans in the MS visited.

The data gathered in the MS shows that the implementation of some of the current mitigation measures is not producing the results expected as the human cases in some cases have been steadily increasing during the last years.

In one MS the number of cases has increased despite the fact that specific national measures have been implemented over the last five years. According to the CAs, the recording of this higher level is probably influenced by the increased awareness of the scientific community of the disease and the subsequent increase in its investigation and detection.

The CA of one of the MS visited stated that the illnesses and chronic effects of campylobacteriosis resulted in 3,700 DALYs (Disability Adjusted Life Years<sup>10</sup>) whereas cost of illness was around €76 million euros in 2014.

According to additional data given by one MS, the incidence of Infectious Intestinal Diseases (IID) in general can be substantial, with around 25% of the population suffering from an episode of IID (diarrhoea and/or vomiting) each year. Approximately 50% of these people report absence from school or work because of their symptoms. However, only 2% of the population visit their doctor for IID symptoms each year.

Epidemiological studies, based on population surveys and surveillance data, carried out in two MS, have indicated that the ratio of unreported infections for campylobacteriosis is significantly high. In one MS, this represents 9.3 unreported actual infections and 1.3 unreported medical consultations for every single reported case. In the other MS, 8,015 confirmed cases of campylobacteriosis are estimated to represent around 98,000 actual cases per year.

### Campylobacter infections in humans

According to the data gathered on campylobacteriosis in the MS:

- The major source of contamination of humans is poultry meat. This fact was also supported by a study that took place during the dioxin crisis period, when lower poultry consumption led to a 40% decrease in incidents of human Campylobacteriosis.
- Campylobacteriosis is mostly reported in summer months and more frequently (data from one MS) from the part of the country with the largest poultry population.
- Data from one MS shows that 40% of campylobacteriosis concerns children below 9 years of age and elderly people (above 65). The CA explained that this data could also be related with a tendency by doctors to collect stool samples for analysis from these age groups. Young adults (between 20 and 29 years old) are also a population at risk and this could be related with the higher consumption of poultry meat in this age range.
- The big majority (86%) of the human isolates of *Campylobacter* spp. referred to *Campylobacter jejuni*.
- Regarding the characteristics of human isolates of *Campylobacter*, one CA presented the results of a study that involved the genotyping and characterisation

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<sup>10</sup> Disability Adjusted Life Years (DALY): a unit to measure the overall burden of disease, expressed as the number of years lost due to ill-health, disability or early death.

of *Campylobacter* strains with sequence typing analysis (72 strains isolated from humans and 97 from poultry). According to this study: -

- There is 27.8% of genetic overlap between human and poultry meat strains. This could be consistent with the fact that the poultry is considered as the cause for 30% of incidents of human Campylobacteriosis.
- The genetic diversity is much bigger among poultry meat strains, highlighting that some of these strains are not pathogenic for humans. The disease in humans might not be always associated with the ingestion of high numbers of bacteria but also with small numbers of highly virulent serotypes of *Campylobacter*.
- The human isolates of *Campylobacter jejuni* showed a significant higher antimicrobial resistance (AMR) than the food (broiler) isolates for Ciprofloxacin, Nalidixic acid and Tetracycline. However, AMR increases steadily in strains isolated from poultry meat.

All the MS and EFTA states visited carried out **epidemiological investigations in cases of food-borne diseases**. In this regard, the CAs informed the mission teams that:

- Whether a medical practitioner has reasonable grounds to suspect that a patient is suffering from food poisoning due to *Campylobacter* spp. he/she must notify it to the relevant public health authority. This notification is compulsory in the case of outbreaks (where two or more human cases are involved) and the incident of campylobacteriosis is laboratory confirmed.
- Due to the survival and growth characteristics of *Campylobacter* (inability to multiply on food) the cases of campylobacteriosis in humans are mostly sporadic and not cases of outbreaks. This makes it much more difficult to trace back the original source of food contamination and exposure to the pathogen.
- When patients with diarrhoea are referred to doctors and hospitals, stool samples for *Campylobacter* spp. are routinely taken in 2 of the 3 MS visited, although this is not compulsory. In one MS the CA explained that this is covered by the medical insurers and has led to a significant increase of the stool samples taken. In the EFTA states, there was no strict protocol requiring general practitioners to take stool samples for *Campylobacter* detection as it depended on their clinical judgment. However, in one EFTA state, stool samples sent to the laboratory for bacteriological faecal examination were routinely examined for *Campylobacter*.
- One of the outcomes of a relevant study carried out in one MS suggests that the doctors are more likely to take a stool sample and/or have improved in recording episodes of IID for those using primary healthcare services nowadays compared to the situation in the past.
- In the MS the obligation to provide a medical certificate in order to justify absence from work varies between one to seven calendar days, both for public and private sector employees. In the EFTA states visited, this obligation depended on the employer.

The CAs met highlighted the fact that some of these factors (which vary between the different MS), could have an impact on the incident rates reported by the MS. Such examples are the obligation and modalities for presenting a medical certificate in case of absence from job/school and the practise of taking routine samples or not.

In two MS the **occurrence of *Campylobacter* in different animal populations** was investigated. The CAs explained that:

- two different projects regarding *Campylobacter* prevalence in laying hens and fattening pigs were carried out. According to the results obtained, *Campylobacter* prevalence was 82% and 92,7% respectively. *Campylobacter coli* (*C. coli*) was mostly isolated from fattening pigs whereas both *C. jejuni* and *C. coli* were isolated from laying hens
- *Campylobacter* isolates were identified from sheep (215), cattle (75), dogs (142), cats (10), birds (2), antelope (1) and rabbit (1). The two avian isolates were identified as *C. coli*.

During the missions, the CAs highlighted the importance of a system that enables MS to gather comprehensive and reliable data concerning campylobacteriosis incidences. According to the CAs, foodborne outbreak investigations should be carried out whenever it is necessary and should be supported by a good communication system between CAs responsible for human health and food safety in order to facilitate the exchange of information and cooperation during those investigations.

#### 4.4 SAMPLING AND ANALYSIS

Sampling plans aiming to monitor the presence of *Campylobacter* in poultry populations and poultry meat are carried out in the MS visited either by the CAs or by FBOs.

In EFTA states sampling plans are almost exclusively carried out at primary production level by the FBOs.

##### Official sampling plans

In the MS, national sampling plans are implemented enabling CAs to have a comprehensive picture of the levels of *Campylobacter* spp. at different production stages and to evaluate the success rate of the public health goals set. These plans include retail surveys and sampling at different stages of poultry meat processing (target monitoring).

The analysis of the results of these plans together with the information received by the CAs, show that:

- The percentage of poultry meat (neck skins) with the highest level of contamination (i.e. more than 1,000 cfu/g) ranges from 14,9 to 22% at the end of the processing phase and during distribution.

This level of contamination is in general stable over the last few years and since the 2008 EFSA survey.

- The data collected are not always comparable, as different parts of poultry carcasses or products derived therefrom are sampled (neck skin, breast skin or different kind of poultry meat cuts and poultry products), with quite different levels of contamination. In one MS the CAs explained that their objective is to sample the most popular poultry cuts/pieces (e.g. breast meat) and not the most frequently contaminated part of the carcase (based on the pathogens epidemiology).

Skinless portions such as breast fillets and slices contain lower *Campylobacter* counts than portions with skin. Breast skin samples are less contaminated than neck skin samples. Moreover, the presence of *Campylobacter* on poultry carcasses is commonly considerably higher than on meat cuts or raw meat preparations.

- The level of *Campylobacter* contamination on poultry carcasses decreases at retail in comparison with the levels in the slaughterhouses (post chill). Despite the high contamination levels at the end of slaughter (in one MS 22% of carcasses above 1,000 cfu/g), the results from retail level revealed much lower levels (in the same MS 2.5 % of poultry products with skin above 1,000 cfu/g)

This has mainly to do with the inability of *Campylobacter* to multiply in certain environments and its natural decrease in numbers with time.

More specifically regarding the retail surveys (as part of the national monitoring plans) in the MS, it was noted that:

- It is not always feasible to take neck skins samples at retail level as some processors are removing this part of the poultry carcasses before placing it on the market. It was explained that this practise is done at slaughterhouse level in order to allow better chilling and drainage of water used during inside washing. This makes also difficult the comparison between different processors/retailers.
- The presence of *Campylobacter* on the outer packaging of chicken products (whole chicken) was considered by the CA as posing a health risk, therefore testing of packaging was also included as part of the retail survey. In this case 6.8% of the outer packaging samples tested positive for the presence of *Campylobacter*.
- In some MS the retails surveys included other types of meat (pig, lamb, veal and beef). However, no elevated levels of *Campylobacter* were detected.

In two MS the national sampling/monitoring plans for *Campylobacter* do not cover live chicken. The CAs explained that previously they took caecal samples at slaughterhouse level. However, as the level of contamination was very high, and the presence of *Campylobacter* at farm level was considered ubiquitous, they decided to stop testing at this stage.

In the other MS, the CA introduced an on-farm *Campylobacter* sampling scheme which included various broiler farms across the country. The aim was to empower farmers to better understand their own flock status and to identify ways which may contribute to reducing flock incidence of *Campylobacter*. Farmers were asked to take boot swab samples 24 hrs before initial and at final depopulation when appropriate, following specific instructions and using the materials provided.

**Picture 11.**

Neck skin sampling



Sampling plans implemented by the FBOs

FBOs have been carrying out sampling plans at the different levels of poultry meat production chain in MS visited. In slaughterhouses and processing establishments, these are implemented in the context of relevant measures applied by the CAs (see also legislation and implemented mitigation measures) or under FBO own-check plans.

A small number of examples of sampling plans implemented by FBOs at farm level, for the detection of *Campylobacter*, was also presented to the mission teams.

A summary of the FBOs sampling plans in the MS and in EFTA states visited and their results are summarised in Annex III.

Laboratory capability and methods of analysis:

All three MS and EFTA states have designated laboratories for the analysis of *Campylobacter* spp. on samples collected by CAs in the context of the national sampling/monitoring plans.

During the visits to the laboratories the laboratory personnel explained briefly the different elements of microbiological analyses of *Campylobacter*. *Campylobacter* is recognised as a bacterium "difficult to handle" in a laboratory because of its specific atmosphere growth requirements. The importance of the ongoing research on new testing applications was also explained. In this regard, some new molecular tests for the rapid detection and identification of *Campylobacter*, and the use of chromogenic agar as an alternative to the media prescribed in the ISO methods, were described.

The designated laboratories are accredited, or are in the process of being accredited, for the enumeration of *Campylobacter* spp. based on EN/ISO/TS 10272 Part 2: 2006-Colony-count technique as recommended by the EU Reference Laboratory (EURL). An alternative rapid chromogenic agar method was used in one designated laboratory, and this was included in the list of approved methods established by the National Reference Laboratory (NRL). The CA noted that this method is validated by the NRL against the ISO one and provides for easier counting of colonies and the availability of results in a shorter time period. Moreover, it allows the short term storage of sample plates (under refrigeration) after incubation.

Information provided by the EFTA Surveillance Authority:

At the time of the visits to the EFTA states, the laboratories were not carrying out enumeration of *Campylobacter*, as only detection was required by the national control programmes.

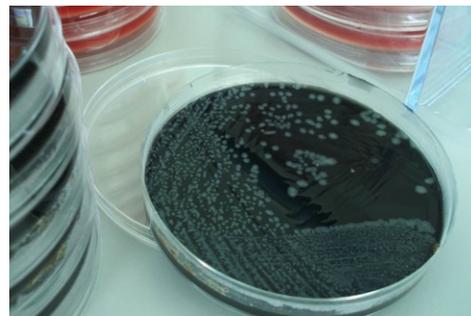
In one EFTA state, one of the designated official laboratories, which is also the NRL, is accredited for *Campylobacter* detection and identification on meat, egg, feed, animal

excrement and swabs with NMKL method 119, 3rd Edition, 2007 (modified), EN/ISO 10272 Part 1 and 2 (modified), and Stern N.J. et. al. (1992, Journal of Food Protection Vol. 55.). The other two official laboratories used are accredited for *Campylobacter* detection based on NMKL method 119, 3rd Edition, 2007, in food. The mission team noted that the official laboratories, apart from the reference and validated methods, used other rapid methods for the detection of *Campylobacter* spp.

In the other EFTA state, there are two official laboratories analysing samples for detection of *Campylobacter* in the framework of the national control programme. The analytical method used for faecal samples taken at farm is qPCR based on *Detection of Campylobacter spp. in chicken faecal samples by Real-Time PCR*, Lund,\* Nordentoft, Pedersen, and Madsen. *Journal of Clinical Microbiology*, 2004, p. 5125-5132, Vol. 42(11). The laboratory explained that there had been an in-house verification of this method, which has a sensitivity of 100-150 CFU /mL in a faecal suspension. Caeca pooled samples taken at slaughter are analysed using the accredited method ISO 10272-1:2006. Isolates of suspect colonies are confirmed and identified by Maldi-Toff. Although poultry products were currently not analysed, one laboratory was accredited for NMKL method 119, 3rd Edition, 2007, for enumeration of *Campylobacter*, with a sensitivity of 100 CFU/g.

**Picture 12.**

Typical *Campylobacter* colonies on plates according to ISO 10272



The CAs provided the following information about the different methods used:

- New molecular tests were used for the rapid detection, such as:
  - VIDAS (Vitek Immunodiagnostic Assay System) method (diagnostic test that is validated according to ISO 16140)
  - RT-PCR (Real Time - Polymerase Chain Reaction) method.

The CAs explained that the designated laboratories used them for the detection and the enumeration of *Campylobacter* spp. in samples (e.g. boot swabs). However, certain limitations and uncertainties exist in each method (e.g. problem of false results due to DNA of dead cells).

- Commercially available ring tests for *Campylobacter*.
- A semi-quantitative method (quick PCR test using loop mediated isothermal amplification (LAMP) is widely used by the poultry industry, mainly for on-farm testing (boot swabs), and can be performed quickly and easily (results are available within an hour)).

The CAs informed the mission teams on the use of sequence typing analysis (ST) for the genotyping and characterisation of *Campylobacter* strains. ST was also used to characterise the genetic overlap between human and poultry strains in addition to the restriction fragment length polymorphism (flaA-RFLP) and Clonal Complex Typing techniques.

## **5 MEETINGS WITH SECTOR REPRESENTATIVES**

During the missions, the mission teams had meetings, organised by the CA of the MS visited, with representatives from the farmers, the poultry industry and retail. In these meetings information was gathered about the actions taken from their side in order to tackle *Campylobacter*, exchanged views and shared their experiences.

In particular, they presented a number of measures that have been taking place at different levels (farm, slaughterhouse and retail) in order to produce fresh poultry carcasses with lower levels of *Campylobacter* spp. In general, they expressed their commitment to this collective effort and noted that any future interventions should not be exclusively end-line solutions but should be implemented progressively along the poultry meat production chain and in broad consultation with all interested stakeholders. Any implementation costs should, in their view, be spread across all operators in the sector.

In this regard, they also mentioned some difficulties encountered and suggested relevant topics that would benefit from further research (e.g. on the role of species other than poultry, as well as pets and the environment, on the cost/benefit parameters of new practical interventions, on the application of recent innovations).

Moreover, they highlighted that in their opinion any future regulatory measures to be put in place at EU level (e.g. PHC) should be accompanied by specific guidelines, in particular concerning the corrective actions needed in cases of contaminated carcasses and poultry flocks. This is considered crucial for these measures to be effective and to facilitate their implementation by FBOs.

### Information provided by the EFTA Surveillance Authority:

In the EFTA states visited, the stakeholders' representatives expressed their commitment to reduce *Campylobacter* prevalence in poultry products and informed the mission team that they had obtained good results. They considered that the main interventions to mitigate *Campylobacter* should target farms so as to reduce the level of contamination of flocks arriving at the slaughterhouses. Furthermore, they considered that cross-contamination at slaughter was not significant if general hygiene requirements were respected. They believed that possible interventions for mitigating *Campylobacter* at slaughterhouses, such as the introduction of a process hygiene criterion or chemical decontamination, had limited benefits in a country with low *Campylobacter* prevalence in poultry.

## **6 ACTIONS TAKEN OR PLANNED BY THE COMMISSION'S SERVICES**

In a parallel process with these fact-finding missions an amendment of Regulation (EC) No 2073/2005 on microbiological criteria for foodstuffs was adopted, establishing specific microbiological criterion (process hygiene criterion) at slaughterhouse level for *Campylobacter*.

## ANNEX 1 – LEGAL REFERENCES

<b>Legal Reference</b>	<b>Official Journal</b>	<b>Title</b>
Reg. 178/2002	OJ L 31, 1.2.2002, p. 1-24	Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety
Reg. 882/2004	OJ L 165, 30.4.2004, p. 1, Corrected and re-published in OJ L 191, 28.5.2004, p. 1	Regulation (EC) No 882/2004 of the European Parliament and of the Council of 29 April 2004 on official controls performed to ensure the verification of compliance with feed and food law, animal health and animal welfare rules
Reg. 2073/2005	OJ L 338, 22.12.2005, p. 1-26	Commission Regulation (EC) No 2073/2005 of 15 November 2005 on microbiological criteria for foodstuffs
Dec. 1082/2013/EU	OJ L 293, 5.11.2013, p. 1-15	Decision No 1082/2013/EU of the European Parliament and of the Council of 22 October 2013 on serious cross-border threats to health and repealing Decision No 2119/98/EC
Dir. 2003/99/EC	OJ L 325, 12.12.2003, p. 31-40	Directive 2003/99/EC of the European Parliament and of the Council of 17 November 2003 on the monitoring of zoonoses and zoonotic agents, amending Council Decision 90/424/EEC and repealing Council Directive 92/117/EEC

## **ANNEX 2 – Risk factors of *Campylobacter* contamination**

(According to EFSA and relevant scientific publications)

### Farm level

The colonisation of live broilers by *Campylobacter* is related to specific risk factors in primary production. Specifically, these are: -

- Increasing bird age. Contamination is rare below 21 days. Close to slaughter date (around 42 days) and until a certain age, bacterial count doubles every ten days.
- Poor biosecurity conditions. The partial depopulation of flocks for slaughter (due to breaches of biosecurity).
- Seasonality. Higher risks in the summer is demonstrated in many countries which are attributed to several factors such as the presence of flies, water run-off and the use of contaminated water, increased ventilation needs, etc.).
- The presence of flocks of various ages in the same farm and farming of multiple species.
- The use of non-potable water.
- The presence of insects.
- Inadequate cleaning of facilities. Disinfection and down-time between flocks.
- The use of antibiotics. This affects the dynamics of colonisation in birds.
- The farming method used. Higher prevalence of colonisation in free-range flocks due to greater exposure to environmental contamination and/or due to the greater age of free-range birds at slaughter.

Feed is not regarded a real vehicle of the bacterium (lack of moisture renders feed a hostile environment for *Campylobacter*). However, *Campylobacter* can survive in water for weeks and persists in run-off from pasture and in waste water from a variety of sources. *Campylobacter* has the ability to survive for considerable periods in the environment, especially in conditions that are moist, cool and out of direct sunlight, making it ubiquitous.

### Processing level

Risk factors and specific characteristics of the pathogen:

- *Campylobacter* is a fragile bacterium, easily inactivated by heat treatment. It is very sensitive to dry conditions and does not survive adequate cleaning and disinfecting procedures. It is killed by oxygen and grows only in environments that have less oxygen levels than the atmosphere. *Campylobacter* grows only in temperatures between 37 and 42 °C.
- The above-mentioned characteristics restrict the ability of *Campylobacter* to multiply outside an animal host. It cannot normally survive on the surfaces of equipment in a meat plant, it does not multiply in foods, e.g. meat samples (at chilled conditions or at room temperature) and its number gradually declines during meat processing and storage. Freezing reduces considerably the number of viable bacteria on raw meat.
- However, because the levels of *Campylobacter* may be very high in live birds coming into a slaughterhouse, it is very difficult to eliminate the pathogen completely from carcasses. High risk materials in poultry slaughterhouses are the caecal content and feathers. The surface of the carcasses is contaminated during

the slaughter process, especially in poultry, where the nature of the slaughter process enables more extensive faecal contamination than in mammals.

- If the contamination of the carcass occurs, then these organisms will be distributed over the carcass surface and survive under the moist, cool storage conditions through to retail level.

## ANNEX 3 – Sampling plans implemented by food business operators

### Sampling plans at slaughterhouses and processing establishments

1. Implementation of a PHC at processing level (meat preparations and minced meat). According to the results of these sampling plans, the level of contamination of these products is very low.
2. Implementation of a voluntary PHC at slaughterhouse level (breast skin samples). The CAs explained that both the CAs and the industry acknowledged the fact that breast skin samples are expected to have a lower level of *Campylobacter* spp. compared to neck skin sample. However, they decided to test breast rather than neck skin because the latter represents a lower risk as it is not normally consumed. Moreover, there is a straight correlation between *Campylobacter* levels on breast skin and levels on breast meat due to their proximity. The results of the first two years of this sampling revealed good results with 10% of breast skin samples above 1000 cfu/g.
3. Implementation of a PHC at slaughterhouse level under a pilot programme of official controls that target *Campylobacter* spp. in one MS (see also measures at processing level). The main characteristics of this programme are:
  - a) Priority testing of flocks that are more likely to be contaminated with *Campylobacter* spp. i.e. flocks that have been previously thinned.
  - b) Collection of two samples from the same batch, one caeca sample and one neck skin sample, in order to verify the compliance of specific production batches and to evaluate any mitigation measures applied at establishment level.
  - c) The results on neck skin will be compared against the PHC for *Campylobacter* set by the CA and corrective actions should be initiated by the FBO in case of unsatisfactory results.
  - d) Occasional testing to be carried out at farm level to assess the prevalence of *Campylobacter* in live birds. The results of the tests would be provided to the slaughterhouse through the FCI document.
  - e) Analyses of the test results of the programme will be undertaken by the CA at a later stage.

The CAs in one MS presented also the results of a sampling programme implemented by the FBOs at slaughterhouse level from 2009 until 2015. This included weekly sampling of breast skin and caecal samples from broiler batches as well as samples from other poultry, i.e. ducks, spent hens and parent birds. In summary, these results were:

- A strong correlation exists between the *Campylobacter* spp. level encountered in the poultry entering the process (caecum) and the results obtained from the end product (breast skin). Generally, there is a seasonal influence on the levels of prevalence with around 30% and 70% of flock found positive during winter and summer respectively.
- Results regarding breast skin have shown improvement over the last few years (5% of breast skin samples above 1,000 cfu/g in 2015 compared to 9.8% in 2009). This was attributed to the knowledge gained by the industry on the pathogen and the investigation of ways to reduce it in the

final product, resulting in an improvement in the hygiene of the slaughtering process.

- The analysis of the data collected, from caecal and breast skin samples, indicated clear differences between products originating from different slaughterhouses. In this regard, it has been observed that during some periods of the year, which did not always coincide with summer months, higher levels of *Campylobacter* contamination have been detected indicating that other causes could be relevant, such as the general hygiene in slaughterhouses.
- Regarding the samples collected from ducks, spent hens and parent birds the results indicated that the majority of these flocks tested were positive. The CA explained that the carcasses of these flocks are usually sold frozen mitigating the *Campylobacter* risk.

During the visits FBOs shared with the mission teams the results of additional sampling plans carried out at slaughterhouse level for *Campylobacter* spp., under their own-check systems, usually on a voluntary basis. These samples consist mainly of neck skin and, to a lesser extent, back and breast skin as they are considered representative of the level of contamination. The majority of the samples are collected post chill. Individual samples from the same batch are usually pooled to form an aggregated sample. Caecal samples are taken to a lesser extent (in one of the three MS) in order to establish a link between caecal and neck levels within the same batch. In a few cases FBOs also sample whole carcasses from retail level and/or collect other environmental samples (mainly swabs for *Campylobacter* spp.).

#### Sampling plans at farm level

A small number of examples of sampling plans implemented by FBOs at farm level, for the detection of *Campylobacter*, was also presented to the mission teams. These refer to:

- Own-check sampling conducted by some farmers in order to know the status of the flocks prior to thinning (and depopulation). Usually this sampling was requested by their customers (slaughterhouses or retail level establishments) and included boot swabs from the individual poultry houses.
- A five year (from 2010 to 2015) plan implemented by a leading retail company in one MS visited. The results indicated very low prevalence of *Campylobacter* at farm level: between 2 and 7% for the last five years and no positive farms in 2015. However, the mission team and the representatives of the CA noted that the results are not reliable as the sampling plan did not take into account the precise epidemiology of *Campylobacter* in order to target its detection (i.e. the sampling of birds was not based on their age). The retail company planned to reorganise the sampling criteria in order to better target the prevalence of the bacterium.

Information provided by the EFTA Surveillance Authority on the sampling plans implemented by the FBOs:

- In one EFTA state, according to the national control programme, FBOs intending to distribute chilled poultry products are required to sample every flock at farm

throughout the year, and every slaughter batch at the slaughterhouse between 1 April and 31 October each year. Apart from sampling carried out by the FBO as prescribed by national rules, CAs did not perform further sampling at farm, slaughterhouses or cutting plants for *Campylobacter* detection. In the other EFTA state, the national control programme foresees sampling by the farmer of every broiler flock within five days of slaughter, from May to October each year. In addition, the CA takes samples in slaughterhouses from each *Campylobacter*-positive flock and flock of unknown status from 1 May to 31 October for monitoring purposes.

#### **ANNEX 4 - Research activities – pilot measures**

During the visits to the MS information was given by the CAs and the FBOs on different research studies:

1. *Epidemiological analysis of Campylobacter data generated in an industry biosecurity study.*

This was launched in one MS supporting a CCA strategy to reduce *Campylobacter* on poultry meat. The aim of the study was to analyse the level of colonisation of poultry batches originating from farms with enhanced biosecurity and from farms with standard biosecurity. Furthermore, the contribution of partial depopulation, empty days between flocks in the houses, type of hybrid, and season to the probability of batch colonisation with *Campylobacter* at high levels was quantified in the research.

The main finding of this study is that biosecurity has a protective effect and it delays colonisation of the flock. However, this effect fades considerably at the time of depopulation. Flocks that had been partially depopulated (thinned) experienced double the higher odds of colonisation at depopulation compared to flocks that had not been subject to partial depopulation. It is likely that thinning itself is in part responsible for weakening the protective effect of biosecurity.

Other key findings of this research are:

The introduction of enhanced biosecurity in all farms could result in up to a 32% reduction in the proportion of highly colonised batches sent to slaughterhouses.

- The risk of batch colonisation exhibits seasonality, with a peak in summer when almost 90% of the studied batches were highly colonised.
- Certain hybrid types of broilers were associated with a higher risk of colonisation, as batches from specific hybrids experienced lower risk of colonisation (48% compared to 70% of others). The differences in *Campylobacter* colonisation between the hybrids may be due to a biological characteristic of the birds, differences in the length of the cycle or unmeasured factors associated with the type of hybrid such as diet or specific husbandry practices.
- A short period (1-3 days) between thinning and depopulation was also associated with a lower risk of colonisation compared to batches for which the period between thinning and depopulation was 7-9 days. A prolonged empty period of more than 3 weeks between the flocks also increased the risk of high colonisation.

2. *A pilot research study on biosecurity, based on a joint initiative by the CAs and the industry.*

This study aimed to test the effectiveness of several elements of enhanced biosecurity and to assess the relationship between selected husbandry factors (thinning, broiler hybrid type and poultry house empty period) and the likelihood of *Campylobacter* spp. colonisation.

Some of the conclusions drawn based on this research were:

- Enhancement of biosecurity in commercial poultry farms can contribute to the reduction of batch colonisation and to the reduction of the highly colonised batches sent to slaughterhouses.

- There is a substantial risk of introducing *Campylobacter* spp. at farm level despite the strict biosecurity conditions (often without being able to identify the source).
  - The risk of flock colonisation exhibits seasonality, with a peak in summer.
  - When thinning is carried-out, the potential impact of increased biosecurity becomes much less apparent.
3. *A quantitative risk assessment of the presence of Campylobacter in meat preparations based on poultry, carried out under the auspices of the CCA.*

This assessment preceded the adoption of a relevant PHC and it mainly covered the assessment of a number of risk factors:

- the epidemiology of the pathogen as regards the food product in question (*Campylobacter*'s survival characteristics and growth ability),
- quantitative and qualitative epidemiological data (exposure and dose response, transmission routes and risk factors of Campylobacteriosis),
- consumption data (importance of meat preparations as a cause of human Campylobacteriosis, their level of contamination during production, the hygiene practices followed by consumers when handling it at home and the extent of inadequate cooking),
- the technical ability and economic burden for the poultry industry to implement the PHC,
- the cost-effectiveness of alternative approaches,
- the relevant official controls involved,
- the sampling and testing methods available for the detection and enumeration of *Campylobacter* and the laboratory measurement uncertainty (measurement uncertainty will be higher around the detection limit of the test method).

The risk assessment team noted that the adoption of a microbiological criterion on specific points of the poultry food chain was one of the limited available options for interventions at farm and slaughterhouse level. Moreover, setting up a “maximum acceptable level of contamination” was an appropriate tool to urgently stimulate the poultry processing industry to monitor the *Campylobacter* contamination level on poultry products.

The contamination level in the MS of poultry meat preparations at the time of the risk assessment was high; 67% of the samples tested were found positive for *Campylobacter* spp. (48% for *C. jejuni* and *C. coli*) while 9% had more than 100 cfu/g *Campylobacter* spp. The risk assessment concluded that if the percentage of preparations above 100 cfu/g fell below 1% the probability of human infection would be thirty times lower.

This report provided also information on specific problems and actions that need to be considered by CAs in order to maximise the benefits of the implementation of a PHC:

- The need for appropriate follow-up actions to evaluate the effectiveness of its implementation (i.e. human cases of Campylobacteriosis),
- The need to collect and analyse quantitative data concerning the consumption of raw poultry meat preparations at national level. This will allow the CAs to define the level of cross-contamination at consumer level,
- The need to implement a national sampling/monitoring plan (evaluation of food contamination levels),
- The need for proper communication and information campaigns in order to point out the hazards of consumption of raw meat and the necessity to cook it

thoroughly. As an additional measure, and depending on the risks, CAs should consider the prohibition of selling specific poultry meat preparations that are to be consumed raw,

- The importance of the information provided to the public, the common habits and level of consumer knowledge concerning food handling. The training of professional food staff should be promoted.
4. An extensive research project that was implemented by a leading slaughterhouse at farm level.

The scope of the project was to investigate the epidemiology of *Campylobacter* and the possibility to apply practical mitigation measures at farm level. According to this research:

- The average prevalence of *Campylobacter* in live birds at slaughter was around 80% (detection level) while this percentage two weeks before slaughter was around 20%. These percentages were found to be significantly lower during the winter (40% and 10% respectively).
- It was not possible to identify the sources of contamination at farm level. Of the 175 farms monitored for 12 months none remained continuously *Campylobacter*-negative over the year. It was noted that even the first flocks housed in newly built farm houses or houses that had to be kept empty for 6 weeks (due to an extensive disinfection following a *Salmonella*-positive flock) were found to be *Campylobacter*-positive.
- Several and different in-house farming methods were tested; with different humidity levels, prolonged age of slaughter (54 days), slower weight gain, etc. Despite the fact that the levels of contamination were lower in some of these cases, these levels did not practically affect the number of pathogens on carcasses.
- Laboratory results obtained were highly influenced even by small changes in the analysis method used.
- The implementation of specific measures such as vaccination and the use of feed additives (e.g. encouraging results have been achieved with the use of butyric acid and medium chain fatty acids) could have an impact lowering the number of pathogens hosted by birds during slaughter. According to the FBO these methods are promising to lower the level of caeca contamination of flocks from  $10^7$  to  $10^4$ .
- One of the main conclusions of this research is that reducing farm contamination with *Campylobacter* is extremely difficult.

5. An extensive research, carried out by the FBO of a big slaughterhouse visited, investigating possible mitigation measures at processing level.

The scope of the research was to investigate the impact of several points or procedures in the slaughter line on *Campylobacter* contamination. An extensive sampling was carried out to assess the impact, for example of: the scalding temperature; the use of water versus steam during scalding; the speed of the slaughter line; the use of spray cooling versus water immersion cooling; the evisceration equipment and the evisceration techniques; the washing of carcasses using water under high pressure; the use of methods of physical decontamination of carcasses (surface steam heating or rapid surface chilling), etc.

According to this research:

- Low level of contamination of flock clearly contributes to low level of contamination of poultry carcasses. Moreover, the possibility of *Campylobacter* contamination of the subsequent negative flock slaughtered (by a previous positive) is limited.
- Significantly different contamination levels exist between carcasses of the same flock but also between the different parts of a carcass (e.g. between neck skin and breast skin). Very low levels of *Campylobacter* were usually found on poultry fillets without skin (with no positive samples at the end of their shelf life).
- It was not feasible for the FBO to identify specific mitigation measures in order to achieve adequate and constant reductions in the level of contamination of carcasses.
- The use of modified atmosphere could have a negative effect on *Campylobacter* reducing its prevalence. However, high oxygen levels could affect the quality of meat.

6. Other research projects partially financed by the CA in the MS visited:

The CAs in the MS visited have taken various initiatives to tackle *Campylobacter* in poultry at different levels for a number of years by engaging the poultry and retail industry and by carrying out and funding both research and public campaigns.

Research project implemented at primary production level were:

- a) The CAMPIMMUN on the immunisation of chickens against *Campylobacter* infections (ends in 2019),
- b) The CAMPYNANOCURE on the protection of chickens against *C. jejuni* by nanobodies of camelids (ends in 2017),
- c) The CAMPOUL on the control of *C. jejuni* colonisation and excretion by broilers by means of organic acids and antibacterial components produced by lactic acid bacteria (ended in 2012),
- d) The CAMPYBRO European project (completed in 2016). The aim of this project was to examine the effects of adding various components to the birds' feed (such as plant extracts, probiotics, prebiotics and organic acids) and to apply this in practice as a tool for reducing the prevalence of flocks testing positive for *Campylobacter*. Within that particular project, research is also being carried out for the development and testing of a vaccine against *Campylobacter*,
- e) The project "Controlling *Campylobacter* within the poultry production chain", which is funded by the business sector and the government. Various research institutions and organisations from the poultry sector are working together on this approved four-year research project. Three topics are covered under the project regarding primary production:
  - Management measures to be used in the primary sector (effective intervention measures, such as fly nets, other fly-defence options and improved biosecurity)

Preliminary results presented to the mission teams regarding this topic indicate that:

- fly nets might have the effect of preventing the introduction of *Campylobacter* in poultry houses especially in mixed farms where other types of animals such as cows are reared in close proximity to the poultry houses;
- strict biosecurity at all times is crucial; and,

- other risk factors e.g. personnel and visitor hygiene, materials/vehicles used, farmers' attitudes and measures to control them should also be taken into account.
- Relationship between the cleanliness of birds plumage entering the process and the level of *Campylobacter* on the final product.

No significant difference was observed in the levels of *Campylobacter* on carcasses in conventionally reared (fast growing) chicken between 'clean' and 'dirty' flocks. Moreover, it has been observed that slower growing broilers had lower levels of *Campylobacter* in neck skin samples post-plucking, pre-chilling and post-chilling, compared to conventionally reared broilers. The reason for that needs to be further investigated.

- Development of a suitable vaccine against *Campylobacter*.

A vaccine development and evaluation is currently being carried out under the project with two vaccine candidates (oral/subcutaneous administration).

- f) A mission team was also informed that further research projects are ongoing in one of the MS visited, for
  - (i) the development of feed additives that will reduce the adhesion of *Campylobacter* spp. to poultry's digestive tract and *Campylobacter* vaccines (autogenous vaccines for breeders or enzyme vaccines for broilers). Preliminary results concerning the use of such feed additives have shown significant (up to three logs) reduction of *Campylobacter* spp. levels in caecal samples.
  - (ii) the use of probiotics in feed that will decrease the virulence properties of *Campylobacter* spp. and therefore minimise the possibility of adhesion.

Research project implemented at slaughterhouse level were:

- a) The CAMPYVAR (from November 2010 to October 2011) focusing on the variability of *Campylobacter* contamination levels for poultry carcasses: identification of risk factors and quantitative monitoring of *Campylobacter* spp. in poultry slaughterhouses, and
- b) the CAMPYTRACE (4-year project, from 2011 to 2015) investigating possible strategies to control *Campylobacter* contamination in slaughterhouses. This project included two different work packages:
  - the enumeration of *Campylobacter* by using the real-time PCR technique after treatment with PMA (propidium monoazide) so that only live cells are counted.
  - the characterisation of *Campylobacter* strains isolated during the slaughterhouse investigations with the use of phenotypic and genotypic typing methods. This work allowed a better insight into the contamination cycles on the slaughter line. The broiler strains were also compared with human strains in order to investigate the overlap of strains present in broilers and the particular parts of broiler strains that cause Campylobacteriosis. This work package was fully financed by the CAs.

The mission teams were further informed by the CAs on the results of these projects, in summary:

- Almost 60% of broiler flocks arriving at slaughterhouses are *Campylobacter* positive and usually broilers are colonised with high numbers (above 7,5 log

cfu/g). However, the level of colonisation in the caecal content and especially the carriage of *Campylobacter* on feathers differ significantly between flocks.

- *Campylobacter* contamination on feathers (and subsequently on breast skin) increases significantly during transport and holding time in the slaughterhouses.
- The variability in *Campylobacter* carcass contamination is high within the same meat batch and between different batches in the same slaughterhouse but not always between slaughterhouses (different results obtained from these two research projects).
- The highest risk materials in the slaughterhouses are the caecal content and the feathers of live birds, while the contamination of carcasses is increased mainly during plucking and evisceration and decreased during washing and chilling (when water immersion chilling is applied). The impact of plucking and evisceration process is bigger when flocks carry low number of *Campylobacter* at the beginning of the process.
- When only *Campylobacter* negative batches are slaughtered, non-contaminated carcasses are produced (i.e. no enumerable levels of  $> 10$  cfu/g)
- When only positive flocks are slaughtered, *Campylobacter* carcass contamination remains at the same level during the process day.
- *Campylobacter* is transmitted from a positive to a subsequent negative batch, but the transmission is restricted and decreases quickly to non-enumerable numbers over time.

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